
Literature Report

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Abstract

Resource extraction with a carbon tax and regime switching prices: Exercising your options

- Energy Economics---2017---Margaret Insley

This paper develops a model of a profit maximizing firm with the option to exploit a non-renewable resource, choosing the timing and pace of development. The resource price is modelled as a regime switching process, which is calibrated to oil futures prices. A Hamilton-Jacobi-Bellman equation is specified that describes the profit maximization decision of the firm. The model is applied to a problem of optimal investment in a typical oils sands in situ operation, and solved for critical levels of oil prices that would motivate a firm to make the large scale investment needed for oil sands extraction, as well as to operate, mothball or abandon the facility. Regime shifts can have an important effect on the optimal timing of investment and extraction. The paper examines the effect of several carbon tax schemes on optimal timing of construction, production and abandonment. A form of Green Paradox is identified.

Google search keywords that best predict energy price volatility

- Energy Economics---2017---Mohamad Afkhami,Lindsey Cormack,Hamed Ghoddusi

Internet search activity data has been widely used as an instrument to approximate trader attention in different markets. This method has proven effective in predicting market indices in the short-term. However, little attention has been paid to demonstrating search activity for keywords that best grab investor attention in different markets. This study attempts to build the best practically possible proxy for attention in the market for energy commodities using Google search data. Specifically, we confirm the utility of Google search activity for energy related keywords are significant predictors of volatility by showing they have incremental predictive power beyond the conventional GARCH models in predicting volatility for energy commodities' prices. Starting with a set of ninety terms used in the energy sector, the study uses a multistage filtering process to create combinations of keywords that best predict the volatility of crude oil (Brent and West Texas Intermediate), conventional gasoline (New York Harbor and US Gulf Coast), heating oil (New York Harbor), and natural gas prices. For each commodity, combinations that enhance GARCH most effectively are established as proxies of attention. The results indicate investor attention is widely reflected in Internet search activities and demonstrate search data for what keywords best reveal the direction of concern and attention in energy markets.

Renewable energy in the equilibrium mix of electricity supply sources

- Energy Economics---2017---Pablo Faúndez

A method to derive the long-run supply curve for a given renewable energy source and technology is proposed. The method accounts for the spatial complexity arising from the distribution of the energy source and the energy transport infrastructure of the territory. The use of the resultant supply curve within the partial equilibrium competitive model for the design and evaluation of renewable energy support schemes and for the determination of optimal supply mixes is illustrated. A case study with the application of the method for wind energy in Rapa Nui (or Easter) Island is presented.

Food-energy-environment trilemma: Policy impacts on farmland use and biofuel industry development

- Energy Economics---2017---Xin Wang,Michael K. Lim,Yanfeng Ouyang

We present a game-theoretic model to analyze the role of two major biofuel policies in the U.S., namely mandates and subsidies, and their implications to biofuel industry development. By characterizing the farmers' land use decision (land allocation among food, energy, and reservation) and biofuel firm's mandate compliance strategy (whether to comply with the mandate or not), we identify the complementarity roles of mandate and subsidy. We further illustrate the impact of coordination in the two policy instruments; lack of coordination may result in excessive biofuel mandate in the early stage of industry development, while it may lead to insufficient mandate during the matured stage. With a case study based on the U.S. Midwest, we address recent trends in the U.S. biofuel industry and further discuss related policy insights.

Does human capital matter for energy consumption in China?

- Energy Economics---2017---Ruhul Salim,Yao Yao,George S. Chen

This article investigates the dynamic relationship between human capital and energy consumption using Chinese provincial data over the period 1990–2010. Considering for cross-sectional dependence and parameter heterogeneity across space and over time, we identify a significant and negative human capital–energy consumption relationship in China. Specifically, we find that a 1% increase in human capital reduces energy consumption by a range between 0.18% and 0.45%. Furthermore, this negative relationship can be attributed to stronger accumulation of post-school human capital in eastern China. This finding suggests that energy conservation in China could be achieved by improving post-school human-capital components such as on-the-job training, experience and learning-by-doing.

Forecasting quantiles of day-ahead electricity load

- Energy Economics---2017---Z. Li,A.S. Hurn,Adam Clements

Accurate load forecasting plays a crucial role in the decision making process of many market participants, but probably is most important for the dispatch planning of an electricity market operator. Despite the competitive forecast accuracy achieved by existing point forecast models, point forecasts can only provide limited information relating to the expected level of future load. To account for the uncertainty of future load, and provide a more complete picture of the future load conditions for dispatch planning purposes, quantile forecasts can be useful. This paper proposes a computationally efficient approach to forecasting the quantiles of electricity load, which is then applied to forecasting in the National Electricity Market of Australia. The proposed model performs competitively in comparison with one industry standard and two recently proposed quantile forecasting methods. One of the main advantages of the proposed approach is the ease with the number of covariates can be expanded. This is a particularly important feature in the context of load forecasting where large numbers of important drivers are usually necessary to provide accurate load forecasts.

Is the recent low oil price attributable to the shale revolution?

- Energy Economics---2017---Erdenebat Bataa,Cheolbeom Park

The U.S. Energy Information Administration estimates that approximately 52% of total U.S. crude oil was produced from shale oil resources in 2015. We examine whether the recent low crude oil price is attributable to this shale revolution in the U.S., using a SVAR model with structural breaks. Our results reveal that U.S. supply shocks are important drivers of real oil price and, for example, explain approximately a quarter of the 73% decline between June 2014 and February 2016. Failure to consider statistically significant structural changes results in underestimating the role played by global supply shocks, while overestimating the role of the demand shocks.

How do daily changes in oil prices affect US monthly industrial output?

- Energy Economics---2017---Abbas Valadkhani,Russell Smyth

Detecting asymmetry has become increasingly difficult using single frequency data. This paper goes beyond the prevailing use of aggregate/averaged data in order to provide a more in-depth treatment of the dynamic effects of the price of crude oil on industrial output growth. To do so, we propose an Asymmetric Mixed Data Sampling (AMIDAS) model to examine if there is any concealed evidence of asymmetry arising from daily effects of the price of crude oil on monthly changes in industrial output in the United States (US). We find that this model is able to detect dynamic asymmetric impacts of a high frequency independent variable on a low frequency dependent variable more effectively than when the high frequency variable is aggregated up at the time interval of the low frequency variable. We find that, in comparison with the marginal lagged effects of a rise in the daily price of crude oil, the effects of a fall in the daily price of crude oil are more sluggish as it takes longer for the effects of the oil price drop to die off over time. This finding implies that a fall in the

price of crude oil shifts the supply curve rightward less and at a much slower pace than an equivalent price rise shifts it to the left.

Analysing energy productivity dynamics in the OECD manufacturing sector

- Energy Economics---2017---Steven Parker,Brantley Liddle

This work aims at developing an understanding of the dynamics of energy productivity. We analyse energy productivities for a sample of 61 OECD country-sector groups in the manufacturing sector over the period 1980 to 2009. We employ two steps of analysis, a preliminary step using a clustering algorithm that sorts countries into groupings or “clubs,” then a second step analysing factors that impact on club membership. We find (i) each group has distinctive dynamics and (ii) evidence that technology structure of production and investment are associated with higher relative energy productivity performance. Further, we find adjusting for energy quality is important.

The relationship between regional natural gas markets and crude oil markets from a multi-scale nonlinear Granger causality perspective

- Energy Economics---2017---Jiang-Bo Geng,Qiang Ji,Ying Fan

This study first decomposes the daily returns of regional gas and crude oil at different time scales, using the ensemble empirical mode decomposition (EEMD) method. It then investigates the causality relationship between each pair of components at the different time scales, by employing the linear and nonlinear Granger causality tests. For the original returns series, this study finds that unidirectional linear Granger causality exists from crude oil markets to North American and European gas markets. However, for nonlinear characteristics, the crude oil and regional gas markets exhibit bidirectional nonlinear Granger causality. On the medium-term time scale, a bidirectional nonlinear spillover effect is found between the markets. The long-term trends for the markets suggest a significant linear

relationship; however, no nonlinear spillover effect is found between the crude oil and regional gas markets.

Supply elasticity matters for the rebound effect and its impact on policy comparisons

- Energy Economics---2017---Hamed Ghodusi,Mandira Roy

We develop a model of the rebound effect which explicitly accounts for both the demand and supply sides of the energy sources. We consider a transportation sector originally using a “dirty” (fossil) fuel and examine the relative effectiveness of alternative policies: efficiency improvements in the dirty fuel technology sector (e.g., CAFE standards) and technology shifts by partial adoption of a new clean technology (e.g., low-carbon fuel standards). The model generates endogenous equilibrium quantities and prices for the dirty and clean fuels. We characterize the magnitude of the rebound effect as a function of demand and supply elasticities and use the equilibrium values to compare policy options. When the supply of the dirty fuel is inelastic, we find that introducing a new technology with non-zero emissions may actually increase the total level of emissions, similar to the leakage effect. A technology shift policy can perform better than an efficiency improvement policy in the dirty fuel sector only when the dirty fuel supply is sufficiently elastic, the emission intensity of the new technology very low, and the technology shift is greater than a threshold value. Using data for gasoline (as a proxy for the dirty technology) and several other cleaner technologies, we show that these conditions are satisfied by a hypothetical zero-emission technology, but not by electric vehicles using the average US generation mix or the current US corn based E85. Our results demonstrate the importance of accounting for the supply side in estimating the magnitude of the rebound effect and its impact on fuel consumption in a large-scale policy implementation.

The price elasticity of U.S. shale oil reserves

- Energy Economics---2017---James Smith,Thomas K. Lee

We formulate a model of shale oil development that identifies how much of the U.S. resource base is likely to be economically viable at various price levels, and what share of potential drilling sites are likely to be exploited. The analysis is driven by the lognormal variability in productivity of individual wells. We find the volume of reserves to be highly inelastic with respect to price. The number of viable drilling sites is less inelastic, which may explain why reserve additions and production fell much less than drilling activity during the recent industry slump.

Forecasting the realized volatility of the oil futures market: A regime switching approach

- Energy Economics---2017---Feng Ma,M.I.M. Wahab,Dengshi Huang,WeiJu Xu

Considering nonlinear and highly persistent dynamics of realized volatility, we introduce Markov regime switching models to the Heterogeneous Autoregressive model of the Realized Volatility (HAR-RV) models to forecast the realized volatility of the crude oil futures market. In-sample results demonstrate that the high volatility regime is short-lived. Out-of-sample results suggest that HAR-RV models with regime switching increase the forecasting ability significantly than those without regime switching. Moreover, these findings are robust for different actual volatility benchmarks, forecasting windows, and model settings.

Lifecycle economic analysis of biofuels: Accounting for economic substitution in policy assessment

- Energy Economics---2017---Boying Liu,C. Richard Shumway,Jonathan K. Yoder

This paper develops a lifecycle economic analysis (LCEA) model that integrates endogenous input substitution into the standard lifecycle analysis (LCA) of biofuel that typically assumes fixed-proportions production. We use the LCEA model to examine impacts of a pure carbon tax and a revenue-neutral tax-subsidy policy on lifecycle greenhouse gas emissions from cellulosic

ethanol using forest residues as feedstock in Washington State. In a model allowing for input substitution in the cellulosic ethanol feedstock, conversion, and transportation process, we consider energy source substitution (woody biomass for coal in the cellulosic ethanol conversion plant and biodiesel for diesel in feedstock production and feedstock and ethanol transportation) as well as substitution of capital and labor for energy in all stages of the lifecycle. We find that ignoring endogenous input substitution by using standard LCA leads to substantial underestimation of the impact of carbon tax policies on carbon emissions. Both tax policies can substantially reduce carbon emissions by inducing substitution among inputs. The revenue-neutral tax-subsidy policy reduces emissions more effectively than the carbon tax policy for carbon tax rates currently in place throughout most of the world. It stimulates substitution of woody biomass for coal and biodiesel for diesel at much lower tax rates when accompanied by corresponding subsidies for reduced emissions from renewable sources.

Consequences of a carbon tax on household electricity use and cost, carbon emissions, and economics of household solar and wind

- Energy Economics---2017---Ahmad F. Ghaith, Francis M. Epplin

The study was conducted to determine the consequences of a carbon tax, equal to an estimated social cost of carbon of \$37.2/Mg, on household electricity cost, and to determine if a carbon tax would be sufficient to incentivize households to install either a grid-tied solar or wind system. U.S. Department of Energy hourly residential profiles for five locations, 20 years of hourly weather data, prevailing electricity pricing rate schedules, and purchase prices and solar panel and wind turbine power output response functions, were used to address the objectives. Two commercially available household solar panels (4kW, 12kW), two wind turbines (6kW, 12kW), and two price rate structures (traditional meter, smart meter) were considered. Averaged across the five households, the carbon tax is expected to reduce annual consumption by 4.4%

(552kWh/year) for traditional meter households and by 4.9% (611kWh/year) for households charged smart meter rates. The carbon tax increases electricity cost by 19% (\$202/year). For a household cost of \$202/year the carbon tax is expected to reduce social costs by \$11. Annual carbon tax collections of \$234/household are expected. Adding the carbon tax was found to be insufficient to incentivize households to install either a solar panel or wind turbine system. Installation of a 4kW solar system would increase the annual cost by \$1546 (247%) and decrease CO₂ emissions by 38% (2526kg) valued at \$94/household. The consequence of a carbon tax would depend largely on how the proceeds of the tax are used.

Has energy efficiency performance improved in China?—non-energy sectors evidence from sequenced hybrid energy use tables

- Energy Economics---2017---Kaiyao Wu, Jiyuan Shi, Tinggan Yang

We conduct a comparative analysis of two energy efficiency indicators for China: heating value energy intensity (HEI) and economic value energy intensity (MEI). We formulate 1997–2002–2007–2012 hybrid energy comparable sequence use tables in an input-output accounting framework, and compare the two indicators using a randomized block ANOVA. The results show that MEIs and HEIs have significantly different variability patterns among sectors and are evolutionarily divergent over time. The directional changes in MEI and HEI are found to be inconsistent at both the sectoral and national levels. A further analysis with a LMDI index decomposition model shows that the difference between HEI LMDI and MEI LMDI is principally caused by energy prices. Based on the evidence from the two indicators and their relationship to energy prices, we are unconvinced about China's purported improvements in energy efficiency in recent years.

A multifactor stochastic volatility model of commodity prices

- Energy Economics---2017---Gonzalo Cor-tazar,Matias Lopez,Lorenzo Naranjo

We propose a novel representation of commodity spot prices in which the cost-of-carry and the spot price volatility are both driven by an arbitrary number of risk factors, nesting many existing specifications. The model exhibits unspanned stochastic volatility, provides simple closed-form expressions of commodity futures, and yields analytic formulas of European options on futures. We estimate the model using oil futures and options data, and find that the pricing of traded contracts is accurate for a wide range of maturities and strike prices. The results suggest that at least three risk factors in the spot price volatility are needed to accurately fit the volatility surface of options on oil futures, highlighting the importance of using general multifactor models in pricing commodity contingent claims.

The macroeconomic rebound effect in China

- Energy Economics---2017---Jiangshan Zhang,C.-Y. Cynthia Lin Lawell

The rebound effect measures the fraction of an energy efficiency improvement that is offset by increased energy consumption. A rebound effect can arise at both the microeconomic level and the macroeconomic level. The macroeconomic rebound effect measures the effect of an increase in energy efficiency on overall energy demand after markets adjust and re-equilibrate. At the macroeconomic level, energy efficiency gains can increase energy consumption through two channels: the macroeconomic price effect and the macroeconomic growth effect. In this paper, we econometrically estimate the macroeconomic energy rebound effect in China. Our results show that there is a statistically significant macroeconomic price rebound effect for China, for each province, and for the short run, intermediate run, and the long run. We also find some evidence of a macroeconomic growth rebound in the short run

and the intermediate run for some years either nation-wide or for some provinces in China; moreover, for some years and some provinces, we cannot reject back-fire. The rebound effect is an important phenomenon that the government of China should not neglect when making energy policy, as it affects how improvements in energy efficiency translate into changes in energy consumption.

Exploring the price dynamics of CO2 emissions allowances in China's emissions trading scheme pilots

- Energy Economics---2017---Kai Chang,Ping Pei,Chao Zhang,Xin Wu

Establishing regional emissions trading scheme pilots in China is a newly transformative and explorative practice. In this paper, we examine the spot price dynamics, asymmetric clustering and regime-switching behaviors of CO2 emissions allowances in the new China-wide emissions trading scheme (CETS) pilots using AR-GARCH, AR-TARCH and MRS-AR-GARCH models. The regional ETS pilots' design in China vary widely in their coverage thresholds, sector coverage, emissions allocation and caps setting methods, market trading rules and price stabilization provisions. Our empirical results indicate that the spot prices of regional emissions allowances exhibit significant dynamic behaviors, asymmetric leverage effects and regime-switching behaviors in the entire period considered; previous market overreactions in the Beijing, Tianjin and Guangdong pilots have stronger price clustering effects on future conditional variances than do the Shanghai and Hubei pilots. Unexpected market shocks and greater persistence in the Beijing, Tianjin and Guangdong ETS pilots display stronger market volatility and higher market risks, and their asymmetric leverage effects display a decreasing trend in the volatility of the BEA, TJEA and GDEA prices. The BEA and SHEA prices exhibit significant regime-switching behaviors, price jumps and higher volatility; in addition, the changes in the regime-switching phases are often related to the political mechanism design and the fundamental market factors. Those empirical results are benefi-

cial for government decision-makers and market participants to strengthen risk management strategies, support emission-related investment decisions and optimize co-benefits of alternative energy-environmental policies.

Revitalising the wind power induced merit order effect to reduce wholesale and retail electricity prices in Australia

- Energy Economics---2017---William Bell,Phillip Wild,John Foster,Michael Hewson

This paper investigates the effect of increasing the number of wind turbine generators on wholesale spot prices in the Australian National Electricity Market's (NEM), given the existing transmission grid, from 2014 to 2025. We use a sensitivity analysis to evaluate the effect of five different levels of wind power penetration on prices, ranging from Scenario A, 'no wind', to Scenario E that includes existing and planned wind power sufficient to meet Australia's original 2020 41TWh Large-scale Renewable Energy Target (LRET). We find divergence in prices between states and similar prices for nodes within states. This supports the Garnaut Climate Change Review assessment on the prevalence of 'gold-plating' the intrastate transmission network and underinvesting in interstate connectivity. We find that increasing wind power penetration decreases wholesale spot prices but that retail prices have increased in deregulated South Australia and Queensland, similarly, in Victoria. We argue that there is a pressing need to split the large generator-retail companies into separate retail and generator companies and to reassess regulatory rules more generally. Interconnector congestion limits the potential for wind power to further reduce wholesale prices across the NEM. So the need for a high capacity transmission backbone in the NEM is becoming clearer and will become pressing when Australia moves beyond its current 2020 LRET.

Energy price variation and competitiveness: Firm level evidence from Indonesia

- Energy Economics---2017---Jun Rentschler,Martin Kornejew

This paper uses firm survey data from the manufacturing and mining sectors in Indonesia, and investigates the extent to which energy prices affect competitiveness (proxied by profitability). Persistent regional price differences due to Indonesia's insular geography enable this study to show that energy prices have a small (but statistically significant) adverse long-run effect on competitiveness – though different energy types matter in different sectors. By estimating cross and own price elasticities and Uzawa-Allen partial elasticities of (inter-fuel) substitution, this study also shows that firms have the ability to respond to higher energy prices by adjusting their energy mix, i.e. substituting certain energy goods for others. Moreover, this study shows that firms also respond to higher energy prices by increasing energy efficiency, and by passing on costs to end-users. Nevertheless, these response measures are not sufficient to fully mitigate the adverse effect of energy prices on firms. Based on these results, policy recommendations are offered which are of immediate relevance for the design of energy pricing reforms.

Nonparametric panel data model for crude oil and stock market prices in net oil importing countries

- Energy Economics---2017---Param Silvapulle,Russell Smyth,Xibin Zhang,Jean-Pierre Fenech

This paper introduces an innovative nonparametric panel data approach to model the long-run relationship between the monthly oil price index and stock market price indices of ten large net oil importing countries; namely, the United States, Japan, China, South Korea, India, Germany, France, Singapore, Italy and Spain. In the proposed model, we allow the coefficient on the oil price index to be a time-varying function which evolves over time in a way that is assumed to be unknown. We also allow the common trend function to evolve over time, as well as extending the model further to incorporate country-specific trend functions. We employ a data-driven local linear method to estimate these time-varying trend and coefficient functions. The results show that, despite being largely positive, there

are several downward trends, reflecting the aftermath of the Iraq war and the recent unprecedented drop in the oil price. Overall, we find that the nonparametric panel data model better captures the way in which the underlying stock-oil price relationship has evolved over time in comparison to the point estimates of the parametric counterpart. Moreover, we find that stock market fundamentals play a significant role in determining the oil-stock price relationship. Our findings have important implication for policymakers and financial speculators.

A regional analysis of carbon intensities of electricity generation in China

- Energy Economics---2017---Nan Liu,Zujun Ma,Jidong Kang

Index decomposition analysis (IDA) has been widely applied to study CO₂ emissions from electricity generation. However, most have focused on emissions at the country level, less attention has been given to emissions at the regional level. To fill the gap, this study firstly utilized a Logarithmic Mean Divisia Index (LMDI) method to analyze the driving forces of aggregate carbon intensity (ACI) of electricity generation in China from 2000 to 2014. A regional attribution analysis was introduced to look into the contributions from 30 provinces to the driving forces. Then, a multi-regional spatial-IDA was further adopted to assess the emission performance of electricity generation in 30 provinces. The results of temporal-IDA and regional attribution analysis show that the ACI in China dropped notably by 14.5% from 2000 to 2014. Thermal efficiency improvement was a major driver for the decrease, due largely to the significant improvement in thermal generation efficiency in the eastern coastal regions. Clean power penetration reduced ACI remarkably as well, of which the western regions were the main contributors. The spatial-IDA results indicate that the emission performance of electricity generation in different regions varied significantly. While the western regions performed better in clean power penetration, the eastern regions performed better in thermal generation efficiency. Based on the findings, several regional policy

strategies were recommended to further lower down ACI of electricity in China.

The uneven development of wind power in China: Determinants and the role of supporting policies

- Energy Economics---2017---Fang Xia,Feng Song

We apply a partial adjustment model to investigate the driving factors of the regional disparity of China's wind power development. We have three major findings. First, similar to many industries, wind power shows an agglomeration effect, that is, existing installed capacity attracts new addition of capacity. Second, demand factors including both local demand, indicated by variables in the local economy, and demand outside the region, indicated by transmission capacity, do not significantly affect the location choice of wind power farms. Lastly, governmental supporting measures have heterogeneous effects on different regions. They are most effective in wind resource rich regions but have little impact in other regions.

Levelized cost of storage — Introducing novel metrics

- Energy Economics---2017---Andreas Belderbos,Erik Delarue,Kris Kessels,D'haeseleer, William

The increasing share of variable renewable generation capacity leads to a growing interest in electricity storage technologies and a summarizing cost metric to analyze the economic viability of such electricity storage units. For conventional generation technologies, the levelized cost of electricity (LCOE) is a well-known metric. In the context of electricity storage however, such LCOE-like metrics are only limitedly applicable as the finite energy storage capacity can limit the charge and discharge scheduling decisions of the storage operator. In addition, the “fuel”, i.e., charged electricity, and “generated electricity”, i.e., discharged electricity, is one and the same commodity which provides the opportunity to use an adapted levelized cost metric. This work analyzes three different levelized cost metrics and their application to electricity storage units

used for electric energy arbitrage. The strengths and shortcomings of these storage cost metrics are analyzed in order to determine how they can be applied correctly. This analysis results in the following recommendations. First, it is recommended to use a levelized cost metric in combination with an analysis of a representative price profile upon which the storage operator will act. This allows a more accurate estimation of the number of charging and discharging hours and the associated charging cost and discharging revenue, given the energy storage capacity constraints of the storage unit. Second, when a number of different representative price profiles, hence with different charging costs, is available, it is recommended to use a cost metric which is independent of the charging cost as this single metric can be compared to each price profile, thereby facilitating the interpretation of the results. The results and conclusions from this work provide a framework on how to use levelized cost metrics in the context of electricity storage. Such metrics may help policy makers and investors in prioritizing energy storage investment decisions.

Production and spatial distribution of switchgrass and miscanthus in the United States under uncertainty and sunk cost

- Energy Economics---2017---Jerome Du-mortier,Nathan Kauffman,Dermot Hayes

The U.S. cellulosic biofuel mandate has not been enforced in recent years. Uncertainty surrounding the enforcement of the mandate in addition to high production and harvest cost have contributed to a delay in the widespread planting of bioenergy crops such as switchgrass and miscanthus. Previous literature has shown that under uncertainty and sunk cost, an investment threshold is further increased due to the value associated from holding the investment option. In this paper, we extend the previous literature by applying a real option switching model to bioenergy crop production. First, we calculate the county-level break-even price which triggers a switching away from traditional field crops (corn, soybeans, and wheat) to bioenergy crops under various scenarios differing by

commodity prices, production cost and biomass price expectations. We show that the resulting break-even prices at the county-level can be substantially higher than previously estimated due to the inclusion of the option value. In a second step, we identify counties that are most likely to grow switchgrass or miscanthus by simulating a stochastic biomass price over time. Our results highlight two issues: First, switchgrass or miscanthus are not grown in the Midwest under any scenario. Under low agricultural residue removal rates, biomass crops are mostly grown in the Southeast. Second, under the assumption of a high removal rates, bioenergy crops are not grown anywhere in the U.S. since the cellulosic biofuel mandate can be covered by agricultural residues.

Forecasting the good and bad uncertainties of crude oil prices using a HAR framework

- Energy Economics---2017---Xu Gong,Boqiang Lin

Good (or bad) uncertainty is the volatility that is associated with positive (or negative) innovations to asset prices. This paper proposes new heterogeneous autoregressive type (HAR-type) models to forecast the good and bad uncertainties of crude oil prices. In this paper we investigate the effects of lagged bad and good uncertainties, daily positive and negative signed jump variations, and leverages on predicting good and bad uncertainties by in-sample and out-of-sample analysis. The in-sample results show that bad and good uncertainties have long memory property, and the predictability of long-term good and bad uncertainties is stronger than that of short- and mid-term good and bad uncertainties. The out-of-sample results indicate that lagged bad (or good) uncertainties, daily positive signed jump variation, and daily negative signed jump variation contain incremental out-of-sample information for forecasting good (or bad) uncertainties, and in most cases lagged leverages also play indispensable roles in forecasting the good and bad uncertainties in the crude oil market. Moreover, the results of out-of-sample analysis remain robust across using the other estimation window, other HAR-type models, and the other sample.

Local acceptance and heterogeneous externalities of biorefineries

- Energy Economics---2017---Gi-Eu Lee,Scott Loveridge,Satish Joshi

Biofuels can potentially reduce lifecycle greenhouse gas emissions from energy use and help address the climate change problem. However, the siting and operation of a biofuel production facility can impact the members of the host community both positively (e.g. local jobs and income) and negatively (e.g. pollution and noise). Such ambivalent and heterogeneous external impacts result in either local support or opposition to the facility, which in turn becomes a key factor affecting biorefinery location decisions, and subsequent success of biorefineries. While a number of prior studies have analyzed economic and environmental impacts of biofuels, systematic analysis of local acceptability of biofuel production facilities is lacking. Our study explores factors that influence community attitudes towards biofuel facilities. We assess the strength of acceptability or opposition by estimating the local community's willingness to pay (WTP) either to support or to oppose a proposed biorefinery. We posit that such WTP estimates provide a more comprehensive measure of local acceptability. Results also suggest that county level socio-economic characteristics significantly influence these attitudes and WTP.

Technological innovation and dispersion: Environmental benefits and the adoption of improved biomass cookstoves in Tigray, northern Ethiopia

- Energy Economics---2017---Zenebe Gebreegziabher,Gerrit van Kooten,Daan van Soest

This paper empirically analyzes adoption and fuel savings efficiency of improved biomass cookstove technology using survey data from a cross-section of 200 farm households from the highlands of Tigray, northern Ethiopia. Results indicate that these farm households are willing to adopt improved biomass cookstove innovations if this leads to economic savings. Moreover, results suggest significant positive environmental

externalities. On a per household basis, we found that adopters collect about 70kg less wood and about 20kg less dung each month. The adoption of improved biomass cookstoves reduces harvest pressure on local forest stands: assuming an average of 120metric tons of biomass per ha, we find the potential reduction in deforestation amounts to some 1400ha per year – an important saving. Further, the reduced use of dung as a fuel has a positive impact on soil productivity in agriculture.

A Bayesian sampling approach to measuring the price responsiveness of gasoline demand using a constrained partially linear model

- Energy Economics---2017---Haotian Chen,Russell Smyth,Xibin Zhang

Partial linear models provide an intuitively appealing way to examine gasoline demand because one can examine how response to price varies according to the price level and people's income. However, despite their intuitive appeal, partial linear models have tended to produce implausible and/or erratic price effects. Blundell et al. (2012) propose a solution to this problem that involves using Slutsky shape restrictions to improve the precision of the nonparametric estimate of the demand function. They propose estimating a constrained partially linear model through three steps, where the weights are optimized by minimizing an objective function under the Slutsky constraint, bandwidths are selected through least squares cross-validation, and linear coefficients are estimated using profile least squares. A limitation of their three-step estimation method is that bandwidths are selected based on pre-estimated parameters. We improve on the Blundell et al. (2012) solution in that we derive a posterior and develop a posterior simulation algorithm to simultaneously estimate the linear coefficients, bandwidths in the kernel estimator and the weights imposed by the Slutsky condition. With our proposed sampling algorithm, we estimate a constrained partially linear model of household gasoline demand employing household survey data for the United States for 1991 and 2001 and for Canada for 2006–2009 and find plausible price effects.

Investing in vertical integration: electricity retail market participation

- Energy Economics---2017---Gabriel Godofredo Fiuza de Bragança,Toby Daglish

Electricity industries are frequently characterised by a high degree of vertical integration. We explore the option for a generator to enlarge its participation in the retail market, and show that the firm will choose to delay if market demand is too high or low. In the former case, high wholesale prices may make fixed price retail customers unattractive, while in the latter, too little revenue is earned to justify the option's expense. Increased volatility can, under some circumstances, lower the value of the option, contrary to conventional real options theory. Firms expand their retail positions more aggressively in concentrated markets, vertically integrated markets, and markets where financial hedging is prevalent.

Modelling UK sub-sector industrial energy demand

- Energy Economics---2017---Paolo Agnolucci,Vincenzo De Lipsis,Theodoros Arvanitopoulos

The importance of considering homogenous economic agents when estimating energy demand functions is recognized in the literature, but so far data availability problems have explained the prevalence of empirical analyses only at an aggregate level. Motivated by the goal of developing the new industrial module to be adopted by the UK government Department of Business, Energy and Industrial Strategy (BEIS) for their econometric Energy Demand Model, we propose the first cointegration analysis that provides evidence on energy demand elasticities with respect to economic activity and energy price at a disaggregated industrial level. While the average of our estimates are comparable to those of the existing literature on the industrial sector as a whole, we find that there is considerable heterogeneity in relation to the long-run impact of economic activity and energy price on energy consumption, as well as to the speed with which firms re-adjust their

equilibrium demand of energy in response to economic shocks. Finally, we learn that long-run disequilibria are tackled through altering the level of energy consumption rather than economic activity, a conclusion that has important implications for policy analysis.

Power it up: Strengthening the electricity sector to improve efficiency and support economic activity

- Energy Economics---2017---C. Di Bella,Francesco Grigoli

Poor performance of the electricity sector remains a drag to economic efficiency and a bottleneck to economic activity in many low-income countries. This paper proposes a number of models that account for different equilibria (some better, some worse) of the electricity sector. They show how policy choices (affecting insolvency prospects or related to rules for electricity dispatching or tariff setting), stochastic generation costs, and initial conditions, affect investment in generation and electricity supply. They also show how credible (non-credible) promises of stronger enforcement to reduce theft result in larger (smaller) electricity supply, lower (higher) government subsidies, and lower (higher) tariffs and distribution losses, which in turn affect economic activity. To illustrate these findings, the paper reviews the experience of Haiti, a country stuck in a bad equilibrium of insufficient supply, high prices, and electricity theft; and that of Nicaragua, which is gradually transitioning to a better equilibrium.

Optimal regulation of renewable energy: A comparison of Feed-in Tariffs and Tradable Green Certificates in the Spanish electricity system

- Energy Economics---2017---Aitor Ciarreta,Maria Paz Espinosa,Cristina Pizarro-Irizar

Incentives for renewable energy based on Feed-in-Tariffs have succeeded in achieving high levels of renewable installed capacity. However, these incentives have not been responsive to market conditions or price

signals, imposing in some cases a great financial burden on consumers when Renewable Energy Sources reached significant levels. A way out of this problem could be a market mechanism where incentives respond to the level of investment on renewables. We explore this issue comparing a regulatory system based on Tradable Green Certificates, able to react to market changes, to a Feed-in-Tariffs incentive scheme. We model the strategic interaction between participants in the electricity pool and the Tradable Green Certificates market and focus on the optimal regulation for the retailer segment, which generates the desired demand for green certificates as a decreasing function of the certificate price. We then calibrate our theoretical model with data from the Spanish electricity system for the period 2008–2013. Simulations show that a green certificate scheme could both achieve the 2020 targets for renewable electricity and reduce regulatory costs. However, the role of regulators is still important, since setting the right target for renewable electricity affects the cost burden of the system.

Directed technical change with capital-embodied technologies: Implications for climate policy

- Energy Economics---2017---James Lennox, Jan Witajewski-Baltvilks

We develop a theoretical model of directed technical change in which clean (zero-emissions) and dirty (emissions-intensive) technologies are embodied in long-lived capital stocks. Switching from dirty to clean innovation leads to ongoing reductions in the relative costs of producing clean investment goods, making them ever cheaper to purchase and so encouraging clean investment. At the same time, falling replacement costs imply falling asset values. Consequently, continuing innovation in capital-embodied clean technologies also generates obsolescence costs, which are borne by users of clean capital. The negative effect of obsolescence costs on demand for clean investment and consequently on the speed of transition to clean growth has been neglected in the literature on directed technical change.

Higher moment risk premiums for the crude oil market: A downside and upside conditional decomposition

- Energy Economics---2017---José Da Fonseca, Yahua Xu

Relying on options written on the USO, an exchange traded fund tracking the daily price changes of the WTI light sweet crude oil, we extract variance and skew risk premiums in a model-free way. We further decompose these risk premiums into downside and upside conditional components and show that they can be partially explained by USO excess returns and, more importantly, these decomposed risk premiums enable a much better prediction of USO excess returns than the standard, or undecomposed, variance and skew risk premiums. A comparison with existing results for the equity index option market further confirms the usefulness of the decomposition for the crude oil market.

Power trade, welfare, and air quality

- Energy Economics---2017---Talat S. Genc, Abdurrahman Aydemir

We use detailed microdata from all generators in the Ontario wholesale electricity market to investigate cross-border electricity trade and its impact on air emissions and welfare (consumer and producer surpluses) in Ontario. Using the technical characteristics of the generators and financial data we run a competition model every hour. We examine how trade expansion across different parts of the interconnected power grid affects the efficiency in the Ontario market. We show that there is a significant welfare gain from power trade. The air emissions savings are also considerable. For instance, when hourly imports double from current levels CO₂ emissions decrease around 13%, and market prices reduce 5.4%. In autarky, CO₂, SO₂, NO_x emissions increase 12%, 22%, 16%, resp., the prices go up 5.8%, and the price volatility rises 12%. However, the impact of negative wholesale prices on market outcomes is small.

Methodological comparison among radial, non-radial and intermediate approaches for DEA environmental assessment

- Energy Economics---2017---Toshiyuki Sueyoshi,Yan Yuan,Aijun Li,Daoping Wang

This study compares three DEA approaches for environmental assessment, all of which are designed to examine the level of simultaneous achievement on economic prosperity and environmental protection, so measuring the degree of sustainability development. DEA, standing for Data Envelopment Analysis, has been widely applied for performance assessment in the past five decades. A new type of applications is referred to as “DEA environmental assessment” and it measures the performance of many organizations that utilize inputs to produce not only desirable outputs (e.g., electricity) but also undesirable outputs (e.g., CO₂). In the previous studies, DEA-based performance evaluation for environment assessment is methodologically classified into radial or non-radial category. Recently, a new “intermediate” approach, analytically locating between the radial and non-radial measures, has been proposed as the third alternative. A use of the intermediate approach has several unique features, all of which cannot be found in the radial and non-radial ones. The new approach measures the degree of unified inefficiency on each production factor and determines the level of total unified inefficiency from the average of the sum of these inefficiency scores. This study discusses the analytical features by comparing the intermediate approach with the radial and non-radial ones. The methodological comparison attempts to convey a message that DEA is indeed an important methodology, but not perfect. Rather, it is an approximation approach to examine the performance of various organizations. Many DEA applications on energy and environment often suffer from a methodological bias, implying that different approaches produce different empirical results. Thus, in guiding a large policy issue such as the global warming and climate change, it is necessary for us to compare several different approaches (e.g., models and concepts) to derive a reliable empirical suggestion. The importance of such a message is

applicable to not only DEA but also the other types of empirical research in natural and social sciences. Therefore, this study discusses the methodological bias issue from the practicality of the three DEA approaches in assessing various concerns on energy and environment.

Dynamic risk spillovers between gold, oil prices and conventional, sustainability and Islamic equity aggregates and sectors with portfolio implications

- Energy Economics---2017---Walid Mensi,Shawkat Hammoudeh,Idries Mohammad Wanas Al-Jarrah,Ahmet Sensoy,Sang Hoon Kang

This paper investigates the time-varying equicorrelations and risk spillovers between crude oil, gold and the Dow Jones conventional, sustainability and Islamic stock index aggregates and 10 associated disaggregated Islamic sector stock indexes (basic materials, consumer services, consumer goods, energy, financials, health care, technology, industrials, telecommunications and utilities), using the multivariate DECO-FIAPARCH model and the spillover index of Diebold and Yilmaz (2012). We also conduct a risk management analysis at the sector level for commodity-Islamic stock sector index portfolios, using different risk exposure measures. For comparison purposes, we add the aggregate conventional Dow Jones global index and the Dow Jones sustainability world index. The results show evidence of time-varying risk spillovers between these markets. Moreover, there are increases in the correlations among the markets in the aftermath of the 2008–2009 GFC. Further, the oil, gold, energy, financial, technology and telecommunications sectors are net receivers of risk spillovers, while the sustainability and conventional aggregate DJIM indexes as well as the remaining Islamic stock sectors are net contributors of risk spillovers. Finally, we provide evidence that gold offers better portfolio diversification benefits and downside risk reductions than oil.

Oil and foreign exchange market tail dependence and risk spillovers for MENA, emerging and developed countries: VMD decomposition based copulas

- Energy Economics---2017---Walid Mensi,Shawkat Hammoudeh,Syed Jawad Hussain Shahzad,Khamis Hamed Al-Yahyaee,Muhammad Shahbaz

This paper examines the short- and medium run dependence structures between oil and currency markets for MENA, other developing and developed countries, using a novel multiresolution decomposition method, namely the variational mode decomposition (VMD), along with a battery of time-invariant and time-varying symmetric and asymmetric copula functions. Further, we assess the downside and upside short- and medium-run risk spillovers from oil to U.S. exchange rate returns and vice versa by computing the conditional Value-at-Risk (CoVaR) risk measures. Before the copula estimations, we apply the spillover index of Diebold and Yilmaz (2012) and network diagrams to identify and select the currencies that are the most significant net contributors or net receivers of returns from/to the oil/currency markets. The copula results show strong evidence of time-varying and high average (tail) dependence between oil returns and the FX markets, which are net transmitters to oil, for the short and medium time horizons. On the other hand, we find average and relatively low dynamic dependence between oil and the net receiver currencies, regardless of the time horizons. Moreover, there is evidence of up and down risk asymmetric systemic risks from oil to currencies and vice versa for some countries in the short-and medium run horizons. Finally, the risk spillovers are asymmetric over time and investment horizons. These results have several important implications for hedging strategies and diversification benefits for oil and FX traders and institutional investors.

Modeling positive electricity prices with arithmetic jump-diffusions

- Energy Economics---2017---Markus Hess

We propose a mean-reverting electricity spot price model of arithmetic jump-diffusion type yielding positive prices. Based on this approach, we derive the corresponding forward and futures price representations. We further discuss different choices for the stochastic mean level process and investigate the long-term behavior of the spot price. In the second part, we take future information available to the traders into account. The latter is modeled by initially enlarged filtrations with respect to (a) the mean level of the spot, (b) the driving diffusion component and (c) the jump term. We also derive forward and futures price representations under these enlarged filtrations. Finally, we consider the evaluation of options in the proposed models.

Forecasting crude-oil market volatility: Further evidence with jumps

- Energy Economics---2017---Amélie Charles,Olivier Darné

This paper analyzes volatility models and their forecasting abilities in the presence of jumps in two crude-oil markets - Brent and West Texas Intermediate (WTI) - between January 6th 1992 and December 31st 2014. We compare a number of GARCH-type models that capture short memory as well as asymmetry (GARCH, GJR-GARCH and EGARCH), estimated on raw returns, to three competing approaches that deal with the presence of jumps: GARCH-type models estimated on jump-filtered returns, and two new classes of volatility models, called Generalized Autoregressive Score (GAS) and Markov-switching multifractal (MSM) models, estimated using raw returns. The forecasting performance of these volatility models is evaluated using the model confidence set approach, which allows us to identify a subset of models that outperform all the other competing models. We find that asymmetric models estimated on filtered returns provide better out-of-sample forecasts than do GARCH-, GAS-type and MSM models estimated on raw return series for Brent and WTI returns.

A fundamental analysis on the implementation and development of virtual natural gas hubs

- Energy Economics---2017---Aurora del Valle,Pablo Dueñas,Sonja Wogrin,Javier Reneses

The ongoing gas market liberalization in Europe has brought up a new competitive environment in which shippers (i.e., companies that are responsible for conveying gas from producers to consumers) must adapt their behavior to the changing conditions. The development of gas virtual hubs increases market interactions among shippers, but the oligopolistic market structure may give room for strategic behavior. The market is in addition segmented by type of costumer. Each shipper maximizes its profit by supplying gas to households, businesses and industries (conventional costumers), participating in the electricity market, trading in the global LNG spot market and interacting with the rest of shippers in a virtual hub. During the hub implementation and development, the following questions arise: How do shippers behave at the different levels of hub maturity? And, to what extent does the implementation of virtual hubs in entry-exit systems diminish the barriers to entry of new market players, provides more flexibility and fosters competition?

The local socio-economic impacts of large hydropower plant development in a developing country

- Energy Economics---2017---Felipe A.M. de Faria,Alex Davis,Edson Severnini,Paulina Jaramillo

Despite extensive discussion in the literature about the socio-economic impacts of hydropower development on surrounding communities, there is (1) a lack of quantitative studies that look at impacts over extended periods of time and (2) a lack of studies including multiple projects in the context of a developing country. Here, we use econometric methods to evaluate the relationship between county-level socio-economic indicators and hydropower development for 56 Brazilian hydropower plants built between 1991 and 2010. We find that counties that built hydropower plants

had greater GDP and tax revenues during their first few years of development than a control group that consisted of counties with hydropower projects planned but not yet built. However, those positive economic effects were short lived (<15years). We also find that social indicators (e.g. average income, life expectancy, educational level, access to piped water and public electricity, teenage pregnancy levels, and HIV cases) in counties that built hydropower did not statistically differ from those in the control counties. The results suggest that, for Brazil, justifications for hydropower projects based on local long-term economic and social development should be questioned, and that more effective mechanisms for turning local short-term economic growth into long-term development are needed.

The impact of the German feed-in tariff scheme on innovation: Evidence based on patent filings in renewable energy technologies

- Energy Economics---2017---Christoph Böhrringer,Alexander Cuntz,Dietmar Harhoff,Emmanuel Asane-Otoo

Over the last two decades, feed-in tariffs have pushed the massive expansion of electricity from renewable energy sources in Germany. Between 1991 and 1999, feed-in tariffs were prescribed through the Electricity Feed-in Law – the so-called *Stromeinspeisungsgesetz* (SEG) – at relatively moderate rates. From 2000 onwards, the SEG was replaced by the Renewable Energy Sources Act – the so-called *Erneuerbare-Energien-Gesetz* (EEG) – with much higher subsidy rates. The rise in subsidies to renewable power generation under the EEG came along with a substantial increase in electricity prices provoking an intense public debate on the benefits of renewable energy promotion. In our regression analysis, we assess one popular justification for feed-in tariffs: the demand-side effect of induced innovation. We find that the innovation impact of the German feed-in tariff scheme over the last two decades supports the positive innovation hypothesis. However, the inducement effect of the feed-in tariff scheme under the EEG is not significantly different from that of the SEG. Given the drastic cost of the EEG, we caution

against the appraisal of the EEG feed-in tariff scheme solely on the grounds of its impact on technological innovation.

Malmquist index measurement for sustainability enhancement in Chinese municipalities and provinces

- Energy Economics---2017---Toshiyuki Sueyoshi,Mika Goto,Derek Wang

This study discusses a use of DEA environmental assessment in a time horizon. We use a radial approach to examine a dynamic change of index measures related to China's regional development and industrial pollution prevention. In applying the proposed assessment to a time-series data, we need to examine components that produce a shift of an efficiency frontier in a time horizon. A unique feature of the proposed assessment is that it incorporates a framework of Malmquist index to examine the frontier shift among multiple periods. Here, the frontier shift indicates a progress potential on technology development and/or managerial improvement among observed periods. Thus, it is not an efficiency measure. Rather, the measurement eliminates inefficiency by shifting an organization to an efficiency frontier. In this study, the index is conceptually separated into 6 subcomponents, which are further disaggregated into 12 different elements (6 subcomponents \times 2 disposability concepts) under natural and managerial disposability concepts. The proposed index measurement needs to consider a possible occurrence of a frontier crossover among different periods because technology diffusion on production activities usually has a time lag until it becomes really effective. Methodologically, this study conveys the message that DEA is an approximation method, so being not perfect. Therefore, it is necessary for us to use several different approaches (e.g., potential improvement by measuring a frontier shift and efficiency analysis) to obtain reliable empirical evidence. As an application, this study examines the level of sustainability related to 30 municipalities and provinces in China from 2003 to 2014. The following six policy implications are obtained in this study. First, all municipalities and provinces have made a

considerable progress on their economies and pollution prevention efforts. Second, the effect of the frontier crossover is limited in China because they attain a high level of their potentials on economic development and pollution prevention. Of course, this effort is within the Chinese boundary, not international, because this study does not compare them with other industrial nations. Third, China needs to allocate its resources to western provinces at a level that it has used for coastal developments. Fourth, the government should reinforce efforts on environmental protection in central and southern regions. Fifth, the government has focused on the sustainability development in urban municipalities and provinces and then has gradually shifted the policy influence toward rural areas. Finally, different empirical results are confirmed by the potential analysis which consists of the Malmquist index measurement and the efficiency analysis. Both approaches need to be examined for future planning on Chinese regional development.

Regime-switching based vehicle-to-building operation against electricity price spikes

- Energy Economics---2017---Lei Zhang,Yaoyu Li

Electricity price may present very large spikes due to imbalance between generation and demand, especially during heavily loaded periods. Such peak price may incur significant cost to building operation. With the vehicle-to-building (V2B) technology, electric vehicle battery can be used as temporal energy source for the building load for a short period, which leads to a possible solution for reducing the energy cost during peak-price periods. In this paper, the problem of reducing the energy cost due to the peak price is approached from the prospective of risk management. A regime-switching based risk management scheme is proposed for the V2B operation based on the availability of electric vehicles (EV) plugged in the parking lots attached to the building. In the low risk regime, the objective is to minimize the EV charging cost. While in the high risk regime, the objective is to reduce the potentially high energy cost due the peak price via the power stored in EV batteries. Based on Markov

regime-switching model, the operation minimizes the conditional value at risk involved. Simulation results show that the proposed framework can greatly reduce the energy cost against the electricity peak prices.

A deep learning ensemble approach for crude oil price forecasting

- Energy Economics---2017---Yang Zhao,Jianping Li,Lean Yu

As crude oil price is influenced by numerous factors, capturing its behavior precisely is quite challenging, and thus leads to the difficulty of forecasting. In this study, a deep learning ensemble approach is proposed to deal with this problem. In our approach, two techniques are utilized. One is an advanced deep neural network model named stacked denoising autoencoders (SDAE) which is used to model the nonlinear and complex relationships of oil price with its factors. The other is a powerful ensemble method named bootstrap aggregation (bagging) which generates multiple data sets for training a set of base models (SDAEs). Our approach combines the merits of these two techniques and is especially suitable for oil price forecasting. In the empirical study, the WTI crude oil price series are investigated and 198 economic series are used as exogenous variables. Our approach is tested against some competing approaches and shows superior forecasting ability that is statistically proved by three tests.

Carbon intensity changes in the Asian Dragons. Lessons for climate policy design

- Energy Economics---2017---Miguel Rodríguez,Yolanda Pena-Boquete

There is a growing political interest in carbon intensity targets because they are the basis for climate pledges from relevant developing countries such as China. They may be also the basis for policy designs in developed countries like EU members. This paper develops a comprehensive econometric study on the main drivers of national emissions intensity in emerging countries in East Asia. This regional focus responds to their pivotal position in global economic growth and remarkable

trends in carbon emissions intensity. The main hypothesis of this paper is that the nature of economic growth has a major effect on carbon intensity trends that deserves some attention. Accordingly, the novelty of this paper is to examine the contribution of “intensive” and “extensive” GDP growth for carbon intensity abatements. Labour productivity is revealed to be the main factor responsible for major carbon intensity reductions by Asian Dragons. Whereas household energy per capita and industrial energy per worker contributed in the opposite direction. Consequently, intensity targets may become “meaningless” for real climate action contributions if they do not take into account labour productivity trends.

Estimation of global rebound effect caused by energy efficiency improvement

- Energy Economics---2017---Taoyuan Wei,Yang Liu

Rebound effect refers to the phenomenon that the actual reduction in energy use and emissions is less than the expected reduction caused by an energy efficiency improvement due to induced behavior adjustment of relevant economic agents. This article studies the global rebound effects on energy use and related emissions caused by an energy efficiency improvement. We adopt a global computable general equilibrium (CGE) model to design a scenario of energy efficiency improvement, which is compared to a business-as-usual (BAU) scenario to identify the global rebound effect. Our results show very large rebound effect on energy use (70%) and related emissions (90%) in 2040 at the global level with regional and sectoral differences. Important determinants, among others, are induced labor movement among economic activities and labor supply, and substitution elasticity between energy and other goods. Labor mobility has a marked impact on both rebound effects and on fuel mix. The global rebound effect is still considerable even with a low substitution elasticity between energy and other goods. The effect of capital accumulation over time contributes marginally to the global rebound effect as it is utilized to promote economic growth by using energy input more efficiently.

Resource rents distribution, income inequality and poverty in Iran

- Energy Economics---2017---Mohammad Reza Farzanegan,Mohammad Mahdi Habibpour

Our goal is to examine the income inequality and welfare effects of the direct distribution of resource rents and subsequent taxation in Iran. We use survey-based microdata that covers 140,000 individuals, which include more than 36,000 Iranian urban and rural households in 2009. We examine how direct distribution of oil and gas rents among all citizens and a subsequent direct income tax differ from distributional impacts of targeted policies on income inequality and poverty in Iran. Our analysis shows that the resource dividend policy with a subsequent direct income tax has a significant decreasing effect on the household Gini index while targeted policies are more effective in reducing number of households under the poverty line.

Can foreign direct investment harness energy consumption in China? A time series investigation

- Energy Economics---2017---Ruhul Salim,Yao Yao,George Chen,Lin Zhang

This study assesses the long-run relationship and short-run dynamics between foreign direct investment (FDI) and energy consumption in China. Applying the bounds testing approach to annual data from 1982 to 2012, we find that a stable FDI–energy nexus exists in the long run and a 1% increase in FDI reduces energy consumption by 0.21%. However, this study shows a positive association between FDI and energy consumption in the short run, attributing to the dominance of the scale effect. Our results remain robust to different measurements and estimators. It is suggested that the Chinese government shall support the inward FDI in the tertiary and energy sectors and strengthen local absorptive capacities to fully internalize FDI-related knowledge spillovers in energy conservation.

Investment and operating choice: Oil and natural gas futures prices and drilling activity

- Energy Economics---2017---Fan Chen,Scott Linn

We present evidence that changes in oil and natural gas field investment measured by drilling rig use respond positively to changes in the futures prices of oil and natural gas, consistent with predictions based upon value-maximizing behavior. These results hold for world regions dominated by private independent oil companies but not national oil companies. In those cases where futures price changes are identified as drivers, the role of spot prices is either absent or weak. The results are robust to several alternative specifications including controls for changes in rig productivity.

The relationship between energy demand and real GDP growth rate: The role of price asymmetries and spatial externalities within 34 countries across the globe

- Energy Economics---2017---Panagiotis Fotis,Sotiris Karkalakos,Dimitrios Asteriou

The aim of this paper is to empirically explore the relationship between energy demand and real Gross Domestic Product (GDP) growth and to investigate the role of regional externalities on per capita Final Energy Consumption (FEC) in 34 countries during the period from 2005 to 2013. The paper utilizes a Dynamic Panel Generalized Method of Moments (DPGGM) approach and spatial econometric techniques in order to analyse the effect of real GDP growth rate on FEC through an Error Correction Model (ECM) and to examine clustered patterns of energy consumption. The results show that a) the demand is elastic both in the industrial and the household/services sectors, b) electricity and natural gas are demand substitutes, c) the relationship between real GDP growth rate and per capita energy consumption exhibits an inverted U-shape for all the sample countries under scrutiny (34 countries, Eurozone and EU28), but not for all the employed sectors of the economy, d) price (electricity and gas) and GDP growth asymmetries are supported from the employed parametric tests, and, e) distance does not

affect per capita FEC, but economic neighbours have a strong positive effect.

Technology invention and adoption in residential energy consumption

- Energy Economics---2017---Giovanni Marin,Alessandro Palma

In this paper we analyse the electricity consumption of a set of four traditional ‘white goods’ in a panel of ten EU countries observed over the period 1995–2013 with the aim of disentangling the amount of technical efficiency from overall energy saving using a stochastic frontier approach. The efficiency trend is modelled as a function of energy efficiency policies and innovation dynamics that combines invention and adoption processes using specific patents weighted by granular production data and worldwide bilateral import flows. Our model also accounts for potential endogeneity arising when innovation processes and economic growth are considered. With this replicable approach, the stochastic frontier framework allows for explicit modelling of innovation processes. Our results show that the efficiency component is related to changes in the energy efficient technological content of appliances. The ‘international’ component represents a predominant share of technological advancement and exerts a significant influence on the transient efficiency. Our evidence calls for an active role to be played by policy makers in focusing on innovation and trade policies in order to achieve more ambitious energy efficiency targets.

Capturing the impact of shocks on the electricity sector performance in the OECD

- Energy Economics---2017---Michael Polemis

This paper focuses on the responses of electricity performance to shocks arising from structural reform policies. With a dynamic panel vector autoregression (pVAR) model that allows endogeneity, we decompose the responses of electricity performance measures to shocks generated by the inclusion of structural reform indicators capturing the effect of competition, regulation and

privatization. The sample spans the period from 1975 to 2011 including 30 OECD countries. The empirical findings do confirm that a robust independent regulatory scheme must be implemented in order to achieve a competitive electricity market. Finally the dynamic pVAR results using impulse response functions and variance decomposition analysis further support the validity of these results.

Good volatility, bad volatility: What drives the asymmetric connectedness of Australian electricity markets?

- Energy Economics---2017---Nicholas Apergis,Jozef Baruník,Marco Chi Keung Lau

Efficient delivery of network services and the electricity infrastructure to meet the long-term consumer’s interests are the main objectives and the strategies of a national electricity market, while the main interests of generators are to maximize their profit through pricing strategies. Therefore, the objective of this study is to explore whether electricity prices across the four Australian States display symmetric price volatility connectedness. The study is the first attempt in the literature to make use of intraday 5-min Australian dispatch electricity prices, spanning the period December 8th, 1998 to May 5th, 2016 to quantify asymmetries in volatility connectedness emerging from good, and bad volatility. The results provide supportive evidence that the Australian electricity markets are connected asymmetrically implying the presence of some degree of market power that is exercised by generators across regional electricity markets.

Do changes in oil prices affect welfare programs? Evidence from Kern County

- Energy Economics---2017---Nyakundi M. Michieka

In this paper, the intertemporal causal relationship between oil prices and welfare programs in Kern County is studied using monthly data between 1999:7 and 2016:8. Results from the autoregressive distributed lag (ARDL)-bounds testing approach show that there is

stable long run equilibrium relationship between CalFresh caseloads, oil prices and unemployment. They also show that adjustment in CalFresh participation due to changes in oil prices and unemployment is slow, and a 10% increase in unemployment led to a 3.3% increase in CalFresh enrollment. Results from a modified Granger Causality method indicated causality running from unemployment to CalWORKs, and no causality from oil prices to CalWORKs participation. The GIRF confirmed that CalWORKs is more responsive to changes in unemployment than to oil price shocks. The FEVDC results demonstrated that contributions of the oil price shocks in explaining variations in CalWORKs were negligible.

The dependence structure across oil, wheat, and corn: A wavelet-based copula approach using implied volatility indexes

- Energy Economics---2017---Walid Mensi,Aviral Tiwari,Elie Bouri,David Roubaud,Khamis Al-Yahyaee

This paper examines the dependence structure between three commodities implied volatility indexes (oil, wheat and corn) during bear, normal and bull markets and at different scales. For this purpose, we combine wavelet and copula methods to analyse the changes of the tail dependence at different scales or investment horizons. The results support evidence of time-varying asymmetric tail dependence between the pair of cereals as well as between oil and the two cereals at different time horizons – short-term horizon, medium term horizon and long term horizon, suggesting that the dependence structure is sensitive to time horizons. These results have important implications for the analysis of portfolio risk management.

Does emission permit allocation affect CO2 cost pass-through? A theoretical analysis

- Energy Economics---2017---M. Wang,P. Zhou

Carbon emissions trading may result in CO2 cost pass-through and its rate is influenced by a number of

factors. This paper theoretically investigates how emission permit allocation affects CO2 cost pass-through rate by developing a Nash-Cournot oligopolistic market equilibrium model. We find that the derived CO2 cost pass-through rates are consistent when grandfathering and auctioning rules are used for permit allocation, which are higher than that for benchmarking rule. It has also been found that the magnitude of CO2 cost pass-through rate is relevant to the type of definition, product market structure and average carbon intensity of the industry. We suggest that policy makers first use benchmarking rule to attract firms to participate at the early stage of emissions trading system (ETS) and then take auctioning rule when ETS is well developed.

The effect of natural gas shortages on the Mexican economy

- Energy Economics---2017---Carlo Alcaraz Pribaz,Sergio Villalvazo

The Mexican economy experienced a shortage of natural gas from the second quarter of 2012 through the second half of 2013. In order to deal with this problem, the state-owned national supplier of natural gas (Pemex) implemented a system that restricts the amount of natural gas used by the manufacturing sector. With this information, we have constructed a “shortage index” that represents the percentage of natural gas restricted per month in each region. We quantify the effect of natural gas shortages on the manufacturing sector and GDP using a panel data model with state and time fixed effects. We estimate that the natural gas shortage reduced Mexican GDP annual growth rate by 0.28 percentage points in the second quarter of 2013.

Social sustainability measured by intermediate approach for DEA environmental assessment: Chinese regional planning for economic development and pollution prevention

- Energy Economics---2017---Toshiyuki Sueyoshi,Yan Yuan

This study examines the level of simultaneous achievement on economic prosperity and environmental protection, so measuring the level of sustainability by a newly proposed intermediate approach. Conventionally, DEA (Data Envelopment Analysis) for performance evaluation was used to assess various economic activities of organizations that utilized inputs (e.g., the number of employees) to yield desirable outputs (e.g., the number of products). The methodology was usually classified into radial or non-radial category. In an effort of extending it to environmental assessment, DEA needs to incorporate undesirable outputs (e.g., the amount of CO₂) into the computational framework. This type of assessment is referred to as “DEA environmental assessment”. The proposed intermediate approach develops a new type of DEA environmental assessment by combining the analytical features of radial approach with those of non-radial approach. The new approach measures the level of unified inefficiency on each production factor and determines the level of total unified inefficiency from the average of the sum of these inefficiency scores. A rank sum test and a mean test are additionally incorporated into the proposed intermediate approach. Such a combination enhances the statistical capability. As an application, this study examines the level of sustainability related to 30 provinces in China from 2003 to 2014. The application finds four policy implications. First, it is important for China to allocate its resources to western provinces at a level that it has used for coastal developments. Second, the government continues to reinforce the policy making effort on environmental protection by paying attention to central and southern regions. The Chinese industries need to transfer toward “green” energy. The transfer should be efficiently executed for their future developments. Third, the government has focused on the sustainability development in urban provinces and then has gradually shifted the policy influence toward rural areas. Finally, the policy implementation needs a time lag until it becomes effective. The time lag on economic policy is longer than that of environmental policy. The economic policy has historically produced a regional imbalance, often leading to educational and income imbalances, among Chinese provinces.

A ladder within a ladder: Understanding the factors influencing a household's domestic use of electricity in four African countries

- Energy Economics---2017---Dil Bahadur Rahut,Bhagirath Behera,Akhter Ali,Paswel Marennya

According to the energy ladder hypothesis, electricity is at the top of the energy ladder of household energy use that depends primarily on wealth status, income and education levels of the users. However, it is often observed that households with higher income, wealth, and education levels do not use electricity for all domestic activities such as lighting, heating, and cooking, creating a ladder within a ladder. Using a comprehensive data set from the Living Standard Measurement Study from four African countries (Ethiopia, Malawi, Tanzania and Uganda), covering >17,000 households, this paper investigates the factors determining a household's adoption of electricity for lighting only and for lighting and cooking. The results of a multinomial logit model and an ordered probit model show that demographic characteristics, a household's wealth and human capital, access to markets and remoteness greatly accelerate a household's use of electricity for light and cooking, which provides evidence of a ladder within a ladder.

Size distribution of national CO₂ emissions

- Energy Economics---2017---Sherzod Akhundjanov,Stephen Devadoss,Jeff Luckstead

We examine the size distribution of national carbon dioxide (CO₂) emissions on a sample of 210 countries and territories for the period 2000–2010. We employ lognormal, double Pareto-lognormal, lognormal-upper tail Pareto, and Pareto tails-lognormal distributions to estimate CO₂ size distribution. The analysis demonstrates that the lognormal-Pareto composite distributions generally fit the size distribution of CO₂ emissions better than the lognormal distribution. The parametric analysis reveals that the upper-tail of CO₂ emissions is characterized by Zipf's law. The power law in the upper-tail implies that large countries emit much of

the CO₂. When controlling for population, Zipf's law no longer holds, but per capita CO₂ emissions still exhibit a strong Pareto upper tail.

Modeling and predicting oil VIX: Internet search volume versus traditional variables

- Energy Economics---2017---I. Campos,G. Cortazar,T. Reyes

As a key variable in option pricing models and monetary policy decisions, volatility is an important factor in valuing and hedging investments. This paper models and predicts the CBOE Crude Oil Volatility Index using Heterogeneous Autoregressive (HAR) models that include traditional macro-finance variables as well as abnormal search volume from Google (ASVI). We find that a pure HAR model fits oil volatility remarkably well. When adding ASVI, we discover that this variable has a significant and positive relationship with oil volatility. This relationship remains statistically significant when traditional financial and macroeconomic variables are accounted for; therefore, ASVI is not only a good proxy for traditional macro-finance variables, but also carries additional information. More importantly, out-of-sample predictions show that ASVI has high economic value, allowing traders of volatility-exposed portfolios to significantly increase returns.

Funding renewable energy: An analysis of renewable portfolio standards

- Energy Economics---2017---Gregory B. Upton,Brian F. Snyder

Thirty states have adopted renewable portfolio standards (RPSs) that set targets for renewable energy generation by mandating that electric power utilities obtain a minimum percentage of their power from renewable sources. Our synthetic control (SC) model finds that states with RPSs have experienced increases in electricity prices and decreases in electricity demand relative to non-RPS states with similar economic, political and renewable natural resource characteristics. While both RPS and non-RPS SCs experienced increases in renewable energy generation over the sample

time period, we do not find evidence that RPS states have experienced increases in renewable energy generation relative to SCs and weak evidence of emissions reductions.

Contagion, volatility persistence and volatility spill-overs: The case of energy markets during the European financial crisis

- Energy Economics---2017---Kostas Andriosopoulos,Emilios Galariotis,Spyros Spyrou

The aim of this paper is to investigate if and to what extent events in financially troubled EU markets (Greece, Ireland and Portugal) affected energy prices during the EU financial crisis. More specifically, (i) we test for contagion effects of bond prices on energy/commodity prices, (ii) we examine whether the nature of energy price volatility is affected and (iii) we investigate whether bond volatility from the financially distressed EU markets spills over to energy/commodity return volatility. Our results indicate the existence of significant contagion effects; notable changes in the nature of energy/commodity volatility during the EU financial crisis; and spill-over effects. The results are robust to the use of short-term yields instead of long-term bond price changes, and to the inclusion of Spain and Italy in the sample.

Composite forecasting approach, application for next-day electricity price forecasting

- Energy Economics---2017---Atom Mirakyan,Martin Meyer-Renschhausen,Andreas Koch

Accurate forecasting of electricity prices can provide significant benefits to energy suppliers when allocating their assets and to energy consumers for defining an optimal portfolio. There are numerous methods that efficiently support the forecasting of time series, such as electricity prices, which have high volatility. However, the performance of these approaches varies depending on data sets and operational conditions. In this work, the concept of composite forecasting is presented and implemented in a retrospective study, in real industrial

forecasting conditions to show the potential of forecast performance improvement and comparable high consistency of a forecast performance across different ‘Day Peak’ and ‘Day Base’ electricity price data sets for different seasons. As individual methods support vector regression, artificial neural networks and ridge regression are implemented. The forecast performances of these methods are evaluated and compared with their forecast combination using different error measures. The results show that composite forecasting processes with ‘inverse root mean squared error’ combination approach can generate, on average, a more accurate and robust forecast than using an individual methods or other combination schemas.

OPEC and demand response to crude oil prices

- Energy Economics---2017---Talat S. Genc

This paper investigates demand response to crude oil price movements before and after the recent global financial and economic crisis. It employs several market power indices to structurally estimate price elasticities. A newly developed market power index for crude oil markets is implemented. In this approach OPEC is the central player and acts as a dominant producer in the global oil market. We quantify how a change in market structure (such as changes in marginal cost of production) would contribute to market power exercise of OPEC and have an ultimate impact on price elasticity of demand for oil. Our price elasticity predictions fall in a range reported in the literature, however estimates for pre-crisis deviate from the post-crisis ones. In fact, demand response to crude oil prices has almost doubled during the crisis. This severe change in price response can be associated with record price levels caused by supply shortages and surge in alternative renewable energy resources. The key advantages of this methodology over the existing literature are that it is simple to use and estimates price elasticity using a competition framework without specifying demand/supply function(s), and utilizes commonly observable market variables that can be applied to any admissible data frequency.

How does daylight saving time affect electricity demand? An answer using aggregate data from a natural experiment in Western Australia

- Energy Economics---2017---Seungmoon Choi,Alistair Pellen,Virginie Masson

Daylight saving time (DST) affects the lives of more than 1.6 billion people worldwide, with energy saving being the original rationale for its implementation. This study takes advantage of natural experiment data from September 2006 to March 2013 in Western Australia in which DST was observed from December 2006 to March 2009, to estimate the effect of DST on electricity demand. Using the difference-in-differences (DD) approach, we find that DST has little effect on overall electricity demand and electricity generation costs. However, it has a strong redistributive effect by reducing electricity demand substantially in the late afternoon and early evening. This redistributive effect of DST may be of particular interest for policymakers who are interested in controlling high demand and the short term energy market price.

Design of yardstick competition and consumer prices: Experimental evidence

- Energy Economics---2017---Peter Dijkstra,Marco Haan,Machiel Mulder

In this paper we analyze the effect of the design of yardstick competition on consumer prices, by means of a theoretical analysis as well as an economic experiment. We compare four different designs: the uniform yardstick, the unweighted uniform yardstick, the discriminatory yardstick, and the best-practice yardstick. The effect of a specific design on prices depends on two separate mechanisms, one which affects the incentive power to increase productive efficiency and another which affects the risk of collusion. We show theoretically that for the best-practice yardstick, which is widely applied in several industries in a number of countries, these two mechanisms point in the same direction (high prices), which is confirmed by the experiment. Both the theoretical analysis as well as the economic experiment show that the discriminatory yardstick results

in lower prices than the unweighted uniform yardstick. The theory, however, does not give a clear answer on the relative performance of the discriminatory versus the weighted uniform yardstick. In the experimental analysis, we find that the advantage of the discriminatory yardstick in terms of giving incentives to improve productive efficiency exceeds the disadvantage of a relatively higher risk of collusion. This conclusion appears to be robust for different degrees of heterogeneity of the industry. Hence the discriminatory yardstick yields the lowest prices for consumers.

Determinants for adoption decision of small scale biogas technology by rural households in Tigray, Ethiopia

- Energy Economics---2017---Haftu Etsay Kelebe,Kiros Meles Ayimut,Gebresilasse Hailu Berhe,Kidane Hintsu

The deployment of biogas energy as alternative energy source can have the potential to fill the gap in the energy needs of the rural community if it is effectively managed and appropriately utilized. Using a logistic regression analysis of cross sectional data, the driving forces for adoption decision of biogas technology by rural households in the Tigray region, Ethiopia, were examined. The study found that the factors that significantly affect biogas adoption decision of rural households were for the most part socio-demographic factors and access to basic infrastructures. Besides, some environmental, institutional and economic attributes were significantly associated with diffusion of biogas technology. From among the variables included in the model, age of household head, family size, level of education, cattle size owned, distance to firewood collection site, access to electricity, access to credit and access to all weather roads were found to positively affect biogas adoption decision of households. On the other hand, distance to the nearest market negatively affected the adoption decision of the households. Female headed households tend more to adopt the biogas technology as compared to their male counterparts. As socio-economic attributes of households and environmental factors are mostly varied contextually and

spatially, the policy of biogas technology promotion should be tailored based on the principle of fit for the purpose instead of the existing unimodal approach for all settings.

Rationality of energy efficiency improvement targets under the PAT scheme in India – A case of thermal power plants

- Energy Economics---2017---Nihar R. Sahoo,Pratap K.J. Mohapatra,Biresh Sahoo,Biswajit Mahanty

The market-based Perform Achieve and Trade scheme was introduced in India to enhance the energy efficiency of energy-intensive sectors, and for thermal power plants by reducing their specific energy consumption within the framework of a tradable certificate scheme. International experience suggests that effectiveness of such schemes is greatly influenced by the assigned targets of the obligated units. Setting rational targets is thus, a key aspect of successful implementation of the scheme. In the present study, we examine the rationality of the targets set for the power sector of India, based on comparing it with energy saving potential of the plants, and the targets assigned to the respective plants. Data envelopment analysis models are used to determine relative efficiency and energy saving potential. The study results indicate that in most cases, (i) The targets are much less than the actual potentials of the thermal power sector, (ii) There exist substantial inefficiencies within the system in both energy use and managerial dexterity; and (iii) If the sector realizes its full potential, then the Energy Saving Certificate market may witness a surplus of 4.7 million certificates on account of thermal power sector alone.

Energy and GHG emission efficiency in the Chilean manufacturing industry: Sectoral and regional analysis by DEA and Malmquist indexes

- Energy Economics---2017---Karen Pérez,Marcela C. González-Araya,Alfredo Iriarte

Global warming produced mainly by the emission of

greenhouse gases is currently a worldwide concern. In the last few decades since the 1950s many of the changes observed in the world climate have been meaningful. This paper presents an analysis of energy efficiency and of greenhouse gas emissions in the Chilean manufacturing industry by region and sector taking into consideration time sequences. Data Envelopment Analysis (DEA) models are used for the analysis. Three ways to handle undesirable outputs are compared, the source of inefficiency in each decision making unit (DMU) is calculated using scale efficiency, and the evolution over time is analyzed using the Malmquist index. The results indicate that the industries located in the Chilean regions of Coquimbo, La Araucania and Aysen were the most efficient while the industries in the regions of Tarapaca, Antofagasta and Biobio were less efficient. The most efficient industrial sectors were those involving communications equipment, base metals, and clothing; the least efficient were those concerned with food and beverages, textiles and nonmetallic minerals. Due to the treatment of the undesirable outputs, differences were found in the efficiency indexes obtained by the three models. This finding suggests using a model better adapted to the characteristics of the outputs in question and the viability of improving industrial practices.

Dynamic fuel price pass-through: Evidence from a new global retail fuel price database

- Energy Economics---2017---Kangni Kpodar,Chadi Abdallah

We estimate the dynamic effects of crude oil price shocks on retail fuel prices, the pass-through, using the local projection approach of Jordà (2005). Using a novel monthly dataset of retail fuel prices in 162 countries over the period from 2000:1 to 2014:12, we find that: (i) retail gasoline prices respond positively to crude oil price shocks, but the responses vary across regions and income groups; (ii) there is also some variation across country groups in the persistence of the effects of crude oil price shocks on retail gasoline prices; and (iii) declines in crude oil prices lead to smaller effects on retail gasoline prices than increases

in crude oil prices, pointing to an asymmetry in the fuel price pass-through.

Measuring national energy performance via Energy Trilemma Index: A Stochastic Multicriteria Acceptability Analysis

- Energy Economics---2017---Lianlian Song,Yelin Fu,Peng Zhou,Kin Keung Lai

The World Energy Council annually releases the Energy Trilemma Index to measure the country-level energy performance. However, the preferences among the trilemma can change from country to country, which always is an undetermined issue and full of controversy. This paper comprehensively considers all possible preferences, and formulates interval evaluation results under certain preference. Such formulations are motivated by the observations that it is difficult to reach a consensus about the weights associated with the trilemma, since different weight elicitation methods inevitably produce different weighting schemes. Therefore, we propose an interval decision making problem and apply a Stochastic Multicriteria Acceptability Analysis to present a holistic measurements of the country-specific energy performance. This differs from the conventional wisdom that assigns exact values to corresponding weights, but explores the weight space to make each country the most preferred one. Our analysis is demonstrated by measuring the energy performance of top 10 countries based on 2015 Energy Trilemma Index.

Where to drill? The petroleum industry's response to an endangered species listing

- Energy Economics---2017---Richard Melstrom

This paper examines the effect of U.S. Endangered Species Act (ESA) regulations on oil and natural gas well drilling in Kansas and Oklahoma. In 2014 and 2015, petroleum companies faced land use restrictions when the imperiled lesser prairie chicken received threatened species-status under the ESA. In Kansas and Oklahoma, as elsewhere, the petroleum industry has been criticized for damaging environmental quality

and developing wildlife habitat. Using data on well locations, I estimate a discrete choice model to measure the effects of ESA regulations on companies' location preferences. While the results show that habitat avoidance increased with regulatory scrutiny, the effect is very modest, which suggests that companies may have discounted the risk of penalties from ESA violations. Results also suggest that pre-listing announcements related to ESA regulations influenced companies' location choice.

Soak up the sun: Impact of solar energy systems on residential home values in Arizona

- Energy Economics---2017---Yueming Qiu,Yi David Wang,Jianfeng Wang

Recent increase of installations of solar energy systems on residential properties begs the question of whether such investments are being recognized by the market. Studies that estimate the impact of solar technologies on home values have been scarce. Using transaction and valuation data for a sample of residential properties in Arizona and matching methodology, results show that solar photovoltaics installation indeed has positive impacts on both house value and transaction prices. This is the first empirical study conducted in Arizona, a state of crucial importance for solar energy development with its abundant solar resources. In particular, properties with electricity-generating solar panels enjoy an average premium of approximately \$45,000 (15% of medium home value) and transaction price premium of \$28,000 (17% of medium home sales price). We do not find a statistically significant premium on homes with solar water heaters alone.

Forecasting the real prices of crude oil using forecast combinations over time-varying parameter models

- Energy Economics---2017---Yudong Wang,Li Liu,Chongfeng Wu

In this paper, we forecast real prices of crude oil using real-time forecast combinations over time-varying parameter (TVP) models with single predictor. We

reveal the significant predictability at all horizons up to 24months. The mean squared predictive error reduction over the benchmark of no-change forecast is as high as 17% and the directional accuracy as high as 0.645. A combination with TVP models is found to generate more accurate forecasts than the same combination with constant coefficient models because the forecast errors of individual TVP models are correlated at a lower degree. We also evaluate the forecasting performance in the framework of density forecasting. Our results indicate that the benchmark model can be significantly outperformed by forecast combination at the horizons longer than 3months.

Income equivalence and a proposed resource rent charge

- Energy Economics---2017---Michael Alexeev,Robert F. Conrad

We demonstrate the equivalence of various income-based charges when perfect certainty prevails, as well as deviations from equivalence under uncertainty. Some of these equivalences are known but the derivations of others, such as cases for two types of free equity, are not. These equivalences lay the foundation for a proposed Accrued Rent Charge (ARC) as an alternative to Resource Rent Taxes (RRT), both as proposed and implemented. We argue that the ARC may be preferred to the RRT because the timing of returns to investors (owners of reproducible capital) and owners of natural assets coincide. That is, returns accrue to owners of natural assets earlier in time with the ARC relative to the RRT. In addition, we argue that, while both charges are inefficient when there is uncertainty, the ARC may be relatively more administratively and economically efficient. Finally, we use simulations to compare the ARC to the RRT and to standard income charges and discuss the results.

The effects of stock market growth and renewable energy use on CO2 emissions: Evidence from G20 countries

- Energy Economics---2017---Sudharshan Reddy Paramati,Di Mo,Rakesh Gupta

The primary objective of this study is to empirically examine the effect of stock market growth and foreign direct investment (FDI) inflows on CO₂ emissions. Further, this study investigates the impact of renewable energy consumption on CO₂ emissions and economic output in a panel of the G20 countries. The empirical analysis was carried out on the full sample as well as on sub-samples of developed and developing economies of the G20 member countries. The results confirm a significant long-run equilibrium relationship among the variables across the panels. Further, the long-run elasticities suggest that FDI significantly reduces CO₂ emissions in the full sample and developing economies while stock market growth reduces in developed economies. Similarly, the renewable energy consumption substantially reduces CO₂ emissions and increases economic output across the panels. Our findings have important policy implications. For instance, the policy makers have to initiate effective policies to promote the renewable energy sources to meet the increasing demand for energy by replacing the use of conventional energy such as coal, gas and oil. This will therefore help to reduce the CO₂ emissions and also ensure sustainable economic development in the G20 nations.

Electricity markets for energy, flexibility and availability — Impact of capacity mechanisms on the remuneration of generation technologies

- Energy Economics---2017---Hanspeter Höschle,Cedric De Jonghe,Hélène Le Cadre,Ronnie Belmans

Increased shares of Renewable Energy Sources (RES) to fulfill ambitious European policy targets, mothballing or decommissioning of existing units, and absent investments lead to concerns about the system and market adequacy. To restore market adequacy, capacity mechanisms (CMs) are widely discussed and implemented in various types. They are intended to provide sufficient and clearly perceivable long-term price signals for available capacity. As integral part of the market, CMs interact with the other markets. Markets like day-ahead markets are used to trade energy. Imbal-

ance markets or reserve requirements are examples for markets for flexibility. Among others, green certificates are in place to value emission-neutral injection from RES. Resulting altered prices and shifting remuneration have effects on all generation technologies. CMs may affect participating technologies by imposing a capacity demand. A resulting change in the generation mix may also have an impact on non-participating technologies. Two gaps can be identified in the discussion and modeling of CMs in the literature. First, proposed game-theoretic equilibrium models fall short in representing the distinctive features of different types of CMs. Second, most models incorporating CMs found in the literature only focus on the interaction with the energy-based market. Valid assessments of CM need to consider the interaction of remuneration for available capacity and flexibility, and the indirect interaction with the remuneration for emission-neutral RES. Two formulations of a game-theoretic market equilibrium model are proposed which represent specific CMs with its distinctive features, in particular a market-wide centralized capacity market (cCM) and targeted strategic reserves (SRs). Moreover, the equilibrium models explicitly combine the CMs with markets for flexibility and indirect with remuneration for RES. We contribute to the discussion of CMs by quantifying the interactions and shifting shares of remuneration. Based on the interaction between CMs and remuneration for emission-neutral injection, the effect of CMs on non-participating RES is described. We conclude based on the case study results that targeted mechanisms, like SRs, implemented with the single purpose of ensuring availability introduce large inefficiencies in the system by missing on the interaction between availability and flexibility. In contrast, a market-wide cCM provides a beneficial outcome for all technologies. At the same time, it yields a sufficient high reserve margin at lowest cost. It provides clear signals for the different values of energy-output, flexibility, availability and emission-neutral injection.

Monopoly regulation, discontinuity & stranded assets

- Energy Economics---2017---Paul Simshauser

For regulated electricity utilities, if trend-load growth enters a state of terminal decline through disruptive competition and costs are unable to contract at a similar rate, the regulatory outcomes that follow produce strikingly different results to an equivalent episode in a competitive market, where profits fall and assets are written-off. Under economic regulation, prices rise to offset volumetric losses and in the presence of disruptive competition, a destructive price spiral can ensue. In these circumstances, some component of the regulated utility's assets meet the definition of 'stranded'. Failure to deal with stranded assets will eventually, and needlessly, damage shareholders, consumers and welfare. However, the 'regulatory compact' makes this an especially complex area of economics. Zero recovery of stranded monopoly assets is not credible policy. A normative analysis of economics and law suggests full recovery is not credible either. In this article, asset stranding experience from the US is reviewed and a series of policy principles are established; viz. asset stranding is a case-by-case proposition involving recovery via non-bypassable pricing mechanisms, quantified and packaged as a partial Return of Capital, possibly financed by Transition Bonds on a time-limited basis. Financial risk tolerances of the utility and the stability of post-stranding consumer tariffs are important parameters that should guide the policy approach to asset stranding. But ultimately, asset stranding is a policy choice, not an analytical determination.

Dynamic spillover between commodities and commodity currencies during United States Q.E

- Energy Economics---2017---Pick Schen Yip, Robert Brooks, Hung Xuan Do

This paper comprehensively discusses the dynamic relationship between commodities and commodity currencies, particularly during the U.S. quantitative easing (QEs), by integrating the generalized spillover index into a fractionally integrated VAR (FIVAR) model.

Our empirical analyses reach the following conclusions. First, the static return and volatility spillovers analyses show that the Food is the only net receiver among all the commodity price indices. Second, the dynamic total return and volatility spillover accelerated growth in term of the index by roughly between 15 and 25% for four regional groups during the initiation of the QE1 and subsequently remained across the first two rounds of the U.S. QE. Nevertheless, both the total return and volatility spillover declined in the midst of the QE3 as the U.S. Federal Reserve signaled the QE tapering due to the anticipated U.S. economic recovery. Third, the Energy and Metals components were the largest net transmitters of return and volatility spillovers during the U.S. QEs. A possible interpretation is that demand for energy and metals increase associated with an increase in economic activity that is triggered by the U.S. QEs. Last, almost all the sample commodity currencies acted as net receivers of return and volatility spillovers during the U.S. QEs, supporting the pass-through of commodities to commodity currencies.

“Asian premium” or “North Atlantic discount” : Does geographical diversification in oil trade always impose costs?

- Energy Economics---2017---Nader AlKathiri, Yazeed Al-Rashed, Tilak K. Doshi, Frederic H. Murphy

We develop a Global Oil Trade Model (GOTM) to examine the ability of large crude oil exporters or importers to influence inter-regional price differentials by allocating their sales or purchases respectively among different crude oil consuming or producing regions. The model is based on the trade-offs among freight costs, qualities of the crude oils traded and the technical configurations of refineries that process the crude oil. Our reference case (based on 2012 data) minimizes the sum of freight costs and the costs of processing sub-optimal grades of crude oil at a refinery. We model a large Middle East exporter allocating its supply regionally as the leader in a Stackelberg game where all other producers and importers are price takers on the competitive fringe. We then examine the ability of a

coalition of importers in Asia to make countervailing strategic purchases rather than act as a price taker. We find that large sellers can increase their revenues while diversifying their customer base by allocating volumes to more distant markets if, by doing so, they capture locational rents from more proximate buyers. Large buyers are unable to reduce their costs compared to the competitive market outcome by adopting countervailing purchase strategies but have the potential to disrupt the rent-seeking of large sellers.

Renewable energy and its impact on thermal generation

- Energy Economics---2017---Christoph Graf,Claudio Marcantonini

Electricity production from renewable sources generally displaces thermal generation, which leads to lower CO₂ emissions in the power sector. However, the intermittent nature of many renewable technologies in combination with less residual demand leads to greater inefficiencies in the operation of existing fossil power plants. This inefficiency translates into a higher rate of emissions relative to output. In this paper we focus on Italian power installations between 2005 and 2014. Using panel econometrics, we show that a 10% increase in photovoltaics and wind infeed has reduced yearly CO₂ emissions of the average thermal installation by about 2% while the average plants emissions relative to its output have increased by about 0.3%.

A micro-based model for world oil market

- Energy Economics---2017---Ramon Espinasa,Enrique ter Horst,Sergio Guerra,Osmel Manzano,German Molina,Roberto Rigobon

In this paper, we study the supply–demand drivers of the price of oil over the last two decades. We address the problem of endogeneity using a novel SVAR approach, which allows us to incorporate technological restrictions that occur at the micro level in the production of crude oil to solve the identification problem in a reduced-form regression analysis that seeks to disentangle the drivers of oil prices. We explore

the relationships between oil prices, rig counts, oil production and an index of world economic activity, and provide results for a heterogeneous set of countries. We find that when oil prices peaked in mid-2008—reaching almost US\$150 compared to US\$14 in 1998, a large proportion of the price move can be explained through a purely demand and supply factors.

The impact of the German response to the Fukushima earthquake

- Energy Economics---2017---Luigi Grossi,Sven Heim,Michael Waterson

The German response to the Fukushima nuclear power plant incident was possibly the most significant change of policy towards nuclear power outside Japan, leading to a sudden and very substantial shift in the underlying power generation structure in Germany, an enthusiastic leading proponent of renewable power. This provides a very useful experiment on the impact of a supply shock in the context of increasing relative generation by renewable compared to conventional fuel inputs into power production. Our quasi-experimental exploration of a modified demand-supply framework finds that despite the swift, unpredicted change in nuclear power, the main impact was a significant average increase in prices, surprisingly particularly at low residual load levels.

European Union gas market development

- Energy Economics---2017---Tobias Baltensperger,Rudolf M. Füchslin,Pius Krütli,John Lygeros

The recently announced Energy Union by the European Commission is the most recent step in a series of developments aiming at integrating the European Union's (EU) gas markets in order to increase social welfare and security of gas supply. Based on simulations with a spatial partial equilibrium model, we analyze the changes in consumption, prices, and social welfare up to 2022 induced by the infrastructure expansions planned for this period, for the current market, as well as for three hypothetical scenarios: a halt of

Russian gas deliveries to the EU during the winter period (RU-); a simultaneous doubling of available LNG (LNG+); and for Brexit, in which the United Kingdom market is isolated from the EU. In the case of the current market, the new infrastructure leads to a slight decrease of wholesale prices. Moreover, the potential of suppliers to exert market power decreases significantly, particularly in the Baltic states and Finland which are the most exposed countries today, and consumer surplus increases by 17.4% in the EU. In the RU- scenario, consumer surplus decreases across Europe, with the largest losses occurring in the Baltic states, as well as in Finland, Poland and Romania. In the LNG+ scenario, the gains in consumer surplus are primarily found in Western Europe. However, the planned infrastructure expansions distribute the gains and losses in consumer surplus more evenly over all EU member states, with the exception of Romania. In the Brexit scenario, consumer surplus decreases by up to 5.1% in the United Kingdom, 19.2% in Ireland, and 3.6% in the other EU countries. Our results allow us to distinguish three categories of projects: (i) Change in gas availability, leading to a general increase or decrease of social welfare all over the EU. The only project increasing social welfare in all scenarios in most countries is the Trans-Anatolian Gas Pipeline (TANAP); (ii) existing gas sources made available to additional countries. This leads to an increase of social welfare in the newly connected countries, while social welfare drops slightly everywhere else; (iii) projects with a marginal effect on the market. Most notably, the recently announced Turkish Stream falls into this category. Our results indicate that if all proposed infrastructure projects are realized, the EU's single market will become a reality in 2019 when Finland is interconnected to the EU markets. However, we also find that social welfare can only be increased significantly for the EU as a whole if new gas sources become accessible. At the same time, efficiency gains, albeit decreasing social welfare, help to improve the situation of consumers and decrease the dependency of the EU as a whole on external suppliers.

Timing strategy performance in the crude oil futures market

- Energy Economics---2017---Nick Taylor

The rewards to speculative trading in the crude oil futures market are assessed. For investors who adopt timing strategies that maximise their (iso-elastic) utility during each trading session, the rewards can be economically significant providing that transaction costs are small. Moreover, we are able to show via a decomposition of performance that the bulk of this benefit is due to their ability to predict realised volatility (that is, the second realised moment). The benefits derived from predicting other realised moments either require unrealistic levels of skill (all odd moments) or an infeasible degree of risk aversion (the fourth moment and higher even moments).

Hedging downside risk of oil refineries: A vine copula approach

- Energy Economics---2017---Kunlapath Sukcharoen,David J. Leatham

The financial health of an oil refinery greatly depends on its refining margin or the difference between the prices of its refined products (typically, gasoline and heating oil) and the cost of crude oil. The refinery may hedge against the downside risk of unfavorable price movements using crude oil, gasoline, and heating oil futures. This paper examines the use of a vine copula approach to estimate multiproduct hedge ratios that minimize the downside risk of the refinery. The advantage of the vine copula approach is that it allows us to capture important characteristics of petroleum price changes, including skewness and fat-tailedness in the marginal distributions of individual price change series as well as heterogeneous (tail) dependence patterns between different pairs of price changes. The out-of-sample hedging effectiveness of two popular classes of vine copula models – canonical (C-) and drawable (D-) vine copula models – are evaluated and compared with that of the widely used nonparametric method and three standard multivariate copula models. The empirical results reveal that the D-vine copula model

is a good and safe choice in managing the downside risk of the refinery.

Crude inventory accounting and speculation in the physical oil market

- Energy Economics---2017---Ivan Diaz-Rainey,Helen Roberts,David H. Lont

This paper uses inventory data from financial accounts to explore whether companies involved in the physical oil market were speculating in the run-up to 2008. Using quarterly inventory data over the period 1990Q4 to 2012Q1 and a sample of 15 of the largest listed oil companies in the world, we derive an Index of Scaled Physical Inventories (ISPI). We find declining ISPI up to the early 2000s is consistent with firms minimizing inventory for efficiency sake; then ISPI starts to increase, suggesting physical inventories could have contributed to the run-up in oil prices between 2003 and 2008. Highlighting heterogeneity in inventory behaviors amongst the large oil companies, the structural break test on the ratio of inventory to sales and the days to sales for individual companies shows that five companies had positive structural breaks during the speculation period, while the other companies had no or negative structural breaks. Contrary to declining inventory expectations due to a tightening oil market, the positive structural breaks suggest speculative behavior. We also examine the relationship between changes in profitability and changes in oil inventory over the pre-speculation and speculation period. Though some coefficients for inventory do switch from negative to positive over the two periods as hypothesized, they are only significant in a few cases. However, aggregate measures of inventory do switch and are significant, suggesting that, on average, inventory holdings negatively affected profitability in the pre-speculation period and positively affected profitability in the speculation period.

Forecasting the VaR of crude oil market: Do alternative distributions help?

- Energy Economics---2017---Yongjian Lyu,Peng Wang,Yu Wei,Rui Ke

Accurate modeling of the empirical distribution of crude oil market returns is extremely important in estimating risk measures. In addition to several commonly used distributions, alternative distributions are explored in this study, some of which account for the asymmetry and heavy tails simultaneously found in distributions, and contain more tail parameters to separately depict the right and left tails when forecasting the Value-at-Risk (VaR) of crude oil markets during highly volatile periods. Seven backtests are also conducted to compare the VaR forecasting accuracy among different distributions. The empirical results indicate that a highly volatile environment challenges the commonly used distributions, and the four risk models based on commonly used distributions are rejected about 27% to 38% of the time. The alternative distributions, i.e., skewed general error distributions (SGED), generalized hyperbolic skewed Student-t distributions (GHST), and generalized asymmetric Student-t (GAST) distributions, generally produce more accurate VaR measurement, and GAST gives the best measurement accuracy. The empirical results imply that risk managers or policymakers should further consider more flexible distributions, such as SGED, GHST, or GAST in particular, when quantifying or managing the risk in turbulent market times.

Oil price shocks and policy uncertainty: New evidence on the effects of US and non-US oil production

- Energy Economics---2017---Wensheng Kang,Ronald Ratti,Joaquin Vespignani

Important interaction has been established for US economic policy uncertainty with a number of economic and financial variables including oil prices. This paper examines the dynamic effects of US and non-US oil production shocks on economic policy uncertainty using a structural VAR model. Such an examination is motivated by the substantial increases in US oil production in recent years with implications for US political and economic security. Positive innovations in US oil production are associated with decreases in US economic policy uncertainty. The economic fore-

cast interquartile ranges about the US CPI and about federal/state/local government expenditures are particularly sensitive to innovations in US oil supply shocks. Shocks to US oil supply disruption causes rises in the CPI forecast uncertainty and accounts for 21% of the overall variation of the CPI forecaster disagreement. Dis-aggregation of oil production shocks into US and non-US oil production yields novel results. Oil supply shocks identified by US and non-US origins explain as much of the variation in economic policy uncertainty as structural shocks on the demand side of the oil market.

Can investor attention predict oil prices?

- Energy Economics---2017---Liyan Han,Qiuna Lv,Libo Yin

This paper sets out to investigate the predictive power of investor attention onto oil prices. We firstly construct investor attention index by using the Google search volume index (SVI) based on a broad set of words related to oil-related variables and terms that are directly linked to real economy to measure investor attention. Then the empirical work is performed via a novel hybrid approach and WN model (Westerlund and Narayan, 2012, 2014) that account for characteristics of persistency, endogeneity, and heteroskedasticity. The empirical results show that investor attention does exhibit statistically and economically significant in-sample and out-of-sample forecasting power to directly forecast oil prices for both daily data and weekly data. In addition, the results exhibit the term structure character, which are helpful for understanding the financial phenomena that irrational attentions have more effect in short-term decision-making.

Can stock market investors hedge energy risk? Evidence from Asia

- Energy Economics---2017---Jonathan A. Batten,Harald Kinatader,Peter G. Szilagyi,Niklas Wagner

The relationship between energy and stock prices is investigated in the context of Asia, including China and Japan. Oil, gas and coal prices are considered both

individually and as an energy portfolio. Consistent with evidence from international markets, during the post Global Financial Crisis (GFC) period, Asian stock markets moved in tandem with oil prices. However, using asset pricing and portfolio theory, we identify a time-varying integration between individual stock markets and the energy portfolio, which in turn may limit the benefit of risk reduction through diversification. This relation can also be used to hedge the common factor arising from energy risk. Doing so provides benefits to investors in the form of positive time-varying risk adjusted returns.

Dynamic relationship of oil price shocks and country risks

- Energy Economics---2017---Chi-Chuan Lee,Chien-Chiang Lee,Shao-Lin Ning

This study investigates the dynamic relationship between oil price shocks and country risks using a Structural VAR framework for a sample of both net oil-exporting and net oil-importing countries over the period January 1994–December 2014. The results reveal that country risk is significantly affected by oil price shocks, but the impacts are different. Unanticipated positive oil price shocks trigger a reduction (addition) in country risk for net oil-exporting country (net oil-importing countries). As to the responses of oil prices to country risk shock, evidence show that country risk shocks have a delayed significantly positive impacts on oil price for oil-exporting country. With respect to the effects of subcomponents of country risk, we find evidence that economic and political risk have a significant impact on supply-side shocks in net oil-exporting countries like Canada, while economic and political risk have a significant effect on supply-side shocks and oil specific demand shocks in net oil-importing countries like the US. These results are particularly important to policy makers and government.

The effects of environmental sustainability and R&D on corporate risk-taking: International evidence

- Energy Economics---2017---Rajabrata Banerjee,Kartick Gupta

In this paper, we ask an important question: can firm-level environmentally sustainable practices and research and development (R&D) intensity individually and jointly affect corporate risk-taking? Using firm-level data from 41 countries spanning 2002–2013, we find environmentally sustainable practices and R&D intensity enhance the risk-taking of firms. Voluntary sustainable practices generate a positive and significant effect on corporate risk-taking. We also find that country-level determinants play a complementary role. Firms operating in countries with better intellectual property rights protection and overall infrastructure benefit more from environment-friendly practices and R&D intensity. Further, we find that ESI has a positive effect on risk taking in countries with higher CO₂ emissions per capita, energy usages per capita and more stringent environmental policies. These results are robust after correcting for potential endogeneity, alternative measures of R&D intensity or ESI score. Overall, our findings provide key insights on policy recommendations at the national and international levels.

The 1000 GtC coal question: Are cases of vastly expanded future coal combustion still plausible?

- Energy Economics---2017---Justin Ritchie,Hadi Dowlatabadi

Decades ago, prospects seemed strong for significantly expanded global coal consumption. Studies of energy futures depicted the full geologic extent of coal as a virtually unlimited backstop energy supply, drawing justification from legacy ratios of reserves-to-production (R-P) on the order of several centuries. Annual consumption and market prices for hard coal have doubled since 1990, providing an opportunity to recalibrate the next century's reference case with an empirically

constrained outlook for this important industrial fuel source.

Energy demand convergence in APEC: An empirical analysis

- Energy Economics---2017---Thai-Ha Le,Youngho Chang,Donghyun Park

This paper empirically examines the cross-country convergence of per-capita energy and electricity usage in APEC, a significant economic bloc. To this end, the study applies conventional panel unit root tests and Sequential Panel Selection Model (SPSM) procedure based on the Panel KSS unit root with a Fourier function for robustness analysis. The results from conventional unit root test results indicate that per capita energy usage and electricity consumption are converging for all APEC countries, in line with improving living standards in APEC. The findings also provide some support for policies to promote energy integration among APEC countries. According to SPSM analysis, evidence of energy convergence is found for 15 out of 19 APEC countries and evidence of electricity convergence is found for 17 out of 19 APEC countries. Pursuit of policies to achieve energy supply stability can move divergent countries toward convergence.

Price pass-through in US gasoline markets

- Energy Economics---2017---Benjamin F. Blair,Randall C. Campbell,Phillip A. Mixon

Using an error-correction model in a seemingly unrelated regression framework, we examine regional differences in the price pass-through from crude oil spot prices to retail gasoline pump prices. We show that regional differences do exist both in the short run and long run adjustment processes. Depending on the region, a \$1 per barrel change in crude oil prices is correlated with a change in retail gasoline pump prices somewhere between 2.36¢ and 2.58¢. We examine the presence of the rockets and feathers phenomenon using both single period coefficient tests and multiple period impulse response functions.

Does speculation in the oil market drive investor herding in emerging stock markets?

- Energy Economics---2017---Mehmet Balcilar,Riza Demirer,Talat Ulussever

This paper examines whether the time variation in the level of investor herding in the stock markets of major oil exporting nations relates to speculation and volatility in the global oil market. We find that speculative activities in the oil market, rather than oil price movements, are positively correlated with anti-herding in the stock markets of major exporters. We argue that traders take the speculative signals from the oil market as a sign of positive expectations and try to generate superior profits by going against the crowd in their local market. While this pattern largely holds during calm (low volatility) market periods, we also find that significant herd behavior takes place during high volatility (or crisis) periods. The findings suggest that policy makers who are concerned about stability in their stock markets should monitor measures of speculative activities in the energy market in order to model and monitor volatility and/or risk transmissions into their markets.

An equilibrium pricing model for wind power futures

- Energy Economics---2017---Gerke Gersema,David Wozabal

Generation from wind power plants is intermittent and affects profits of wind power generators and conventional generators alike. Currently, generators have limited options for transferring the resulting wind-related volume risks. The European Energy Exchange (EEX) recently introduced exchange-traded wind power futures to address this market imperfection. We propose a stylized equilibrium pricing model featuring two representative agents and analyze equilibrium prices as well as the mechanics behind risk premia for wind power futures. We calibrate and simulate stochastic models for wind power generation, power prices, electricity demand, as well as other relevant sources of uncertainty and use the resulting scenarios to conduct

a case study for the German market; analyzing prices, hedging effectiveness, and risk premia. Our main result suggests that wind generators are willing to pay an insurance premium to conventional generators to reduce their risks. We conduct a thorough sensitivity analysis to test the influence of model parameters and find that our results on risk premia hold for a broad range of reasonable inputs.

Where do all the windmills go? Influence of the institutional setting on the spatial distribution of renewable energy installation

- Energy Economics---2017---A. Pechan

Promoting renewable energy sources is one policy response to climate change. Not only is there currently a debate over the best policy instrument, it is also discussed whether the renewable energy production should be expanded centralized at locations with the highest production potential or decentralized close to load. It is yet not fully understood what influences the spatial distribution of renewable energy installation.

Downscaling heterogeneous household outcomes in dynamic CGE models for energy-economic analysis

- Energy Economics---2017---Nikolai B. Melnikov,O' Neill, Brian C.,Michael G. Dalton,Bas van Ruijven

Downscaling methods for dynamic computable general equilibrium models are developed and analyzed. The methods produce outcomes for a variety of different household types by downscaling the aggregate quantities from an economic growth model with a representative household. This approach uses household survey data and long-term population projections for different household types to compare the performance of the downscaling methods vs. a general equilibrium model with multiple household groups under a variety of conditions, including demographic change, technological change, and a carbon tax. Both recursive-dynamic and forward-looking downscaling methods produce results that approximate well a multiple household model run.

The recursive-dynamic downscaling method is applied to an illustrative example estimating impacts of a carbon tax on aggregate CO₂ emissions and the energy demand of different household groups for a middle of the road development scenario.

Can an oil-rich economy reduce its income inequality? Empirical evidence from Alaska's Permanent Fund Dividend

- Energy Economics---2017---Kate Kozminski,Jungho Baek

The main focus of this paper is to empirically examine the effect of the Permanent Fund Dividend (PFD) payouts on Alaska's income inequality by taking into account the roles of income and population. To that end, an autoregressive distributed lag (ARDL) approach to cointegration and the Johansen cointegration approach are applied to annual time series data from 1963 to 2012. We find that the PFD payouts tend to worsen income inequality in Alaska in both the short- and long-run. We also provide evidence to support the existence of Kuznets' hypothesis for Alaska – growth deteriorates income inequality initially and improves it later. Finally, population is found to reduce Alaska's income inequality in the short- and long-run.

The effects of border-crossing frequencies associated with carbon footprints on border carbon adjustments

- Energy Economics---2017---Zengkai Zhang,Kunfu Zhu,Geoffrey Hewings

The fragmentation of production across national boundaries has become an important feature of the world economy. This present paper adopts the viewpoint that not only the size and composition of carbon footprints are relevant but also the border-crossing frequency associated with these carbon footprints, which is defined as the number of borders a product crosses in a supply chain; this process will affect the spatial accounting of the carbon emissions produced to support the economic activity. The calculation of border-crossing frequencies of carbon footprint is accomplished by decomposing

the Leontief inverse matrix derived from the world input–output database. We find that the aggregated average border crossing frequencies of carbon footprints show an increasing tendency, which is influenced by the economic crisis obviously. The policy application focuses on the United States, which we assume to levy carbon tariffs on foreign emissions embodied in imports. We find that the indirect carbon tariff on emissions embodied in international trade take a significant share. The border carbon adjustments are mainly targeted at emissions generated in China, which also pays the greatest share of the tariff burden. The implication of carbon tariffs faces the problem of multiple taxation.

Income and energy use in Bangladesh: A household level analysis

- Energy Economics---2017---Syed Hasan,Pallab Mozumder

We examine how energy use at the household level moves with income in Bangladesh. Using the 2010 wave of Bangladesh Household Income and Expenditure Survey data, our analyses indicate a U-shaped relationship of both electricity use and other types of energy use (combined) with household expenditure. The findings imply that as income grows households increase their energy expenditure less than proportionally, up to a threshold level of income. Beyond the threshold income, energy use increases as a proportion of income, particularly for electricity use. We identify the threshold (turning point) for both electricity and other types of energy use. Based on the current level of expenditure and its growth, reaching the turning point would require 17years for the former category but only 7years for the latter group.

Wind power feasibility analysis under uncertainty in the Brazilian electricity market

- Energy Economics---2017---Giancarlo Aquila,Paulo Rotela Junior,Edson de Oliveira Pamplona,Anderson Rodrigo de Queiroz

Investors must be able to plan and analyze their investments in order to optimize decisions and turn them

into profits associated with a particular project. Since electricity producers in the Brazilian electric power system are exposed to a short-term market, the goal of this paper is to propose a framework for investment analysis capable of encompassing different uncertainties and possibilities for wind power generators in a regulated market, characterized by auctions. In order to reach the proposed objective we employ a simulation technique which allows modeling cash flows considering uncertainties in variables related to project financial premises, electricity generation and producer exposure to the short-term market. For such goal, this study presents a new approach for investment analysis that allows the identification of the main uncertainty parameters and risks associated to this class of projects in the Brazilian electricity market. We also employ the Value at Risk technique to perform a risk management analysis in such context.

Multiplicative structural decomposition analysis of aggregate embodied energy and emission intensities

- Energy Economics---2017---Bin Su,B.W. Ang

Aggregate intensity indicators, such as the ratio of a country's energy and emissions to its GDP, are often used by researchers and policymakers to study energy and environmental performance. This paper analyzes the relationship between energy (or emissions) and value added (or GDP) from a different viewpoint, namely from the demand rather than the production perspective, using the input-output (I-O) framework. The aggregate embodied intensity (AEI), defined as the ratio of embodied energy (or emissions) to embodied value added, can be defined at the aggregate, final demand category and sectoral levels. The total aggregate intensity can be presented as a weighted sum of the AEIs at the final demand category or sectoral level. Changes of the AEI at different levels can be decomposed to identify the driving forces using multiplicative SDA. A study using the latest 2007 and 2012 datasets of China indicates that (a) its aggregate intensity of CO₂ emissions was mainly determined by the AEI in investment and (b) the emission intensity

effect generally contributed the most to the AEI ratio changes at different levels. The proposed framework can be applied to other aggregate intensity indicators and extended to multi-country/region analysis.

Impacts of US biodiesel mandates on world vegetable oil markets

- Energy Economics---2017---Jingbo Cui,Jeremy I. Martin

In this paper we seek to understand the impact of expanded use of soybean oil biodiesel to address biofuel mandates on global vegetable oil markets, and in particular on the demand for palm oil. An open-economy equilibrium model is derived to investigate the market effects of biodiesel expansion on related energy and vegetable oil markets. The model is calibrated to represent the recent benchmark data in calendar year 2014. The simulation estimates suggest that the expanded use of soy oil for biodiesel in the US will have considerable impacts on world vegetable oil markets. The majority of the vegetable oil replacement is likely to occur through substitution of palm oil under a wide range of plausible elasticity values on the demand for vegetable oil and the demand substitution between soy oils and palm oils.

Switch off the light, please! Energy use, aging population and consumption habits

- Energy Economics---2017---Rossella Bardazzi,Maria Grazia Pazienza

In parallel with worldwide population growth, Europe is experiencing a fast demographic shift widely studied but generally undervalued by policymakers. Population aging may imply smaller household sizes and more home-based energy consumption, which will change the energy mix. Consumer preference shifts and different attitudes towards environment among the generations determine additional effects. Study of the link between an aging population and energy demand is even more important for Italy because its energy dependence is almost complete and its population is aging quickly.

This paper aims to assess the role of changing generational preferences in the energy expenditure trend in Italy by distinguishing between a pure age effect and a cohort effect. The decomposition shows significant differences in the shape of age and cohort effects, thus confirming that, beside an aging effect, we must consider that recent generations have a higher residential energy expenditure. Indeed, the energy culture of post war Italian generations seems more linked to thermal comfort (heating and air conditioning) than to environmental attitudes.

Do economic and societal factors influence the financial performance of alternative energy firms?

- Energy Economics---2017---Kartick Gupta

Prior studies find that the technology sector and oil prices strongly influence the financial performance of alternative energy firms. The results, however, are country-specific and the role of country-level determinants is yet to be investigated. We argue that economic and societal factors are important in explaining cross-country differences in the financial performance of alternative energy firms. We analyse the financial performance of alternative energy firms using firm-level data from 26 countries. We find that the market rewards alternative energy firms when country-level technology and innovation are well developed. Additionally, we find that national cultural dimensions explain cross-country differences in the financial performance of alternative energy firms.

The CO₂–growth nexus revisited: A nonparametric analysis for the G7 economies over nearly two centuries

- Energy Economics---2017---Muhammad Shahbaz,Muhammad Shafiullah,Vassilios Papavassiliou,Shawkat Hammoudeh

Using a long dataset and some recently popularized nonparametric econometric techniques, this study revisits the nexus between economic growth and carbon dioxide (CO₂) emissions for the G7 countries over

nearly two centuries. The use of nonparametric modelling is warranted by the fact that long historical time series are often subject to structural breaks and other forms of nonlinearity over the course of time. We employ nonparametric cointegration and causality tests along with the cross-validated Local Linear regression analysis and validate the existence of the environmental Kuznets curve in six of the G7 countries – Canada, France, Germany, Italy, U.K. and the U.S. – and the only exception is Japan. Our empirical analysis also finds CO₂ emissions and economic growth to be cointegrated and closely interrelated in the Granger sense. Our results are robust and highlight the nonlinear causal relationship between the two variables.

What is the value of the option to defer an investment in Transmission Expansion Planning? An estimation using Real Options

- Energy Economics---2017---A. Henao,E. Sauma,T. Reyes,A. Gonzalez

In deregulated markets, Transmission Expansion Planning (TEP) is usually performed by a central network planner seeking to maximize social welfare. In doing that, the network planner commonly follows a traditional project valuation, considering a discounted cash flow (DCF) methodology, although incorporating uncertainty and reliability considerations. Accordingly, once the optimal transmission expansion plan is determined, the network planner frequently auctions the needed investments, obligating the investor to execute the expansion in the fixed (inflexible) terms defined in the bidding process. A key problem is that DCF does not take into account the responses of the planner when uncertainties are resolved because DCF evaluates the project with the information available today. In TEP, managerial flexibility may be valuable because optimal decisions may change over time with the release of new information. Transmission investors may want to defer or expand according to such information. The aim of this article is to estimate the value of adding some flexibility in TEP through real options. In particular, by means of using a real-option approach with binomial trees, we study the benefits for a social network plan-

ner of having the option to defer some transmission investments. Our results suggest that incorporating flexibility in TEP may increase social welfare.

Cyclical properties of supply-side and demand-side shocks in oil-based commodity markets

- Energy Economics---2017---Tomas Krehlik,Jozef Baruník

Oil markets profoundly influence world economies through determination of prices of energy and transports. Using novel methodology devised in frequency domain, we study the information transmission mechanisms in oil-based commodity markets. Taking crude oil as a supply-side benchmark and heating oil and gasoline as demand-side benchmarks, we document new stylized facts about cyclical properties of the transmission mechanism generated by volatility shocks with heterogeneous frequency responses. Our first key finding is that shocks to volatility with response shorter than one week are increasingly important to the transmission mechanism over the studied period. Second, demand-side shocks to volatility are becoming increasingly important in creating short-run connectedness. Third, the supply-side shocks to volatility resonating in both the long run and short run are important sources of connectedness.

The impact of oil prices on bioenergy, emissions and land use

- Energy Economics---2017---Niven Winchester,Kirby Ledvina

We evaluate how alternative future oil prices will influence the penetration of biofuels, energy production, greenhouse gas (GHG) emissions, land use and other outcomes. Our analysis employs a global economy wide model and simulates alternative oil prices out to 2050 with and without a price on GHG emissions. In one case considered, based on estimates of available resources, technological progress and energy demand, the reference oil price rises to \$124 by 2050. Other cases separately consider constant reference oil prices

of \$50, \$75 and \$100, which are targeted by adjusting the quantity of oil resources. In our simulations, higher oil prices lead to more biofuel production, more land being used for bioenergy crops, and fewer GHG emissions. Reducing oil resources to simulate higher oil prices has a strong income effect, so decreased food demand under higher oil prices results in an increase in land allocated to natural forests. We also find that introducing a carbon price reduces the differences in oil use and GHG emissions across oil price cases.

Stochastic convergence in per capita energy use in world

- Energy Economics---2017---Firouz Fallahi

This paper examines the pattern of convergence in per capita energy use in a sample of 109-country covering the period 1971–2013. In addition to the full sample of countries, existence of convergence is also examined in seven subsets of countries: OECD countries, OPEC countries, and also countries in America, Africa, Asia and Oceania, Europe, and the Middle East. In contrast to the previous studies which mainly used unit root or stationarity tests, we use the results from subsampling confidence intervals. Furthermore, instead of considering convergence to a particular country benchmark, we explore all the possible pair-wise convergences. The findings, based on 7962 pairs of countries, are more favorable to the existence of the convergence. Another finding of the paper is that the per capita energy use, despite being convergent, is highly persistent.

What motivates merger and acquisition activities in the upstream oil & gas sectors in the U.S.?

- Energy Economics---2017---Kuang-Chung Hsu,Michael Wright,Zhen Zhu

The U.S. oil and gas (O&G) industry has experienced a tremendous amount of growth in the last decade or so due to the development of horizontal drilling and fracking technology. In the meantime, the industry has experienced heavy merger and acquisition (M&A) activity, especially in the upstream sectors. While these M&A activities may be related to the aggregate M&A

waves in the country, they are unique in their own respect. We recognize that the M&A activities in the energy industry in general, and the O&G sectors in particular, can be different from the traditional sense of M&A activities. In this paper, we provide some stylized facts on the M&A patterns in the upstream O&G sectors, focusing on the factors that influenced these patterns. Our empirical evidence suggests that among the variables we studied, oil price and O&G production are the most important factors that influence M&A activities, while other variables do not show consistent effect across regions and definitions of M&A. In addition, the M&A activities had momentum-building periods and had patterns consistent with a wave hypothesis. Our findings support the notion that industry-specific factors are more important than general economic conditions in determining M&A in the O&G industry. We find evidence supporting both the behavioral and neoclassical theories on M&A.

Implications of the EU Emissions Trading System for the South-East Europe Regional Electricity Market

- Energy Economics---2017---Verena Višković,Yihsu Chen,Afzal S. Siddiqui

As part of its climate policy, the European Union (EU) aims to reduce greenhouse gas (GHG) emissions levels by 20% by the year 2020 compared to 1990 levels. Although the EU is projected to reach this goal, its achievement of objectives under its Emissions Trading System (ETS) may be delayed by carbon leakage, which is defined as a situation in which the reduction in emissions in the ETS region is partially offset by an increase in carbon emissions in the non-ETS regions. We study the interaction between emissions and hydropower availability in order to estimate the magnitude of carbon leakage in the South-East Europe Regional Electricity Market (SEE-REM) via a bottom-up partial equilibrium framework. We find that 6.3% to 40.5% of the emissions reduction achieved in the ETS part of SEE-REM could be leaked to the non-ETS part depending on the price of allowances. Somewhat surprisingly, greater hydropower availability

may increase emissions in the ETS part of SEE-REM. However, carbon leakage might be limited by demand response to higher electricity prices in the non-ETS area of SEE-REM. Such carbon leakage can affect both the competitiveness of producers in ETS member countries on the periphery of the ETS and the achievement of EU targets for CO₂ emissions reduction. Meanwhile, higher non-ETS electricity prices imply that the current policy can have undesirable outcomes for consumers in non-ETS countries, while non-ETS producers would experience an increase in their profits due to higher power prices as well as exports. The presence of carbon leakage in SEE-REM suggests that current EU policy might become more effective when it is expanded to cover more countries in the future.

Public preferences for alternative electricity mixes in post-Fukushima Japan

- Energy Economics---2017---Katrin Rehdanz,Carsten Schröder,Daiju Narita,Toshihiro Okubo

Using representative household survey data from Japan after the Fukushima accident, we estimate peoples' willingness-to-pay (WTP) for renewable, nuclear, and fossil fuels in electricity generation. We rely on random parameter econometric techniques to capture various degrees of heterogeneity between the respondents, and use detailed regional information to assess how WTP varies with the distance to both the nearest nuclear power plant and to Fukushima. Compared to fossil fuels, we find a positive WTP for renewable and a negative WTP for nuclear fuels. These effects, in absolute terms, increase with the proximity to Fukushima.

The long-term relationship between CO₂ emissions and economic activity in a small open economy: Uruguay 1882–2010

- Energy Economics---2017---Matías Piaggio,Emilio Padilla,Carolina Román

The long-term relationship between carbon dioxide (CO₂) emissions from energy use and economic activity level is estimated for Uruguay between 1882 and

2010. We include CO₂ emissions both in levels and in per capita terms, which allows to analyze if a decoupling exists both in absolute and in relative terms. We also test for the functional form of the relationship, something that is usually missed in the literature, but which is very relevant, because a misspecification could lead to biased estimates. We apply cointegration techniques and estimate a vector error correction model (VECM) for testing whether these variables are endogenous over the long-term while also considering the short-term dynamics. The economic productive structure, the degree of openness, and the share of clean sources in the total energy supply are also considered as explanatory variables. In addition, other variables that measure changes in the economic structure are included to check for robustness of the estimates. The results show that there is a linear relationship (when a log-log transformation is employed) between CO₂ emissions and per capita economic activity level (which would involve an exponential relationship between the non-transformed variables). Moreover, we cannot reject the level-log model, indicating that emissions increase at a decreasing rate in reference to the increase in economic level activity. Emissions increase jointly with the industrial sector's participation in the total output, as a consequence of the intensity of this activity in the consumption of energy from fossil fuel sources. The degree of openness is inversely related to CO₂ emissions. This is because the periods of major opening were based on primary input exports, which are lower in energy intensity than industrial products. The changes in CO₂ emission are inversely related to the variation in the share of clean sources in the total energy supply. Finally, all the variables included in the cointegration vector are endogenous, adjusting together to the deviations from the long-term relationship. As a consequence of the above, economic growth appears not to be enough for diminishing Uruguayan emissions in the long term. Changes in the energy matrix should be encouraged, and emissions reduction should come not through energy constraints but through the development of clean sources, or improvements in energy use efficiency, given the impact of energy on the economic activity level.

Cost efficiency and electricity market structure:

A case study of OECD countries

- Energy Economics---2017---Victor Ajayi,Thomas Weyman-Jones,Anthony Glass

The OECD electricity sector has witnessed significant institutional restructuring over the past three decades. As a consequence, many power generation utilities now act as unregulated companies that technically compete to sell power on an open market. This paper analyses the performance in term of cost efficiency for electricity generation in OECD power sector while accounting for the impact of electricity market structures. We employ the short-run cost function in which capital stock is treated as a quasi-fixed factor input. Empirical models are developed for the cost function as a translog form and analysed using panel data of 25 countries during the period 1980 to 2009. We show that it is necessary to model latent country-specific heterogeneity in addition to time-varying inefficiency. The estimated economies of scale are adjusted to take account of the importance of the quasi-fixed capital input in determining cost behaviour, and long run constant returns to scale are verified for the OECD generation sector. The research findings suggest there is a significant impact of electricity market regulatory indicators on cost. In particular, public ownership and vertical integration are found to have significant and sizable increasing impacts on cost, thereby indicating policy lessons on the desirable ways to implement structural electricity generation reforms.

Crowdfunding cleantech

- Energy Economics---2017---Douglas J. Cumming,Gael Leboeuf,Armin Schwenbacher

This paper provides insights on the crowdfunding of new alternative energy technologies by enabling inferences from large pools of small investors. We provide large sample evidence from 81 countries around the world that cleantech crowdfunding is more common in countries with low levels of individualism and more common when oil prices are rising. Cleantech crowdfunding campaigns are more likely to have higher capi-

tal goals, more photos, a video pitch, and longer text descriptions of the campaign. Relative to non-cleantech campaigns, the success of cleantech campaigns, in terms of achieving funding goals, is more economically sensitive to the campaign's goal size, being not-for-profit, and having a video pitch. The evidence is consistent with the view that while alternative energies are viewed as being more risky, and investors face greater information asymmetries relative to other types of investment projects, there are mechanisms for entrepreneurs to mitigate these information problems and be at least as successful in cleantech crowdfunding markets.

Aiming low and achieving it: A long-term analysis of a renewable policy in Chile

- Energy Economics---2017---Francisco D. Munoz, Bruno J. Pumarino, Ignacio A. Salas

We use an Integrated Resource Planning model to assess the costs of meeting a 70% renewables target by 2050 in Chile. This model is equivalent to a long-term equilibrium in electricity and renewable energy certificate (REC) markets under perfect competition. We consider different scenarios of demand growth, resource eligibility (e.g., large hydropower), and transmission system configuration. Our numerical results indicate that the sole characteristics of the available renewable resources in the country and reductions in technology costs will provide sufficient economic incentives for private investors to supply a fraction of renewables larger than 70% for a broad range of scenarios, meaning that the proposed target will likely remain a symbolic government effort. Increasing transmission capacity between the northern and central interconnected systems could reduce total system cost by \$400 million per year and increase the equilibrium share of nonconventional renewable energy (NCRE) in the system from 45% to 52%, without the need for any additional policy incentive. Surprisingly, imposing a 70% of NCRE by 2050 results in a REC price lower than the noncompliance fine used for the current target of 20% of NCRE by 2025, the latter of which represents the country's maximum willingness to pay for the attributes of electricity supplied from NCRE resources.

Oil prices and the global economy: Is it different this time around?

- Energy Economics---2017---Kamiar Mohaddes, M. Pesaran

The recent plunge in oil prices has brought into question the generally accepted view that lower oil prices are good for the US and the global economy. In this paper, using a quarterly multi-country econometric model, we first show that a fall in oil prices lowers interest rates and inflation in most countries, and increases global real equity prices. The effects on real output are positive, although they take longer to materialize (around 4 quarters after the shock). We then re-examine the effects of low oil prices on the US economy over different sub-periods using monthly observations on real oil prices, real equity prices and real dividends. We confirm the perverse positive relationship between oil and equity prices over the period since the 2008 financial crisis highlighted in the recent literature, but show that this relationship has been unstable when considered over the longer time period of 1946–2016. In contrast, we find a stable negative relationship between oil prices and real dividends which we argue is a better proxy for economic activity (as compared to equity prices). On the supply side, the effects of lower oil prices differ widely across the different oil producers, and could be perverse initially, as some of the major oil producers try to compensate their loss of revenues by raising production. Taking demand and supply adjustments to oil price changes as a whole, we conclude that oil markets equilibrate but rather slowly, with large episodic swings between low and high oil prices.

Gain and loss of money in a choice experiment. The impact of financial loss aversion and risk preferences on willingness to pay to avoid renewable energy externalities

- Energy Economics---2017---Anna Bartczak, Susan Chilton, Mikolaj Czajkowski, Jürgen Meyerhoff

We examine how the direction of price changes affects the value people place on avoiding renewable energy

externalities in Poland. Additionally, we investigate the influence of individuals' financial loss aversion and financial risk preferences on this valuation. In our study we conduct a choice experiment survey in which respondents' choices indicate the value they place on avoiding wind, solar, and biomass externalities. We combine this survey with a financial lottery choice task that elicits the respondents' risk preferences and degree of loss aversion. In the choice experiment we use both increases and decreases in electricity bills to depict the uncertain effect of new sources of energy generation on the current price level. This design allows us to investigate if obtained values are independent of the payment mechanism. In the analyzed context, our results indicate that marginal utility of money seems to be lower with a rebate on the energy bill than with a surcharge. We find that financial risk preferences affect people's choices both in a case of a surcharge and a rebate, while loss aversion for money affects them just in the case of a rebate. Loss aversion for money seems to not be present during a buying process. The results indicate that the more risk seeking people are in a financial domain the more they are willing to pay for proposed changes in renewable energy development, at the same time people who are more risk averse require less compensation before they accept externalities from renewable electricity production. Moreover, a higher compensation is required by people who are more loss averse with regard to money.

Electricity demand response to price changes: The Portuguese case taking into account income differences

- Energy Economics---2017---Susana Silva, Isabel Soares, Carlos Pinho

In this paper we study the behavior of electricity use in Portuguese households using microdata from five independent surveys. Our sample covers the period from 1989 to 2010, which was characterized by major changes in the country. We adopt the pseudo-panel methodology creating 350 cohorts based on the size of the household, the type of location (rural or urban), the region, and the income quintile. Our results show

relatively high medium/long-run own price elasticities indicating that an increase in the electricity price due to, for instance, policy intervention would, in fact, decrease electricity use. Cross price elasticities indicate that electricity and gas are substitutes. Additionally, the income quintiles analysis shows significant differences in the elasticities depending on the income group. Hence, political interventions in the electricity sector may have important redistributive effects.

The impact of wind power support schemes on technology choices

- Energy Economics---2017---Nils May

In energy systems with large shares of variable renewable energies, electricity generation is lower during unfavorable weather conditions. System-friendly wind turbines (SFTs) rectify this by producing a larger share of their electricity at low wind speeds. This paper analyzes to what extent SFTs' benefits outweigh their additional costs and how to incentivize investments into them. Using a wind power investment model for Germany, I show that SFTs indeed deliver benefits for the energy system that over-compensate for their cost premium. Floating market premium schemes incentivize their deployment only where investors bear significant price risks and possess sufficient foresight. Alternatively, a new production value-based benchmark triggers investors to install SFTs that meet the requirements of power systems with increasing shares of variable renewable energies.

The impact of energy consumption and economic development on Ecological Footprint and CO2 emissions: Evidence from a Markov Switching Equilibrium Correction Model

- Energy Economics---2017---Lanouar Charfeddine

Reducing the impact of air pollution and global environmental degradation on human health and quality of life for Qatari citizens represents the most important objective of the Qatar National vision 2030. With respect to this vision, this study investigates the effects of economic growth, energy consumption, trade openness,

urbanization and financial development on environmental degradation by using the Markov Switching Equilibrium Correction Model with shifts in both the intercept and income per capita slope for the period 1970–2015. Unlike existing studies and in addition to the CO₂ emissions pollutant, this paper uses the total Ecological Footprint and Ecological Carbon Footprint as new proxies of environmental degradation.

Bayesian calibration and number of jump components in electricity spot price models

- Energy Economics---2017---Jhonny Gonzalez,John Moriarty,Jan Palczewski

We find empirical evidence that mean-reverting jump processes are not statistically adequate to model electricity spot price spikes but independent, signed sums of such processes are statistically adequate. Further we demonstrate a change in the composition of these sums after a major economic event. This is achieved by developing a Markov Chain Monte Carlo (MCMC) procedure for Bayesian model calibration and a Bayesian assessment of model adequacy (posterior predictive checking). In particular we determine the number of signed mean-reverting jump components required in the APXUK and EEX markets, in time periods both before and after the recent global financial crises. Statistically, consistent structural changes occur across both markets, with a reduction of the intensity and size, or the disappearance, of positive price spikes in the later period. All code and data are provided to enable replication of results.

Measuring scale efficiency and returns to scale on large commercial rooftop photovoltaic systems in California

- Energy Economics---2017---Toshiyuki Sueyoshi,Derek Wang

Electricity generated by solar Photovoltaic (PV) power systems is emerging as one of the most promising cleaner alternatives to replace conventional energy sources, such as coal, oil, and natural gas. This study examines managerial sources of operational efficiency or

inefficiency on 855 large commercial rooftop PV power systems in California by examining both scale efficiency and Returns to Scale (RTS). For the research purpose, this study utilizes Data Envelopment Analysis (DEA) as a methodology to assess the scale measures. A difficulty in applying DEA to the performance analysis of PV power systems is that it contains uncontrollable variables such as ambient temperature and solar irradiation, all of which are influenced by weather. It is also widely known that PV power systems cannot produce electricity during night, so being unable to serve as a base load. Thus, these uncontrollable factors often influence the performance of PV power systems. Paying attention to the effects of those uncontrollable factors, this study discusses how to measure scale efficiency and RTS within the framework of DEA. Then, as an application of the proposed approach, this study examines the performance of large commercial rooftop PV power systems in California. This study finds that they belong to increasing (48), constant (807) and decreasing (0) RTS, implying that most of the PV power systems in California have been operating in their appropriate sizes. This further indicates that the operational inefficiency of PV power systems is due to managerial inappropriateness, not their sizes for generation. Thus, there is a space to improve operational efficiency of rooftop PV systems under constant RTS, through managerial efforts such as increase in transmission capacity and operational flexibility to improve solar penetration, and routine maintenance to minimize detrimental effects of dust deposition.

Energy intensity and firm growth

- Energy Economics---2017---Bongseok Choi,Wooyoung Park,Bok-Keun Yu

Using micro-level data, we attempt to identify the causal relationship between improvement (decline) in energy intensity and firm growth in six countries, namely, France, Germany, Japan, Korea, the U.K., and the U.S., and 21 manufacturing industries during the period 1991 to 2005. We run a panel regression of firm growth using the inverse of a country- and industry-specific relative energy intensity (REI) mea-

sure with the corresponding industrial sector in the reference case (the U.S. industry) in addition to the inverse of the traditional energy intensity measure (EI) after controlling several firm, industry, and country variables.

Comparison of data-rich and small-scale data time series models generating probabilistic forecasts: An application to U.S. natural gas gross withdrawals

- Energy Economics---2017---Kannika Duangnate, James W. Mjelde

Time series models derived from using data-rich and small-scale data techniques are estimated to examine: 1) if data-rich methods forecast natural withdrawals better than typical small-scale data, time series methods; and 2) how the number of unobservable factors included in a data-rich model influences the model's probabilistic forecasting performance. Data rich technique employed is the factor-augmented vector autoregressive (FAVAR) approach using 179 data series; whereas the small-scale technique uses five data series. Conclusions drawn are ambiguous. Exploiting estimated factors improves the forecasting ability, but including too many factors tends to exacerbate probabilistic forecasts performance. Factors, however, may add information about seasonality for forecasting natural gas withdrawals. Results of this study indicate the necessity to examine several measures and to take into account the measure(s) that best meets the purpose of the forecasts.

Noncausality and the commodity currency hypothesis

- Energy Economics---2017---Matthijs Lof, Henri Nyberg

This paper provides new evidence on the role of exchange rates in forecasting commodity prices. Consistent with previous studies, we find that commodity currencies hold out-of-sample predictive power for commodity prices when using standard linear predictive regressions. After we reconsider the evidence using

noncausal autoregressions, which provide a better fit to the data and are able to accommodate the effects of nonlinearities and omitted variables, the predictive power of exchange rates disappears.

Burning wood pellets for US electricity generation? A regime switching analysis

- Energy Economics---2017---Bin Mei, Michael Wetstein

Applying a regime switching model under the theoretic framework of real options, we inspect the optimal timing boundaries for coal and coal mixed wood pellets as two alternative fuels for a power plant in Georgia, United States. Results indicate that cofiring wood pellets with coal is generally not a commercially viable option. However, lower-level (with wood pellets < 15%) cofiring could have been feasible during the infancy period (2009–2011) when wood pellet price was declining. Sensitivity analysis shows that our conclusions are robust and the most important factors are relative prices of coal and mixed fuel. Therefore, we reject the null hypothesis that cofiring is economically feasible and suggest using policy vehicles to stimulate the bioenergy market and meet the greenhouse gas emission reduction target. In particular, a subsidy of \$1.40/mmBtu to the 10% mixed fuel or a tax of \$1.50/mmBtu on coal would prompt the conversions of coal-only power plants to cofiring ones, and a subsidy of \$0.45/mmBtu to the 10% mixed fuel or a tax of \$0.50/mmBtu on coal would maintain existing cofiring power plants in the status quo.

Energy paths in the European Union: A model-based clustering approach

- Energy Economics---2017---Zsuzsanna Csereklői, Paul W. Thurner, Johannes Langer, Helmut Küchenhoff

This paper examines typical “energy paths”, i.e. the intertemporal development of the energy mixes of the member states of the European Union over 1971–2010. We apply model-based clustering to detect major energy profiles and their compositional dynamics. The

seven identified clusters show typical combinations of energy carriers dominating the primary energy consumption of a country. We find that countries tend to take a path towards higher quality energy mixes over time, however path inertia and dependencies arise from both infrastructure and resource endowments. Higher energy quality profiles are usually associated with higher national income and energy use per capita, providing some evidence of the existence of a national-level energy ladder. We also find convergence in energy intensity over time, and a relationship between a country's own resources and import dependency.

A two-part feed-in-tariff for intermittent electricity generation

- Energy Economics---2017---Werner Antweiler

As electricity generation from intermittent energy sources (wind, sun, tides) is gaining momentum, it becomes increasingly important to price these electricity sources efficiently. Conventional flat feed-in-tariffs ignore the heterogeneity of these sources. Taking into account the degree of substitutability or complementarity of these sources with respect to each other and with respect to stochastic demand variations, this paper derives optimal pricing instruments composed of a feed-in-tariff (FIT) and a capacity-augmentation-tariff (CAT). An empirical analysis looks at wind and solar farms operating in Ontario in order to determine the optimal use of FIT-CAT pricing. The magnitude of optimal price differentiation turns out to be economically significant. Furthermore, the emergence of grid-scale electricity storage underscores the need to price energy and capacity separately.

Habit formation and exhaustible resource risk-pricing

- Energy Economics---2017---Johnson Kakeu,Pierre Nguimkeu

This paper studies the risk-pricing implications of introducing habit formation in consumption in a model that encompasses growth with nonrenewable resources and capital markets. It is shown that the expected

return on nonrenewable resource stocks incorporates both short-run and long-run risk factors. The short-run risk factor is associated with shocks to current surplus consumption growth. The long-run risk factor reflects the investor's desire to hedge against long-run shocks to future surplus consumption prospects (long-run habit risk premium). The model is tested using energy commodities index and US aggregate real per capita consumption data, and the results confirm that habit enters significantly in the pricing equation by entertaining a long-run time-varying risk coefficient. Compared to results obtained with a no-habit formation model (time-separable preferences), we found that long-run future prospects of surplus consumption constitute a forward-looking risk factor to be taken into account in explaining the dynamics of energy prices under uncertainty.

A multi-regional input–output analysis of the pollution haven hypothesis from the perspective of global production fragmentation

- Energy Economics---2017---Zengkai Zhang,Kunfu Zhu,Geoffrey Hewings

Pollution haven hypothesis is an important debate on the environmental effects of international trade, the pattern of which has been reshaped obviously by global production fragmentation recently. The production process is distributed globally, and the pollution haven effect of international trade is becoming more complicated. For instance, intermediate product trade corresponds to the largest share of embodied emissions, and the share of emissions induced by the global value chain related trade is increasing gradually. The aim of this paper is to make a comprehensive analysis on the pollution haven hypothesis in carbon emissions embodied in three different trade patterns from global, bilateral, and national perspectives. We propose a method to parcel the pollution haven hypothesis in a multi-regional input–output analysis and discuss the contribution of production fragmentation for global emissions. It is found that international production fragmentation generates global emissions savings. The intermediate product trade has a negative balance of

avoided emissions. The final product trade becomes increasingly less environmentally effective during the period 1995–2009. There are significant differences in the environmental effects of different trade patterns for each country.

Oil price pass-through along the price chain in the euro area

- Energy Economics---2017---César Castro,Rebeca Jiménez-Rodríguez

This paper analyzes how oil price shocks are transmitted downstream to producer and consumer prices in the euro area at the highest disaggregate level. In doing so, we first generate an appropriate database that identifies each industrial production sector with its corresponding price of consumer goods for the euro area. We next estimate a constrained vector autoregressive model. Our findings show a statistically significant increase in producer prices after an oil price shock for branches with high oil consumption, although this statistical pass-through is only partial. However, there is no evidence of a significant oil price pass-through to consumer prices for most branches, which suggests the adaptability of European producers from the most branches to higher oil price pressures without transmitting them to consumers (exceptions: chemical and metal).

Effect of internal migration on the environment in China

- Energy Economics---2017---Shuddhasattwa Rafiq,Ingrid Nielsen,Russell Smyth

We examine the effect of inter-provincial migration on air and water pollution for a panel of Chinese provinces over the period 2000–2013. To do so, we employ linear and non-linear panel data models in a Stochastic Impacts by Regression on Population, Affluence and Technology (STIRPAT) framework. Results from linear and non-linear models suggest that inter-provincial migration has contributed to pollution. Second-generation linear panel data model results suggest that for every additional 10,000 inter-provincial migrants, chemi-

cal oxygen demand (COD) increases 0.27–0.58%, sulphur dioxide (SO₂) increases 0.08–0.25% and aggregate waste disposed (WST) increases 0.04–0.26%. Non-linear threshold panel model results suggest that for every additional 10,000 inter-provincial migrants, COD increases 0.2–0.5%, SO₂ increases 0.10–0.20% and WST increases 3.1–4.2%.

Marginal reductions in vehicle emissions under a dual-blend ethanol mandate: Evidence from a natural experiment

- Energy Economics---2017---Michael D. Noel,Travis Roach

Among the many reasons policy makers across the world have sought to supplement fuel supplies with ethanol-blended fuels are the cited environmental benefits that come with replacing a fossil-fuel with a cleaner burning alternative. Dual-blend ethanol mandates, in which multiple ethanol blends are simultaneously available, are one way policy makers can move forward with more aggressive mandates more quickly. The recent ethanol mandate in the state of New South Wales, Australia offers a unique natural experiment to quantify the potential environmental benefits and costs of a dual blend ethanol policy. This paper estimates the impact on carbon dioxide (CO₂) emissions from road-activity that are attributable to the implementation of the New South Wales ethanol requirements. We find that there was a decrease in emissions due to the policy, but that the decrease is relatively minor given the size of the market and that it comes at a high cost. The cost was over \$1200 per ton of carbon to reduce gasoline emissions by just 1.2%.

Transmission expansion in an oligopoly considering generation investment equilibrium

- Energy Economics---2017---S. Saeid Taheri,Jalal Kazempour,Seyedjalal Seyedshenava

Transmission expansion planning (TEP) is a sophisticated decision-making problem, especially in an oligopolistic electricity market in which a number of strategic (price-maker) producers compete together.

A transmission system planner, who is in charge of making TEP decisions, requires considering the future generation investment actions. However, in such an oligopolistic market, each producer makes its own strategic generation investment decisions. This motivates the transmission system planner to consider the generation investment decision-making problem of all producers within its TEP model. The strategic generation investment problem of each producer can be represented by a complementarity bi-level model. The joint consideration of all bi-level models, one per producer, characterizes the generation investment equilibrium that identifies the future evolution of generation investment in the market. This paper proposes a tri-level TEP decision-making model to be solved by the transmission system planner, whose objective is to maximize the social welfare of the market minus the expansion costs, and whose constraints are the transmission expansion limits as well as the generation investment equilibrium problem. This model is then recast as a mixed-integer linear programming problem and solved. Numerical results from an illustrative example and a case study based on the IEEE 14-bus test system demonstrate the usefulness of the proposed approach.

Setting the standard? A framework for evaluating the cost-effectiveness of building energy standards

- Energy Economics---2017---Maya Papineau

The adoption rate and stringency of building energy standards in the U.S. have been increasing since the mid-1990s as a result of the Energy Policy Act mandate of 1992 (EPAAct). Current evidence on the energy savings that accrue from commercial building energy standards is based on engineering simulations, which do not account for realized behaviour once a standard is actually adopted. This paper uses quasi-experimental variation in commercial building energy standard adoptions to estimate their effect on realized electricity consumption and cost-effectiveness. In states induced by EPAAct to adopt an energy standard where all new nonresidential construction was erected under a com-

mercial standard, electricity consumption per service worker is lower by about 12%, and total commercial electricity consumption is lower by 10%. Including early adopters and never-adopters to the analysis leads to a downward bias in the treatment effect. The realized electricity savings in the EPAAct states represent three quarters of predicted simulated savings, and electricity saved in 2010 came at a cost of approximately 7.7 cents per kWh.

Econometric analysis of 15-minute intraday electricity prices

- Energy Economics---2017---Rüdiger Kiesel, Florentina Paraschiv

The trading activity in the German intraday electricity market has increased significantly over the last years. This is partially due to an increasing share of renewable energy, wind and photovoltaic, which requires power generators to balance out the forecasting errors in their production. We investigate the bidding behaviour in the intraday market by looking at both last prices and continuous bidding, in the context of a reduced-form econometric analysis. A unique data set of 15-minute intraday prices and intraday-updated forecasts of wind and photovoltaic has been employed. Price bids are explained by prior information on renewables forecasts and demand/supply market-specific exogenous variables. We show that intraday prices adjust asymmetrically to both forecasting errors in renewables and to the volume of trades dependent on the threshold variable demand quote, which reflects the expected demand covered by the planned traditional capacity in the day-ahead market. The location of the threshold can be used by market participants to adjust their bids accordingly, given the latest updates in the wind and photovoltaic forecasting errors and the forecasts of the control area balances.

How much can CO2 emissions be reduced if fossil fuel subsidies are removed?

- Energy Economics---2017---Gabriela Mundaca

This paper analyzes consumers' price elasticities of

demand for fossil fuels, and how a reduction of fossil fuel subsidies can lead to important reduction in CO₂ emissions for various groups of countries that have relatively high fossil fuel subsidies and notably on diesel, including countries in the Middle East and North Africa (MENA). These countries continue to maintain significant levels of fuel subsidies, with Iran and Saudi Arabia being the largest contributors to CO₂ emissions. This paper illustrates that fuel price policy reforms by these countries would be an important instrument for both climate and economic policies. We estimate that a reduction in subsidies to both gasoline and diesel by about 20 US\$ cents per liter will lead to significant decreases in CO₂ emissions, both in the MENA region and globally. In Iran, for example, the reductions could be up to 90% and 50% of current emissions generated from diesel and gasoline consumption, respectively, and for Saudi Arabia, approximately 70% and 40%, respectively.

A wavelet analysis of mean and volatility spillovers between oil and BRICS stock markets

- Energy Economics---2017---Heni Boubaker,Syed Raza

This paper investigates the spillover effects of volatility and shocks between oil prices and the BRICS stock markets using multivariate approach and wavelet analysis at different time horizons. Hence, we combine a multivariate ARMA-GARCH model and wavelet multiresolution analysis to study this phenomenon. A bivariate ARMA(1,1)-GARCH(1,1)-cDCC-Student-t model was joined with MODWT filter to capture a broad range of possible spillover effects in mean and variances of level prices at various time horizons. Generally, empirical results provide strong evidence of time-varying volatility in all markets under study. However, our proposed approach shows that oil price and stock market prices are directly affected by their own news and volatilities and indirectly affected by the volatilities of other prices and wavelet scale. The results show also, that mean and volatility spillover effects was decomposed into many sub-spillovers on different time scales according to heterogeneous investors and

market participants. The practical implications of this study are critical, innovative and useful for the local and international investors and also for the portfolio managers. They can utilize this study to formulate the optimal oil-BRICKS stock portfolios as well as lead to more accurate predictions of volatility spillovers patterns also in developing their hedging strategies.

Energy efficiency and economic growth: A retrospective CGE analysis for Canada from 2002 to 2012

- Energy Economics---2017---Chris Bataille,Noel Melton

The efficiency with which energy is used by firms and households has widespread impacts on economic activity, which in turn has implications for environmental quality and energy security. Using a novel method that could be used for other jurisdictions, we estimate the impact of energy efficiency improvements on Canadian GDP, employment, economic structure, and welfare from 2002 to 2012. We use a counterfactual back-casting method with a sectorally and regionally disaggregated dynamic recursive computable general equilibrium model, in effect “reverse calibrating” the model from observed data to isolate the effects of energy efficiency. We estimate that total energy efficiency improvements in Canada during this period increased GDP by 2.0% (0.19%/yr), employment by 2.5% (0.24%/yr) and household welfare by about 1.5% (0.15%/yr). Additionally, energy efficiency improvements reoriented economic structure from capital intense energy supply sectors to relatively labour intense manufacturing and services. We find evidence of widespread “rebound” on an energy expenditure basis across most sectors, and “backfire” (where energy efficiency leads to absolute energy use increases) in oil sands in situ extraction, bitumen upgrading, shale gas extraction, lime production, pulp & paper, and metal smelting, but overall energy use is reduced by energy efficiency improvements over this period.

Coordination and uncertainty in strategic network investment: Case on the North Seas Grid

- Energy Economics---2017---Ioannis Konstantelos,Rodrigo Moreno,Goran Strbac

The notion of developing a transnational offshore grid in the North Sea has attracted considerable attention in the past years due to its potential for substantial capital savings and increased scope for cross-border trade, sparking a European-wide policy debate on incentivizing integrated transmission solutions. However, one important aspect that has so far received limited attention is that benefits will largely depend on the eventual deployment pattern of electricity infrastructure which is currently characterized by severe locational, sizing and timing uncertainty. Given the lack of coordination between generation and network developments across Europe, there is a real risk for over-investment or a premature lock-in to options that exhibit limited adaptability. In the near future, important choices that have to be made concerning the network topology and amount of investment. In this paper we identify the optimal, in terms of reduced cost, network investment (including topology) in the North Seas countries under four deployment scenarios and five distinct policy choices differing in the level of offshore coordination and international market integration. By drawing comparisons between the study results, we quantify the net benefit of enabling different types of coordination under each scenario. Furthermore, we showcase a novel min-max regret optimization model and identify minimum regret first-stage commitments which could be deployed in the near future in order to enhance strategic optionality, increase adaptability to different future conditions and hence reduce any potential suboptimality of the initial network design. In view of the above, we put forward specific policy recommendations regarding the adoption of a flexible anticipatory expansion framework for the identification of attractive investment opportunities under uncertainty.

Derivatives of the nodal prices in market power screening

- Energy Economics---2017---Piotr Palka

This paper proposes a novel method for market power screening. This method is developed for horizontally and vertically consolidated power markets, and is based on the optimal power flow (OPF) model properties. It undertakes the calculation and analysis of a matrix of derivatives of the nodal prices with respect to generating unit offer prices. The analysis takes into consideration the influence of particular partakers and energy groups on the nodal prices. This paper presents a theoretical analysis of the partakers' and groups' profits as well as a method for the market power screening. Moreover, the issue wherein the LMP model generates prices above the highest bidding price is discussed. Illustrative case studies and case studies based on the Polish wholesale balancing power market model are also presented.

Robust portfolio optimization for electricity planning: An application based on the Brazilian electricity mix

- Energy Economics---2017---Oswaldo L.V. Costa,Celma de Oliveira Ribeiro,Erik Eduardo Rego,Julio Michael Stern,Virginia Parente,Solange Kileber

One of the major challenges of today's policy makers and industry strategists is to achieve an electricity mix that presents a high level of energy security within a range of affordable costs and environmental constraints. Bearing in mind the planning of a more reliable electricity mix, the main contribution of this paper is to consider parameter uncertainties on the electricity portfolio optimization problem. We assume that the expected and the covariance matrix of the costs for the different energy technologies, such as gas, coal, nuclear, oil, biomass, wind, large and small hydropower, are not exactly known. We consider that these parameters belong to some uncertainty sets (box, ellipsoidal, lower and upper bounds, and convex polytopic). Three problems are analyzed: (i) finding a energy portfolio of

minimum worst case volatility with guaranteed fixed maximum expected energy cost; (ii) finding an energy portfolio of minimum worst case expected cost with guaranteed fixed maximum volatility of the energy cost; (iii) finding a combination of the expected and variance of the cost, weighted by a risk aversion parameter. These problems are written as quadratic, second order cone programming (SOCP), and semidefinite programming (SDP), so that robust optimization tools can be applied. These results are illustrated by analyzing the efficient Brazilian electricity energy mix considered in Losekann et al. (2013) assuming possible uncertainties in the vector of expected costs and covariance matrix. The results suggest that the robust approach, being by nature more conservative, can be useful in providing a reasonable electricity energy mix conciliating CO₂ emission, risk and costs under uncertainties on the parameters of the model.

Impacts of the US dollar (USD) exchange rate on economic growth and the environment in the United States

- Energy Economics---2017---Jaeseok Lee, Chengyan Yue

This paper investigates the impact of the USD exchange rate on economic growth and the environment in the United States by using a Structural Vector Autoregression (SVAR) model. The analysis is based on quarterly country-level data on the real trade weighted US dollar index, petroleum consumption, renewable energy consumption, net imports of pollution intensive products, real GDP and CO₂ emissions during the 1989–2015. The result shows that the USD exchange rate is positively related to petroleum consumption, net imports of the United States in pollution intensive industries with major U.S. trading partners, real GDP and CO₂ emissions. Moreover, petroleum consumption increases real GDP and domestic CO₂ emission levels, while net imports of pollution intensive products decrease real GDP and does not significantly affect CO₂ emissions.

Stochastic valuation of energy storage in wholesale power markets

- Energy Economics---2017---Nanpeng Yu, Brandon Foggo

Energy storage systems are well poised to mitigate uncertainties of renewable generation outputs. Grid-scale energy storage projects are major investments which call for rigorous valuation and risk analysis. This paper provides a stochastic energy storage valuation framework in wholesale power markets which considers all key revenue streams simultaneously. As part of this framework, an operational optimization model is developed to determine the energy storage system's optimal dispatch sequences. A future curve model is built to capture the volatilities of electricity prices. In addition, a frequency regulation service price forecasting model is developed. Simulation results with a realistic battery storage system reveal that the majority of the market revenues comes from frequency regulation services. Simulation results also show that both round-trip efficiency and power-to-energy ratio are crucial to the cost effectiveness of energy storage systems.

Inducing truthful revelation of generator reliability

- Energy Economics---2017---Mel T. Devine, Muireann Lynch

Liberalised electricity markets often include a capacity remuneration mechanism to allow generation firms recover their fixed costs. Various de-rating factors and/or penalties have been incorporated into such mechanisms in order to reward the unit based on the contribution they make to system security, which in turn depends on the unit's reliability. However, this reliability is known to the firm but not to the regulator. We adopt a mechanism design approach for capacity payments based on a declaration by the firm of their reliability. The mechanism scales payments and penalties according to this declared reliability such that the firm's profit-maximising strategy is to truthfully reveal its reliability. A stochastic mixed complementarity problem (MCP) is used to model the interactions between the

firms, and we apply this methodology to a test system using Irish electricity market data. Truth-telling is induced, increasing the efficiency of capacity payments while eliminating the requirement for the regulator to allocate resources to discovering reliability.

Turbulent times: Uncovering the origins of US natural gas price fluctuations since deregulation

- Energy Economics---2017---Seth Wiggins,Xiaoli Etienne

In this paper, we investigate supply and demand shocks in the U.S. natural gas market, focusing on how the effects of these shocks have changed over time. Using a sign-identified structural vector autoregression (SVAR) model that allows for both time-varying parameters and stochastic volatility, we find that supply and demand shocks are the main drivers of natural gas price fluctuations during 1993–2015, with speculative activities playing a minor role during a portion of the sample period. We also find that after the recent shale boom, the supply and demand of natural gas in the US have become somewhat more elastic. An examination of several volatile episodes during the sample period suggest that though natural gas price fluctuations are predominately determined by fundamental factors, supply and demand shocks have significantly evolved over time.

Foreign direct investment, income, and environmental pollution in developing countries: Panel data analysis of Latin America

- Energy Economics---2017---Pratikshya Sapkota,Umesh Bastola

Effects of foreign direct investment (FDI) and income on pollution emissions are examined using time series data from 1980 to 2010 for 14 Latin American countries. Specifically, we test the validity of Pollution Haven Hypothesis (PHH) and Environmental Kuznets Curve (EKC) hypothesis for this region. Results from panel fixed and random effects models that controlled the effects of physical capital, energy, human capital, population density, and unemployment

rate indicate the validity of both the PHH and EKC hypothesis. Estimating two separate models for high and low-income countries does not alter the findings for the PHH, however, the impacts of human capital on pollution emission are found to be different for the two groups of countries. Policies that focus on attracting clean and energy efficient industries through FDI have potential to improve environmental health while enhancing economic growth in Latin America.

Does risk aversion affect transmission and generation planning? A Western North America case study

- Energy Economics---2017---Francisco D. Munoz,Adriaan van der Weijde,Benjamin F. Hobbs,Jean-Paul Watson

We investigate the effects of risk aversion on optimal transmission and generation expansion planning in a competitive and complete market. To do so, we formulate a stochastic model that minimizes a weighted average of expected transmission and generation costs and their conditional value at risk (CVaR). We show that the solution of this optimization problem is equivalent to the solution of a perfectly competitive risk-averse Stackelberg equilibrium, in which a risk-averse transmission planner maximizes welfare after which risk-averse generators maximize profits. This model is then applied to a 240-bus representation of the Western Electricity Coordinating Council, in which we examine the impact of risk aversion on levels and spatial patterns of generation and transmission investment. Although the impact of risk aversion remains small at an aggregate level, state-level impacts on generation and transmission investment can be significant, which emphasizes the importance of explicit consideration of risk aversion in planning models.

Strategic real option and flexibility analysis for nuclear power plants considering uncertainty in electricity demand and public acceptance

- Energy Economics---2017---Michel-Alexandre Cardin,Sizhe Zhang,William Nuttall

Nuclear power is an important energy source especially in consideration of CO₂ emissions and global warming. Deploying nuclear power plants, however, may be challenging when uncertainty in long-term electricity demand and more importantly public acceptance are considered. This is true especially for emerging economies (e.g., India, China) concerned with reducing their carbon footprint in the context of growing economic development, while accommodating a growing population and significantly changing demographics, as well as recent events that may affect the public's perception of nuclear technology. In the aftermath of the Fukushima Daiichi disaster, public acceptance has come to play a central role in continued operations and deployment of new nuclear power systems worldwide. In countries seeing important long-term demographic changes, it may be difficult to determine the future capacity needed, when and where to deploy it over time, and in the most economic manner. Existing studies on capacity deployment typically do not consider such uncertainty drivers in long-term capacity deployment analyses (e.g., +40years). To address these issues, this paper introduces a novel approach to nuclear power systems design and capacity deployment under uncertainty that exploits the idea of strategic flexibility and managerial decision rules. The approach enables dealing more pro-actively with uncertainty and helps identify the most economic deployment paths for new nuclear capacity deployment over multiple sites. One novelty of the study lies in the explicit recognition of public acceptance as an important uncertainty driver affecting economic performance, along with long-term electricity demand. Another novelty is in how the concept of flexibility is exploited to deal with uncertainty and improve expected lifecycle performance (e.g. cost). New design and deployment strategies are developed and analyzed through a multistage stochastic programming framework where decision rules are represented as non-anticipative constraints. This approach provides a new way to devise and analyze adaptation strategies in view of long-term uncertainty fluctuations that is more intuitive and readily usable by system operators than typical solutions obtained from standard real options analysis techniques, which are typically

used to analyze flexibility in large-scale, irreversible investment projects. The study considers three flexibility strategies subject to uncertainty in electricity demand and public acceptance: 1) phasing (or staging) capacity deployment over time and space, 2) on-site capacity expansion, and 3) life extension. Numerical analysis shows that flexible designs perform better than rigid optimal design deployment strategies, and the most flexible design combining the above strategies outperforms both more rigid and less flexible design alternatives. It is also demonstrated that a flexible design benefits from the strategies of phasing and capacity expansion most significantly across all three strategies studied. The results provide useful insights for policy and decision-making in countries that are considering new nuclear facility deployment, in light of ongoing challenges surrounding new nuclear builds worldwide.

Portfolio optimization of renewable energy assets: Hydro, wind, and photovoltaic energy in the regulated market in Brazil

- Energy Economics---2017---Daywes Pinheiro Neto,Elder Geraldo Domingues,António Paulo Coimbra,Aníbal Traça de Almeida,Aylton José Alves,Wesley Pacheco Calixto

This study proposes a methodology for risk analysis and portfolio optimization of power generation assets with hydro, wind, and solar power, considering the Regulated Contracting Environment and the Mechanism for Reallocation of Energy in Brazil. Innovative stochastic models are used to generate synthetic time series for the random variables water inflow, wind speed, solar irradiance, temperature of the photovoltaic panel, and average generation capacity of the Mechanism for Reallocation of Energy. The simulation is implemented using the Monte Carlo method associated with a Cholesky decomposition. An economic approach is presented taking into account taxation and financing, as well as the Markowitz Portfolio theory. The results show that the initial correlation between the energy resources is altered by the cash flow model and mainly by the debt. In the diversification process, the complemen-

tarity between sources helps to reduce the economic risk. The increase in debt increases the correlation, decreases the return and risk and, consequently, affects the diversification process and economic results. The Mechanism for Reallocation of Energy significantly reduces the hydroelectric economic risk and increases the financial return, which directly benefits the formation of portfolios.

The impact of socioeconomic characteristics on CO2 emissions associated with urban mobility: Inequality across individuals

- Energy Economics---2017---Germà Bel, Jordi Rosell

Concerns about the unequal distribution of greenhouse gas emissions attributable to mobility are gaining increasing attention in scholarly analyses as well as in the public policy arena. The factors influencing the emissions of individuals are largely undocumented, but they are assumed to be the same for all, be they low or high emitters. We use a household travel survey conducted in the metropolitan area of Barcelona to differentiate the factors that result in different rates of emission. It shows that the top 10% of emitters produce 49% of total emissions while ‘non-daily’ emitters make up 38.5% of the sample. We adopt a quantile regression approach, which reveals significant socioeconomic differences between groups of emitters. Gender, income and home-municipality type are influential in accounting for CO2 emissions for all groups. Educational level appears to be less significant, and occupation shows no significance at all. The study confirms the ineffective nature of toll policy design in the area. Overall, socioeconomic factors have different impacts on different emitting groups, but these characteristics do not impact equally across all the population. Quantile regression using mobility survey data gathered from various cities would provide useful evidence for improving the design of urban mobility policies.

Residential and non-residential electricity dynamics

- Energy Economics---2017---Michael P. Tonkovic, Syed Azfar Hussain

This paper uses U.S. panel data to instrument and examine the dynamics of electricity within the world market while separating between both residential and non-residential electricity consumptions during the time period of 1990–2014. To better assess the true differences within each causal relationship, all panel data has been separated into one Full panel and three subpanels of High, Middle, and Low income. The empirical framework used consists of various tests that identify the existence of cross-sectional dependency, a Pesaran panel unit root test, a Westerlund panel cointegration test, and the Dumitrescu–Hurlin method of the Granger causality test. Furthermore, this paper utilizes DOLS to estimate any long-run elastic relations between real GDP and residential or non-residential electricity consumption. Based on the results, this paper determines that no long-run relationship exists between non-residential electricity consumption and economic growth throughout and that the relationship between residential electricity consumption and economic growth possesses unit elastic behavior in the long run. Other findings throughout imply causality moves from economic growth in the direction of residential electricity consumption for all panels.

Welfare implications of capacity payments in a price-capped electricity sector: A case study of the Texas market (ERCOT)

- Energy Economics---2017---Raúl Bajo-Buenestado

The aim of this paper is to analyze the welfare consequences of introducing capacity compensation payments in restructured and liberalized electricity markets. For that purpose, we set up a two-stage framework in which two kinds of electricity generators, peak load and base load generators, choose their capacity investment levels first and then compete on the basis of bids in a centralized market to sell electricity to consumers. We use data from the Texas ERCOT to

evaluate consumers' welfare. We find that the introduction of capacity payments has two countervailing effects. On the one hand, it increases the wholesale electricity price. On the other hand, it reduces price volatility and increases the reliability of the system. We find that capacity payments are more beneficial for consumers in a perfectly competitive market than in the presence of certain degree of market power.

Construction of an efficient portfolio of power purchase decisions based on risk-diversification tradeoff

- Energy Economics---2017---Javier Contreras,Yeny E. Rodríguez,Aníbal Sosa

We present a methodology based on the tradeoff between risk and diversification in order to evaluate a purchase portfolio of energy, where the assets refer to purchasing strategies of a retailer-generator of electricity in three markets: spot, regulated and non-regulated markets. We use two measures of diversification: i) entropy based on factors, constructed by principal components analysis, and ii) entropy based on asset risk. In each case, weights for each strategy are estimated by using the interior point method, for which monthly forecasts of returns are calculated a year ahead for each market. Spot prices are modeled using an ARIMA model and bilateral contracts are modeled using growth rates. We compare risk-diversified portfolios with mean-variance portfolio. Although diversification does not necessarily mean a lower risk, we show that the mean-variance portfolio's risk is not always lower than the risk-diversified approaches. Also, we show that diversification converges to one for the highest risk portfolio, but this does not happen in the case of entropy based on factors, because one asset can participate in more than one principal component. Clearly, the mean-variance approach is unable to perform a diversified allocation. These results are useful for retailer-generators who want combine the criteria of risk and diversification.

The Seven Sisters versus OPEC: Solving the mystery of the petroleum market structure

- Energy Economics---2017---José Noguera

This paper provides an explanation of the changing behavior of the crude oil market and tests it using the U.S. data from January 1913 to September 2014. We claim that the crude oil market has experienced two important structural breaks in its industrial organization. The first occurred when Venezuela and the Arab crude oil exporting countries forced the so-called Seven Sisters to sign the Fifty-Fifty profit-sharing agreements. The second occurred after OPEC succeeded in cracking the secrets of the international crude oil marketing and in undertaking the wave of nationalizations of the 1970s.

Measurement of returns to scale on large photovoltaic power stations in the United States and Germany

- Energy Economics---2017---Toshiyuki Sueyoshi,Mika Goto

This study discusses how to classify the type of RTS (Returns to Scale) in the framework of DEA production analysis under the assumption on a unique optimal solution on projection and a reference set. The RTS measurement is classified into two categories: input-based RTS and output-based RTS. The two measures depend upon the sign of an intercept (σ) of a supporting hyperplane on a production possibility set. In the DEA framework, multiple solutions usually occur on the intercept. This study discusses how to handle such an occurrence of multiple intercepts within the framework of the input-based and output-based RTS classifications. As an application, this study applies the proposed approach to classify the type of RTS on large photovoltaic power stations, often referred to as “mega solar parks”, in the United States (US) and Germany. The input-based RTS measurement identifies that US photovoltaic power stations are classified into increasing (64 stations: 80.0%), constant (5 stations: 6.3%) and decreasing (11 stations: 13.8%), respectively. German photovoltaic power stations are classified into increasing (73 stations: 91.3%), constant (7 stations: 8.8%) and decreasing (0 station: 0.0%), respectively. The finding is confirmed by the output-based RTS measurement on the German photovoltaic

power stations. However, the output-based RTS on US photovoltaic power stations shows an opposite result. The US photovoltaic power stations are classified into increasing (26 stations: 32.5%), constant (6 stations: 7.5%) and decreasing (48 stations: 60.0%), respectively. The decreasing RTS is because the US photovoltaic power stations have less efficiently operated than those of Germany in such a manner that they cannot produce sufficient outputs from a given level of inputs in such a manner that they have failed to utilize a scale merit for their operations.

Costs of meeting a cellulosic biofuel mandate with perennial energy crops: Implications for policy

- Energy Economics---2017---Ruiqing Miao, Madhu Khanna

We develop an analytical framework to examine the extent to which farmers' risk and time preferences, availability of credit to cover establishment cost, and subsidized crop insurance for conventional crops influence the decision to allocate land to a perennial energy crop and affect the costs of meeting a biofuel mandate using this crop as feedstock and its implications for the effectiveness of two alternative policies to supplement the mandate: an establishment cost subsidy and subsidized energy crop insurance. We examine the design of these policies to minimize the total (public and private) costs for meeting a one-billion-gallon biofuel mandate by using miscanthus as feedstock. We find that a high degree of risk aversion, high discount rate, credit constraint, and availability of crop insurance for conventional crops can increase the cost of producing enough biomass for a one-billion-gallon biofuel mandate by up to 43% and increase the land required by 16% as compared to otherwise; removal of subsidized crop insurance and credit constraints could lower these costs by 50%. We find that in most cases the cost-effective energy crop insurance subsidy rate is 0% whereas the cost-effective establishment cost subsidy rate is 100%. Relative to the case with no policy intervention for energy crops, energy crop insurance can reduce the total costs (net of government expenditures on subsidies) of

meeting the 1 billion gallon mandate by 1.3% whereas establishment cost subsidy can reduce these costs by 34%.

Correcting the uneven burden sharing of emission reduction across provinces in China

- Energy Economics---2017---Lin Zhang

Although China committed to reduce its energy and emission intensity, the allocation of such national targets in the provincial level is still a political negotiation process and lack of a systematic principle from the perspective of efficiency. This paper proposes an allocation principle based on the efficiency levels. The efficiency levels are estimated by employing a stochastic frontier analysis approach and the links between energy intensity and efficiency are constructed. The results show that energy efficiency change is not the major contributor to energy intensity reduction. Furthermore, this analysis indicates that (i) the efficiency-based allocation can distribute reduction burdens among regions smoothly compared to the intensity-based allocation; and (ii) the national target of emission intensity reduction can be achieved solely through efficiency measures.

Modeling net energy balance of ethanol production from native warm season grasses

- Energy Economics---2017---Prabodh Illukpitiya, K.C. Reddy, Ankit Bansal

There has been an increasing interest in the use of perennial grasses as potential feedstock for ethanol production. The characteristics which make perennial grasses attractive for bioenergy feedstock development initiative are their high yield potential and the high contents of lignin and cellulose. The objective of the study is to model energy input and output and simulate Net Energy Value (NEV) of producing ethanol from native warm season grasses. According to simulated results, the mean NEV of ethanol production from native warm season grasses considered in the analysis was positive. Mean NEV for switchgrass and eastern gamagrass was higher compared to Indiangrass and

big bluestem. Although the probability of having positive NEV is high, there is a risk of having negative energy balance under low output scenarios.

Demystifying RINs: A partial equilibrium model of U.S. biofuel markets

- Energy Economics---2017---Christina Kort-ing,David Just

We explore four fundamental channels of mandate compliance available under current U.S. biofuel policy: increased ethanol blending through E10 or E85, increased biodiesel blending, and a reduction in the overall compliance base. Simulation results highlight the interplay and varying importance of these channels at increasing blend mandate levels. In addition, we establish how RIN prices are formed: The value of a RIN in equilibrium is shown to reflect the marginal cost of compensating the blender for employing one additional ethanol-equivalent unit of biofuel. This contrasts with existing research equating the price of RINs to the gap between ethanol supply and demand evaluated at the mandate level. We demonstrate the importance of this distinction in case of binding demand side infrastructure constraints such as the ethanol blend wall: as percentage blend mandates increase, the market for low-ethanol blends may contract in order to reduce the overall compliance base. This has important implications for implied ethanol demand in the economy.

Economic and technical challenges of flexible operations under large-scale variable renewable deployment

- Energy Economics---2017---John Bistline

Fundamental characteristics of solar and wind power have generated controversy about their economic competitiveness and appropriate techniques for assessing their value. This research presents an approach to quantify the economic value of variable renewable capacity and demonstrates its dependence on renewable deployment levels, regional resource endowments, fleet flexibility, and trade assumptions. It assesses economic

and technical impacts of large-scale renewable penetration by linking two models, representing electric-sector investments and detailed operations. Model results for California and Texas suggest that operational constraints and costs of dispatchable generators (e.g., minimum load levels, ramping limits, startup costs) can impact renewable integration costs, but the temporal and spatial variability of solar and wind are larger determinants of their value. Restrictions on transmission and regional coordination in capacity planning and dispatch decrease the economic value of variable renewable energy, highlighting the potential roles of market design and trade. Energy storage is shown to be a valuable balancing asset at higher solar and wind penetration levels, but potential revenues diminish with increased storage deployment.

Spatial statistical methods applied to the 2015 Brazilian energy distribution benchmarking model: Accounting for unobserved determinants of inefficiencies

- Energy Economics---2017---Guilherme Dôco Roberti Gil,Marcelo Azevedo Costa,Ana Lúcia Miranda Lopes,Vinícius Diniz Mayrink

In 2015 the Brazilian regulator presented a DEA benchmarking model to set the regulatory operational cost goals, to be reached in four years for 61 electricity distribution utilities. The DEA model uses: adjusted operational cost as the input variable, seven output variables and weight restrictions. Although non-discretionary variables or environmental variables are available in the dataset, the regulator argued that no statistically significant correlation was found between the DEA efficiency scores and the non-discretionary variables. This study evaluates the statistical correlation between the DEA efficiency scores and the available environmental variables. Spatial statistic methods are used to show that the efficiency scores are geographically correlated. Furthermore, due to Brazil's environmental diversity and large territory it is unlikely that only one environmental component is sufficient to adjust inefficiencies across the Brazilian territory. Thus, a new combined environmental variable is proposed. Finally, a second

stage model using the proposed environmental variable and accounting for a spatial latent structure is presented. Results show major differences between original and corrected efficiency scores, mainly for utilities located in harsh environments and which originally achieved lower efficiency scores.

Market and welfare effects of renewable portfolio standards in United States electricity markets

- Energy Economics---2017---Suparna Bhat-tacharya,Konstantinos Giannakas,Karina Schoengold

This study analyzes the market and welfare effects of the introduction of Renewable Portfolio Standards (RPS) while considering the empirically relevant (a) interaction of compliance with voluntary green power markets, (b) differences in consumer preferences, and (c) imperfect competition among electricity suppliers. The study accounts for both the supply and demand effects of RPS — i.e., increased costs and a higher consumer valuation for regular power. Our analysis shows that the regular power price always increases after the introduction of RPS, while the effect of RPS on the equilibrium price of green power, the quantities of regular and green power, the welfare of consumers, and suppliers' profits is case-specific and dependent on the relative magnitude of the cost and utility effects, the strength of consumer preference for green power, the suppliers' costs before RPS, the impact of RPS on green power costs, and the degree of competition among power suppliers. While the introduction of RPS aims at increasing the use of green energy in electricity production, our analysis shows that the introduction of the policy can end up reducing the total quantity of green power used. Intriguingly, this adverse policy impact will occur under seemingly optimal conditions for the green power sector; i.e., a high consumer valuation of green energy and/or low cost difference between the green power and its conventional counterpart. Finally, the analysis shows that the policy design can play a key role in determining the incidence of RPS, while the identification of the winners and losers of the policy can provide insights on the political economy of RPS

and the positions held by different groups in policy negotiations.

Demand-side management by electric utilities in Switzerland: Analyzing its impact on residential electricity demand

- Energy Economics---2017---Nina Boogen,Souvik Datta,Massimo Filippini

In this paper, we use panel data from a survey conducted on 30 utilities in Switzerland to estimate the impact of demand-side management (DSM) activity on residential electricity demand. Using the variation in DSM activity within utilities and across utilities over time we identify the impact of DSM programs and find that their presence reduces per customer residential electricity consumption by around 5%. If we consider monetary spending, the effect of a 10% increase in DSM spending causes a 0.14% reduction in per customer residential electricity consumption. The cost of saving a kilowatt hour is around 0.04CHF while the average cost of producing and distributing electricity in Switzerland is around 0.18CHF per kilowatt hour. We conclude that current DSM practices in Switzerland have a statistically significant effect on reducing the demand for residential electricity.

Hedging size risk: Theory and application to the US gas market

- Energy Economics---2017---Andrea Roncoroni,Rachid Id Brik

Many corporate commitments exhibit a combined financial exposure to both market prices and idiosyncratic size components (e.g., volume, load, or business turnover). We design a customized contract to optimally mitigate the risk of joint fluctuations in price and size terms. The hedge is sought out among contingent claims written on price and any quoted index that is statistically dependent on commitment size. Closed-form solutions are derived for the optimal custom hedge pay-off and for the asset holdings of two market strategies, one based on price-linked forwards,

the other based on price-linked and index-linked forwards. Analytical hedges are obtained using a stylized lognormal market model. Detailed comparative statics provide a thorough analysis of optimal hedging pay-off functions. Performance assessment is conducted in the context of the US gas market and a prototypical urban region. Results suggest that hedging through suitable custom claims written on price and an additional index significantly outperforms standard price-based as well as mixed price-index forward hedging alternatives. Our optimal custom hedge could be adopted as a benchmark for the relative assessment of any risk management solution.

Generating options-implied probability densities to understand oil market events

- Energy Economics---2017---Deepa Dhume Datta,Juan M. Londono,Landon J. Ross

We investigate the informational content of options-implied probability density functions (PDFs) for the future price of oil. Using a semiparametric variant of the methodology in Breeden and Litzenberger (1978), we investigate the fit and smoothness of distributions derived from alternative PDF estimation methods, and develop a set of robust summary statistics. Using PDFs estimated around episodes of high geopolitical tensions, oil supply disruptions, macroeconomic data releases, and shifts in OPEC production strategy, we explore the extent to which oil price movements are expected or unexpected, and whether agents believe these movements to be persistent or temporary.

Empirical evidence of news about future prospects in the risk-pricing of oil assets

- Energy Economics---2017---Johnson Kakeu,Mohammed Bouaddi

This empirical paper investigates the relevance of long-run risks associated with uncertainty shocks to future growth prospects (news about future prospects) for explaining the risk-pricing of oil stocks. An econometric method that incorporates dynamic factor analysis is used for estimating the pricing equation of oil

stocks. The results indicate that oil investors care about long-run risks associated with future growth prospects. Long-run risks account for almost half of the total risk-premium of oil stocks. Long-run risks associated with future growth prospects are significantly shaped by latent factors related to the labor market, the price indices, and financial markets. Moreover, our estimated model captures some historical events including the oil crisis of the seventies, the economic crisis of the mid-eighties, the stock market crash of 1987, and the economic crises of 1998 and 2000.

Where do jobs go when oil prices drop?

- Energy Economics---2017---Ana María Herrera,Mohamad Karaki,Sandeep Kumar Rangaraju

In this paper, we estimate a factor augmented vector autoregressive (FAVAR) model to investigate the effect of oil price shocks on total private job flows as well as on industry-level job creation and destruction. Following an unexpected oil price drop in the first year, we find that in oil and gas extraction and support activities for mining exhibit a reduction in job creation and an increase in job destruction. Instead, industries in construction, manufacturing and services exhibit an increase in the net employment change. An unexpected decline in the real oil price slows down the pace of gross job reallocation. We demonstrate that the increase (decrease) in private job destruction (creation) observed during the first year is primarily driven by the response of closing (expanding) firms in services and manufacturing.

Testing substitution between private and public storage in the U.S. oil market: A study on the U.S. Strategic Petroleum Reserve

- Energy Economics---2017---Daniel Scheitrum,Colin Carter,Amy Myers Jaffe

The U.S. Strategic Petroleum Reserve (SPR) was established in 1975 to mitigate major oil supply disruptions and to deter the use of energy as a geopolitical “weapon.” However, policies towards the utilization of

strategic oil stocks have varied under different presidencies and the SPR has often not been used in sufficient quantity or soon enough to avoid the negative economic consequences that can follow oil supply outages. Economic theory suggests that the existence of public stockpiles of commodities will alter inventory management practices of private market participants. This paper models private crude oil storage in the United States and estimates the private storage response to presidential announcements regarding the SPR. We investigate the incidence of different kinds of announcement events including releases and test sales from the SPR, announced changes in fill rates, and changes of presidency and how these events impact private land-based storage in the United States by region (PADD) as well floating storage. We find significant substitution between private and public stocks for crude oil and find that announcement events are associated with observable changes in private inventory levels, with implications for public policy choices and geopolitical strategies.

Diversifying away the risk of war and cross-border political crisis

- Energy Economics---2017---Ayman M.A. Omar,Tomasz Piotr Wisniewski,Sandra Nolte

This paper investigates the behavior of crude oil prices, government bonds, and stock market indices around outbreaks of severe international crises and wars. Using a constant mean return event study, we show that these events are associated with positive and significant abnormal returns on oil and bonds, which means that these two asset classes can potentially shelter shareholders from plummeting equity values during international crises. A formal safe haven analysis confirms this insight. Such price movements may reflect a reallocation of funds across asset classes in response to the events, as well as shifts in the demand for oil due to precautionary, speculative, and military motives. We also calculate the weights for optimal portfolios, which could provide insurance against conflict risk.

The long-run oil–natural gas price relationship and the shale gas revolution

- Energy Economics---2017---Massimiliano Caporin,Fulvio Fontini

The gas extraction technological developments of the 2000s have allowed shale gas production, which in the US has become a significant part of the total gas production. Such a significant change might have affected the long-run relationship between oil and natural gas prices postulated by several authors. By using monthly data of oil and gas prices, as well as gas quantities from 1997 to 2013, we test for the presence of a long-run relationship, allowing also for possible breaks. We first show the stationarity of gas quantity data before the production of shale gas and the existence of a break in the trend (and in the intercept) on the integrated gas price time series, by the time shale gas enters the market. Then, applying a Vector Error Correction Model, we show that shale gas production has affected the relationship across variables. Gas quantities become relevant in the formation of gas prices after the beginning of shale gas production, while impact of oil prices on the gas ones doubles. However, on the basis of the available data, it is not unequivocally possible to assess whether or not a new long-run relationship between oil and gas has been established.

Shaking Dutch grounds won't shatter the European gas market

- Energy Economics---2017---Franziska Holz,Hanna Brauers,Philipp Richter,Thorsten Roobeek

The Netherlands have been a pivotal supplier in Western European natural gas markets in the last decades. Recent analyses show that the Netherlands would play an important role in replacing Russian supplies in Germany and France in case of a Russian export disruption. Lately, however, the Netherlands have suffered from a series of earthquakes that are related to the natural gas production in the major Groningen field. By consequence, natural gas production rates – that are politically mandated in the Netherlands – have been substantially reduced, by almost 45% in 2015 compared

to 2013-levels. We implement this reduced production path for the next decades in the Global Gas Model and analyse the geopolitical impacts. We find that the diversification of European natural gas imports allows spreading the replacement of Dutch natural gas over many alternative sources, with diverse pipeline and LNG supplies. There will be hardly any price or demand reduction effect. Even if Russia fails to supply Europe, the additional impact of the lower Dutch production is moderate. Hence, the European consumers need not to worry about the declining Dutch natural gas production and their security of supplies.

Identifying the main uncertainty drivers of energy security in a low-carbon world: The case of Europe

- Energy Economics---2017---Céline Guivarch,Stéphanie Monjon

This analysis contributes to recent efforts to better understand the evolution of energy security in a low-carbon world. Our objective was to assess how energy security may change over the course of the century, and to what extent these changes depend on the uncertainty of the factors that drive the evolution of energy systems, including future technologies, improved energy efficiency, fossil fuel resources and markets, and economic growth. To this end, we focused on Europe and on a set of energy security indicators based on three perspectives: sovereignty, robustness and resilience. A database of scenarios allowed us to account for the large uncertainties surrounding the determinants of future energy systems. We then analyzed the way energy security indicators evolve over time, and how their trajectories vary across scenarios. We identified the indicators that vary the most between scenarios, i.e., the indicators whose future evolution is the most uncertain. For these indicators, we performed an analysis of variance to estimate the contribution of each driver to the uncertainty of the indicators. The paper shows that the European double target of significantly decreasing CO₂ emissions and increasing the security of the supply of energy may be difficult to reach. Nevertheless, some levers could facilitate the transition to

a low-carbon society while improving energy security, or by limiting its degradation. The results emphasize not only the importance of policies in favor of low or zero carbon technologies in power generation but also the differences in their contributions to the complete uncertainty of the indicators. Policies promoting energy efficiency also play a role but only in the resilience of TPES. These policies are thus important levers for mitigating the negative impacts of climate policies on energy security.

Assessment of wind and solar power in global low-carbon energy scenarios: An introduction

- Energy Economics---2017---Gunnar Luderer,Robert C. Pietzcker,Samuel Carrara,Harmen Sytze de Boer,Shinichiro Fujimori,Nils Johnson,Silvana Mima,Douglas Arent

This preface introduces the special section on the assessment of wind and solar in global low-carbon energy scenarios. The special section documents the results of a coordinated research effort to improve the representation of variable renewable energies (VRE), including wind and solar power, in Integrated Assessment Models (IAM) and presents an overview of the results obtained in the underlying coordinated model inter-comparison exercise.

An improved global wind resource estimate for integrated assessment models

- Energy Economics---2017---Kelly Eureka,Patrick Sullivan,Michael Gleason,Dylan Hettinger,Donna Heimiller,Anthony Lopez

This paper summarizes initial steps to improving the robustness and accuracy of global renewable resource and techno-economic assessments for use in integrated assessment models. We outline a method to construct country-level wind resource supply curves, delineated by resource quality and other parameters. Using mesoscale reanalysis data, we generate estimates for wind quality, both terrestrial and offshore, across the globe. Because not all land or water area is suitable for development, appropriate database layers provide

exclusions to reduce the total resource to its technical potential. We expand upon estimates from related studies by: using a globally consistent data source of uniquely detailed wind speed characterizations; assuming a non-constant coefficient of performance for adjusting power curves for altitude; categorizing the distance from resource sites to the electric power grid; and characterizing offshore exclusions on the basis of sea ice concentrations. The product, then, is technical potential by country, classified by resource quality as determined by net capacity factor. Additional classifications dimensions are available, including distance to transmission networks for terrestrial wind and distance to shore and water depth for offshore. We estimate the total global wind generation potential of 560 PWh for terrestrial wind with 90% of resource classified as low-to-mid quality, and 315 PWh for offshore wind with 67% classified as mid-to-high quality. These estimates are based on 3.5MW composite wind turbines with 90m hub heights, 0.95 availability, 90% array efficiency, and 5MW/km² deployment density in non-excluded areas. We compare the underlying technical assumption and results with other global assessments.

Application of a high-detail energy system model to derive power sector characteristics at high wind and solar shares

- Energy Economics---2017---Yvonne Scholz,Hans Christian Gils,Robert C. Pietzcker

Solar irradiation and wind speed vary with climatic, as well as seasonal and daily weather conditions. In order to represent these variable renewable energy (VRE) resources in specialized energy system models, high temporal and spatial resolution information on their availability is used. In contrast, integrated assessment models (IAM), typically characterized by long-term time scales and low temporal and spatial resolution, require aggregated information on VRE availability and balancing requirements at various levels of VRE penetration and mix. Parametric studies that provide such information typically regard solar energy synonymously with photovoltaic power generation. However, solar energy can also be harvested with concentrating

solar power (CSP) plants, which can be dispatchable if equipped with thermal storage. Accounting for this dispatchable use of the variable solar resource can change the balancing requirements at any solar energy penetration level. In this paper, we present an application of the high-resolution energy system model REMix to a set of European supply scenarios with theoretical VRE shares ranging from 0% to 140%, three solar-to-wind ratios, with CSP included in the solar share. We evaluate balancing measures, curtailments and costs and compare the findings to previous results in which CSP is regarded a backup option among other dispatchable power plants. The results show that CSP potentials in Europe are widely exploited in most scenarios. System costs are found to be lowest for wind-dominated systems or balanced mixes of wind and solar and for an overall VRE share between 40% for a low and 80% for a high scenario of the future CO₂ emission certificate price. The comparison with previous results shows that storage capacity is the only system variable that is significantly affected by allocating CSP to the VRE resources category. It is reduced by 24% on average across all VRE shares and proportions and by around 80% at most.

System integration of wind and solar power in integrated assessment models: A cross-model evaluation of new approaches

- Energy Economics---2017---Robert C. Pietzcker,Falko Ueckerdt,Samuel Carrara,Harmen Sytze de Boer,Jacques Després,Shinichiro Fujimori,Nils Johnson,Alban Kitous,Yvonne Scholz,Patrick Sullivan,Gunnar Luderer

Mitigation-Process Integrated Assessment Models (MP-IAMs) are used to analyze long-term transformation pathways of the energy system required to achieve stringent climate change mitigation targets. Due to their substantial temporal and spatial aggregation, IAMs cannot explicitly represent all detailed challenges of integrating the variable renewable energies (VRE) wind and solar in power systems, but rather rely on parameterized modeling approaches. In the ADVANCE project, six international modeling teams have devel-

oped new approaches to improve the representation of power sector dynamics and VRE integration in IAMs.

Representation of variable renewable energy sources in TIMER, an aggregated energy system simulation model

- Energy Economics---2017---(H.S.) de Boer, Harmen Sytze,(D.P.) van Vuuren, Detlef

The power system is expected to play an important role in climate change mitigation. Variable renewable energy (VRE) sources, such as wind and solar power, are currently showing rapid growth rates in power systems worldwide, and could also be important in future mitigation strategies. It is therefore important that the electricity sector and the integration of VRE are correctly represented in energy models. This paper presents an improved methodology for representing the electricity sector in the long-term energy simulation model TIMER using a heuristic approach to find cost optimal paths given system requirements and scenario assumptions. Regional residual load duration curves have been included to simulate curtailments, storage use, backup requirements and system load factor decline as the VRE share increases. The results show that for the USA and Western Europe at lower VRE penetration levels, backup costs form the major VRE cost markup. When solar power supplies more than 30% of the electricity demand, the costs of storage and energy curtailments become increasingly important. Storage and curtailments have less influence on wind power cost markups in these regions, as wind power supply is better correlated with electricity demand. Mitigation scenarios show an increasing VRE share in the electricity mix implying also increasing contribution of VRE for peak and mid load capacity. In the current scenarios, this can be achieved by at the same time installing less capital intensive gas fired power plants. Sensitivity analysis showed that greenhouse gas emissions from the electricity sector in the updated model are particularly sensitive to the availability of carbon capture and storage (CCS) and nuclear power and the costs of VRE.

Including system integration of variable renewable energies in a constant elasticity of substitution framework: The case of the WITCH model

- Energy Economics---2017---Samuel Carara,Giacomo Marangoni

The penetration of variable renewable energies (VREs) in the electricity mix poses serious challenges in terms of management of the electrical grids, as the associated variability is in contrast with the requirement that the load be instantaneously equalized by the generation. One of the goals of Integrated Assessment Models (IAMs) is to simulate the evolution of electricity demand and generation mix over time, therefore a proper modeling of VRE system integration is crucial.

The impacts on climate mitigation costs of considering curtailment and storage of variable renewable energy in a general equilibrium model

- Energy Economics---2017---Hancheng Dai,Shinichiro Fujimori,Diego Silva Herran,Hiroto Shiraki,Toshihiko Masui,Yuzuru Matsuoka

The curtailment and storage associated with the fluctuation of electricity supplied by variable renewable energy (VRE) may limit its penetration into electricity systems. Therefore, these factors need to be explicitly treated in the integrated assessment models (IAMs). This study improves the representation of curtailment and storage of VRE in a computable general equilibrium (CGE) model. With the data generated from an hourly power sector model, curtailment and storage of VRE electricity are treated as a function of the shares of solar and wind in the electricity mix. This relationship is incorporated into a CGE model and we also updated the VRE costs and resource potential. The results show that with such improvement, by 2100, in a 450 ppm atmospheric CO₂ equivalent concentration (henceforth ppm) scenario, some electricity generated from VRE is either curtailed (2.1%) or needs to be stored (2.9%). In contrast, if VRE fluctuation is not considered, the long-term global economic cost of carbon mitigation is significantly underestimated (by

52%) in the same scenario. Conversely, updating the VRE costs and resource potential leads to a decrease in mitigation costs. Our simulation implies that the fluctuation of VRE cannot be ignored and needs to be incorporated into CGE models. Moreover, in addition to storage with batteries, many other options are available to reduce curtailment of VRE. The top-down type CGE model has limitations to fully incorporate all aspects due to its limited spatial, temporal, and technological resolution.

Storage as a flexibility option in power systems with high shares of variable renewable energy sources: a POLES-based analysis

- Energy Economics---2017---Jacques Després,Silvana Mima,Alban Kitous,Patrick Criqui,Nouredine Hadjsaid,Isabelle Noirot

In this paper, we demonstrate the role of electricity storage for the integration of high shares of variable renewable energy sources (VRES) in the long-term evolution of the power system. For this, a new electricity module is developed in POLES (Prospective Outlook on Long-term Energy Systems). It now takes into account the impacts of VRES on the European power system. The power system operation relies on EUCAD (European Unit Commitment and Dispatch), which includes daily storage and other inter-temporal constraints. The innovative aspect of our work is the direct coupling between POLES and EUCAD, thus combining a long-term simulation horizon and a short-term approach for the power system operation. The storage technologies represented are pumped-hydro storage, lithium-ion batteries, adiabatic compressed air energy storage (a-CAES) and electric vehicles (charging optimisation and vehicle-to-grid). Demand response and European grid interconnections are also represented in order to include, to some extent, these flexibility options.

A reduced-form approach for representing the impacts of wind and solar PV deployment on the structure and operation of the electricity system

- Energy Economics---2017---Nils Johnson,Manfred Strubegger,Madeleine McPherson,Simon C. Parkinson,Volker Krey,Patrick Sullivan

In many climate change mitigation scenarios, integrated assessment models of the energy and climate systems rely heavily on renewable energy technologies with variable and uncertain generation, such as wind and solar PV, to achieve substantial decarbonization of the electricity sector. However, these models often include very little temporal resolution and thus have difficulty in representing the integration costs that arise from mismatches between electricity supply and demand. The global integrated assessment model, MESSAGE, has been updated to explicitly model the trade-offs between variable renewable energy (VRE) deployment and its impacts on the electricity system, including the implications for electricity curtailment, backup capacity, and system flexibility. These impacts have been parameterized using a reduced-form approach, which allows VRE integration impacts to be quantified on a regional basis. In addition, thermoelectric technologies were updated to include two modes of operation, baseload and flexible, to better account for the cost, efficiency, and availability penalties associated with flexible operation. In this paper, the modeling approach used in MESSAGE is explained and the implications for VRE deployment in mitigation scenarios are assessed. Three important stylized facts associated with integrating high VRE shares are successfully reproduced by our modeling approach: (1) the significant reduction in the utilization of non-VRE power plants; (2) the diminishing role for traditional baseload generators, such as nuclear and coal, and the transition to more flexible technologies; and (3) the importance of electricity storage and hydrogen electrolysis in facilitating the deployment of VRE.

Decarbonizing global power supply under region-specific consideration of challenges and options of integrating variable renewables in the REMIND model

- Energy Economics---2017---Falko Ueckerdt,Robert Pietzcker,Yvonne Scholz,Daniel Stetter,Anastasis Giannousakis,Gunnar Luderer

We present two advances in representing variable renewables (VRE) in global energy-economy-climate models: accounting for region-specific integration challenges for eight world regions and considering short-term storage. Both advances refine the approach of implementing residual load duration curves (RLDCs) to capture integration challenges. In this paper we derive RLDCs for eight world regions (based on region-specific time series for load, wind and solar) and implement them into the REMIND model. Therein we parameterize the impact of short-term storage using the highly-resolved model DIMES. All RLDCs and the underlying region-specific VRE time series are made available to the research community. We find that the more accurate accounting of integration challenges in REMIND does not reduce the prominent role of wind and solar in scenarios that cost-efficiently achieve the 2°C target. Until 2030, VRE shares increase to about 15–40% in most regions with limited deployment of short-term storage capacities (below 2% of peak load). The REMIND model's default assumption of large-scale transmission grid expansion allows smoothening variability such that VRE capacity credits are moderate and curtailment is low. In the long run, VRE become the backbone of electricity supply and provide more than 70% of global electricity demand from 2070 on. Integration options ease this transformation: storage on diurnal and seasonal scales (via flow batteries and hydrogen electrolysis) and a shift in the non-VRE capacity mix from baseload towards more peaking power plants. The refined RLDC approach allows for a more accurate consideration of system-level impacts of VRE, and hence more robust insights on the nature of power sector decarbonization and related economic impacts.

The real options to shutdown, startup, and abandon: U.S. electricity industry evidence

- Energy Economics---2017---Stein-Erik Fleten,Erik Haugom,Carl J. Ullrich

The purpose of this paper is to examine empirically the partially irreversible decisions to shutdown, startup, and abandon existing production assets under cash flow uncertainty and regulatory uncertainty. We use detailed information for 1121 individual electric power generators located in the U.S. for the period 2001–2009 and find strong evidence of real options effects. We find that both profitability uncertainty and regulatory uncertainty decrease the probability of shutdown. Regulatory uncertainty also decreases the probability of startup, but we find that cash flow uncertainty increases the probability of startup, especially for large generators.

The economic viability of gas-to-liquids technology and the crude oil–natural gas price relationship

- Energy Economics---2017---David J. Ramberg,Y.H. Henry Chen,Sergey Paltsev,John E. Parsons

This paper explores the viability of a gas-to-liquids (GTL) technology and examines how GTL penetration could shape the evolution of the crude oil–natural gas price ratio. Much research has established the cointegrated relationship between crude oil and natural gas prices in the U.S. The persistently low U.S. natural gas prices in recent years seem to mark a shift in this relationship, and have led some in industry to begin considering investments in GTL capacity in the US. In order to look forward over decades when the underlying economic drivers may be outside of historical experience, we use a computable general equilibrium model of the global economy to evaluate the economic viability of GTL and its impact on the evolution of the crude oil–natural gas price ratio. Our results are negative for the potential role of GTL. In order to produce any meaningful penetration of GTL, we find it necessary to evaluate scenarios that seem extreme.

With any carbon cap GTL is not viable. Moreover, even without a carbon cap of any kind, extremely optimistic assumptions about (i) the cost and efficiency of GTL technology and about (ii) the available resource base of natural gas and the cost of extraction, before the technology penetrates and it impacts the evolution of the crude oil–natural gas price ratio.

Energy efficiency barriers in commercial and industrial firms in Ukraine: An empirical analysis

- Energy Economics---2017---Gal Hochman,Govinda R. Timilsina

Improvement in energy efficiency is one of the main options to reduce energy demand and greenhouse gas emissions. However, large-scale deployment of energy-efficient technologies is constrained by several factors. Employing a survey of 509 industrial and commercial firms throughout Ukraine and a generalized ordered logit model, we quantified the economic, behavioral, and institutional barriers that may impede the deployment of energy-efficient technologies. Our analysis shows that behavioral barriers resulted from lack of information, knowledge, and awareness are major impediments to the adoption of energy-efficient technologies in Ukraine, and that financial barriers may further impede investments in these technologies especially for small firms. This suggests that carefully targeted information provisions and energy audits will enhance Ukrainian firms' investments in energy-efficient technologies to save energy consumption, improve productivity, and reduce carbon emissions from the productive sectors.

Is hedging the crack spread no longer all it's cracked up to be?

- Energy Economics---2017---Pan Liu,Dmitry Vedernov,Gabriel J. Power

The traditional approach to hedging the crude oil refining margin (crack spread) adopts a fixed 3:2:1 ratio between the futures positions of crude oil, gasoline, and heating oil. However, hedging the latter in arbitrary proportions might be more effective under some conditions. The paper constructs optimal hedging strategies

for both scenarios during the periods of relatively stable and volatile oil prices observed in recent years. Minimization of downside risk (LPM2) and variance are used as alternative hedging objectives. The joint distribution of spot and futures price log returns is modeled using a kernel copula method. The hedging performance of the constructed strategies is compared using hedging effectiveness, expected profit, and expected shortfall. The results show that allowing for arbitrary proportions in the sizes of futures positions generally achieves a better hedging performance. The advantage becomes particularly important during periods characterized by greater variation of the cross-dependence between the price log returns of individual commodities. In addition, using LPM2 as a hedging criterion can help hedgers to better track downside risk as well as lead to higher expected profit and lower expected shortfall.

“Lock-in” effect of emission standard and its impact on the choice of market based instruments

- Energy Economics---2017---Haoqi Qian,Wu Libo,Tang Weiqi

A country's existing emission standard policy will lead to a “lock in” effect. When the country plans to adopt new market-based instruments to control greenhouse gas emissions, it must consider this effect as it chooses among instruments to avoid larger efficiency loss. In this paper, we find that the “lock in” effect will cause a kink point to occur on the marginal abatement cost (MAC) curve. This change of shape for the MAC curve reminds us to be cautious in choosing market-based instruments when applying Weitzman's rule. We also introduce this concept into a dynamic multi-regional computable general equilibrium (CGE) model for China and simulate MAC curves for all regions. After applying Weitzman's rule, we propose a timeline for introducing price instruments under different marginal benefit (MB) curve scenarios.

Electricity price modeling with stochastic time change

- Energy Economics---2017---Svetlana Borovkova,Maren Diane Schmeck

In this paper, we develop a novel approach to electricity price modeling, based on the powerful technique of stochastic time change. This technique allows us to incorporate the characteristic features of electricity prices (such as seasonal volatility, time varying mean reversion and seasonally occurring price spikes) into the model in an elegant and economically justifiable way. The stochastic time change introduces stochastic as well as deterministic (e.g., seasonal) features in the price process' volatility and in the jump component.

How does the U.S. natural gas market react to demand and supply shocks in the crude oil market?

- Energy Economics---2017---Ali Jaddidzadeh,Apostolos Serletis

In this paper we use monthly data (over the period from January 1976 to December 2012) and a structural VAR model to disentangle demand and supply shocks in the global crude oil market and investigate their effects on the real price of natural gas in the United States. We identify the model by assuming that innovations to the real price of crude oil are predetermined with respect to the natural gas market and show that close to 45% of the variation in the real price of natural gas can be attributed to structural supply and demand shocks in the global crude oil market.

Switching towards coal or renewable energy? The effects of financial capital on energy transitions

- Energy Economics---2017---Rohan Best

Does a country's stock of financial capital affect its ability to achieve energy transitions? This paper uses data for up to 137 countries for the period 1998–2013 to investigate the importance of financial capital for changes in the use of each energy type. I find that

financial capital supports transition to more capital-intensive energy types. For high-income countries, financial capital facilitates transitions from fossil fuels to modern renewable energy sources, especially wind. Both private credit from banks and domestic private debt securities support greater shares of wind energy. For lower-income countries, financial capital supports progression from biomass towards fossil fuel energy sources such as coal. I also find that countries with larger stocks of financial capital are more likely to move to more capital-intensive electricity generation systems.

The econometric consequences of an energy consumption variable in a model of CO2 emissions

- Energy Economics---2017---Mohammad Jaforullah,Alan King

Many studies that model the determinants of CO2 emissions treat energy consumption as one of its determinants. Itkonen (2012) argues that this causes underestimation of both the responsiveness of CO2 emissions to income growth and the turning point of the carbon Kuznets curve. We first demonstrate that Itkonen's (2012) conclusions are sensitive to the assumed form of the relationship between energy consumption and income. We then argue that the presence of an energy consumption variable in a model of CO2 emissions can lead to systematic volatility in its coefficients, which has the potential to change their magnitude and sign. We also argue that misleading cointegration test results can be generated by such a model. The potential nature and severity of these effects are illustrated with data for seven countries.

Optimal hedging in the US natural gas market: The effect of maturity and cointegration

- Energy Economics---2017---Hamed Ghodusi,Sahar Emamzadehfard

We use the US natural gas market as the rich experimental context to test multiple features of hedging

performances. First, we compare the hedging effectiveness of a single futures contract (i.e. Henry Hub) used for hedging six different physical price positions. Second, we examine the performance of hedging, when one uses a futures contract with time-to-maturity beyond the hedging horizon (i.e. a non-matching hedging strategy). Finally, we quantify the effect of accounting for cointegration and also the time varying volatility in the calculation of optimal hedge ratios. As a robustness check we conduct our analysis using both ex-ante (out of sample) and ex-post (in sample) methods. Our findings suggest that using longer maturity contracts may improve the hedging effectiveness. We also find that accounting for cointegration and time varying prices has minimal effect on the hedge ratio and hedging effectiveness for almost all physical prices. Our findings can inform businesses exposed to commodity price risks in on making better risk-management decisions.

Environmental policy design, innovation and efficiency gains in electricity generation

- Energy Economics---2017---Nick Johnstone, Shunsuke Managi, Miguel Cárdenas Rodríguez, Ivan Haščič, Hidemichi Fujii, Martin Souchier

This paper explores the relationship between environmental regulation, innovation, and competitiveness using environmental patent data. The analysis is conducted in two stages. First, a non-parametric frontier analysis is implemented to estimate efficiency scores, including a measure of technological innovation based on patent stocks. Second, econometric methods are applied to analyse the role of policy stringency and policy design on efficiency. Our estimation sample covers thermal power plant sectors in 20 countries from 1990 to 2009. The results show that the stringency of environmental regulations is a significant determinant of productive efficiency with respect to pollutant emissions as well as fuel use. However, these effects turn negative once the level of stringency leaps over a certain threshold. In addition, the paper concludes that the positive effect of regulatory stringency can be diminished by a negative effect of regulatory dif-

ferentiation with measures which vary in stringency across plant size and age having negative consequences, and these effects are increasing over time. Finally, it is found that integrated approaches to environmental innovation are more likely to bring about efficiency improvements than end-of-pipe technologies.

Sensitivity of modeling results to technological and regional details: The case of Italy's carbon mitigation policy

- Energy Economics---2017---Gabriele Standardi, Yiyong Cai, Sonia Yeh

Model differences in technological and geographical scales are common, but their contributions to uncertainties have not been systematically quantified in the climate policy literature. This paper carries out a systematic assessment on the sensitivity of Computable General Equilibrium models to technological and geographical scales in evaluating the economic impacts of carbon mitigation policies. In particular, we examine the impacts of sub-national details and technological details of power generation on the estimate of carbon price and economic cost. Taking Italy as an example, we find that the estimation for carbon price and the economic cost of a de-carbonization pathway by means of a model with technological and regional details can be lower than a model without such details by up to 40%. Additionally, the effect of representing regional details appears to be far more important than the effect of representing the details of electricity technology in both the estimated carbon prices and the estimated economic impacts. Our results for Italy highlight the importance of modeling uncertainties of these two key assumptions, which should be appropriately acknowledged when applying CGE models for policy impact assessment. Our conclusions can be generalized to different countries and policy scenarios not in terms of absolute numbers but in terms of economic explanations. In particular, intra-national trade and the sub-national sectoral/technological specialization are important variables for understanding the economic dynamics behind these outcomes.

Modeling and forecasting extreme commodity prices: A Markov-Switching based extreme value model

- Energy Economics---2017---Rodrigo Herrera,Alejandro Rodriguez,Gabriel Pino Saldías

We propose a Markov-Switching Multifractal Peaks-Over-Threshold (MSM-POT) model to capture the dynamic behavior of the random occurrences of extreme events exceeding a high threshold in time series of returns. This approach allows introducing changes of regimes in the conditional mean function of the inter-exceedance times (i.e., the time between two consecutive extreme events) in order to admit the presence of short- and long-term memory patterns. Further, through its multifractal structure, the MSM-POT approach is able to capture the typical stylized facts of extreme events observed in financial time series, such as temporal clustering of the size of exceedances and temporal behavior of tail thickness.

Political orientation, environmental values, and climate change beliefs and attitudes: An empirical cross country analysis

- Energy Economics---2017---Andreas Ziegler

Based on unique data from representative computer-based surveys among more than 3400 citizens, this paper empirically examines the determinants of several climate change beliefs and attitudes in three countries which are key players in international climate policy, namely the USA, Germany (as the largest country in the European Union), and China. Our econometric analysis implies that political orientation in the USA is by far more relevant for general climate change beliefs and beliefs in anthropogenic climate change than in Germany and China. Furthermore, US and German citizens with a conservative, but not green identification significantly less often support publicly financed climate policy, while US and German respondents with a social-green identification and Chinese respondents belonging to the Communist Party have a significantly higher willingness to pay a price premium for climate-friendly products. However, our econometric analysis

overall reveals that environmental values, which are measured by a New Ecological Paradigm (NEP) scale, are the major factors for climate change beliefs and attitudes in all three countries and thus play an even more dominant role than political orientation. In addition, environmental values weaken the differences in several climate change beliefs and attitudes between a right-wing and a left-wing identification. These interaction effects between political orientation and the NEP scale are especially strong in the USA, only relevant for the support of publicly financed climate policy in Germany, and negligible in China. Our estimation results suggest alternative strategies such as specific communication campaigns in order to reduce the climate change skepticism in conservative and right-wing circles in the USA and to increase the support of climate policies among such population groups.

Electricity consumption and metropolitan economic performance in Guangzhou: 1950–2013

- Energy Economics---2017---Yiming He,Thomas Fullerton,Adam G. Walke

This study analyzes the relationship between electricity consumption and metropolitan economic growth for Guangzhou, China using 64years of annual-frequency data. The capital stock is used as a control variable because of its role in mediating the relationship between energy utilization and economic output. Empirical results indicate unidirectional Granger causality from electricity consumption to metropolitan economic performance in the short run. This is consistent with the argument that dependable electricity infrastructure and service can play a vital role in facilitating economic growth. Implications for conservation efforts and regional development are discussed.

Spatial spillover effects in determining China's regional CO2 emissions growth: 2007–2010

- Energy Economics---2017---Bo Meng,Jianguo Wang,Robbie Andrew,Hao Xiao,Jinjun Xue,Glen P. Peters

This study proposes an alternative input–output based spatial structural decomposition analysis to elucidate the importance of domestic regional heterogeneity and inter-regional spillover effects in determining China’s regional CO2 emissions growth. Our empirical results, based on the 2007 and 2010 Chinese inter-regional input–output tables, show that changes in most regions’ final demand scale, final expenditure structure, and export scale have positive spatial spillover effects on other regions’ CO2 emissions growth; changes in most regions’ consumption and export preference help reduce other regions’ CO2 emissions; changes in production technology and investment preferences may exert positive or negative effects on other region’s CO2 emissions growth through domestic supply chains. For some regions, the aggregate spillover effect from other regions may be larger than the intra-regional effect in determining regional emissions growth. All these facts can significantly help provide a better, deeper understanding of the driving forces behind the growth of regional CO2 emissions and can thus enrich the policy implications concerning a narrow definition of “carbon leakage” through domestic inter-regional “trade” as well as a relevant political consensus about responsibility sharing between developed and developing regions inside China.

Pure martingale and joint normality tests for energy futures contracts

- Energy Economics---2017---Keshab Shrestha,Ravichandran Subramaniam,Puspavathy Rassiah

In this study, we empirically analyze to see if the pure martingale hypothesis holds for three energy-related commodities: crude oil, heating oil and natural gas. We also test this hypothesis for five different hedging horizons: 1-day, 1-week, 4-week, 8-week and 12-week. Our empirical results show that the pure martingale hypothesis holds for all three commodities and all five horizons. This implies that the expected return on futures contract can be ignored in determining the optimal hedge ratio. We also test to see if the joint normality between futures and spot returns holds for

the same three commodities and five hedging horizons. We reject the joint normality hypothesis for all three commodities and five hedging horizons. This implies that hedgers with different utility function have different optimal hedge ratios. Thus, in general, one needs to take into account of hedger’s utility function when deriving optimal hedge ratio. Our results are robust to pre- and post-financial crisis as well as some other specifications considered in the paper.

OPEC vs US shale: Analyzing the shift to a market-share strategy

- Energy Economics---2017---Alberto Behar,Robert Ritz

In November 2014, OPEC announced a new strategy geared towards improving its market share. Oil-market analysts interpreted this as an attempt to squeeze higher-cost producers, notably US shale oil, out of the market. Over the next year, crude oil prices crashed, with large repercussions for the global economy. We present a simple equilibrium model that explains the fundamental market factors that can rationalize such a “regime switch” by OPEC: (i) the growth of US shale oil production; (ii) the slowdown of global oil demand; (iii) reduced cohesiveness of the OPEC cartel; and (iv) production ramp-ups in other non-OPEC countries; while (v) reductions in US shale costs act against these factors. We show that these qualitative predictions are broadly consistent with oil market developments during 2014–2015. The model is calibrated to oil market data; it predicts accommodation up to 2014 and a market-share strategy thereafter, and explains large oil-price swings as well as realistically high levels of OPEC output.

Energy consumption, financial development and economic growth in India: New evidence from a nonlinear and asymmetric analysis

- Energy Economics---2017---Muhammad Shahbaz,Thi Hong Van Hoang,Mantu Mahalik,David Roubaud

This paper investigates the asymmetric relationship

between energy consumption and economic growth by incorporating financial development, capital and labour into a production function covering the Indian economy from 1960Q1–2015Q4. The nonlinear autoregressive distributed lag bounds testing approach is applied to examine the asymmetric cointegration between the variables. An asymmetric causality test is also employed to examine the causal association between the considered variables. The results indicate cointegration between the variables in the presence of asymmetries. The asymmetric causality results show that only negative shocks to energy consumption have impacts on economic growth. In the same vein, only negative shocks to financial development have impacts on economic growth. By contrast, symmetrically, capital formation causes economic growth. Finally, over the study period, a neutral effect exists between the labour force and economic growth in India. The implications of these results for growth policies in India are also discussed.

The relationship between oil prices and rig counts: The importance of lags

- Energy Economics---2017---Ahmed Khalifa, Massimiliano Caporin, Shawkat Hammoudeh

This study deals with a timely and relevant issue in the oil market in the wake of the recent drastic drop in oil prices, which is the relationship between changes in oil prices and changes in rig counts, while accounting for other determinants of this relationship. This relationship is of strong interest to analysts, investors and policymakers in the United States and other countries. We empirically verify the impact of changes in oil prices on rig counts, which has lags up to one quarter. This evidence is stable across time and over different linear and non-linear models. The analysis also suggests that the relationship is non-linear, which is verified by both the quantile regression and quantile-on-quantile models. We find evidence of non-linearity that has softened in the most recent years where the relationship between the variables has stabilized.

Modelling asymmetric volatility in oil prices under structural breaks

- Energy Economics---2017---Bradley T. Ewing, Farooq Malik

This paper shows that accounting for endogenously determined structural breaks within an asymmetric GARCH model reduces volatility persistence in oil prices. More importantly, we find that both good and bad news have significantly more impact on volatility if structural breaks are accounted for in a model. Thus, previous studies have significantly underestimated the impact of news on volatility as they have inadvertently ignored these structural breaks in volatility. Our empirical results suggest that it is best to include both asymmetric effects and structural breaks in a GARCH model to accurately estimate oil price volatility dynamics. Our results have important practical implications not only for option valuation and hedging decisions but also have major consequences for broader financial markets, the energy industry, and the overall economy.

Is information assimilated at announcements in the European carbon market?

- Energy Economics---2017---Jiayuan Chen, Cal B. Muckley, Don Bredin

We examine the high frequency new information impact on prices, volatility, trading volume and illiquidity at scheduled macroeconomic and verified emissions announcements for the European carbon futures market. Verified emissions, United States non-farm payroll and German new factory order macroeconomic announcements impact carbon prices swiftly, within 5min. We show that a one standard deviation surprise increase in verified emission announcements is associated with an approximate ten percentage point (9.96%) increase in carbon futures returns. A wait-and-see stylized trading behavior is evident at announcements in volatility and trading volumes. Market illiquidity increases at announcements in relation to United States non-farm payroll, albeit there is no evidence of an increase in illiquidity prior to announcements. The development

of new information impact, over time, occurs mainly in the at-announcement 5-minute time interval.

Tradable quota taxation and market power

- Energy Economics---2017---D' Amato, Alessio, Edilio Valentini, Mariangela Zoli, Alessio D'Amato

We investigate how corrective taxation can improve the efficiency properties of tradable quota systems affected by market power. Indeed, we show that, when there is a dominant firm in the tradable quota market, the regulator can set an ad hoc taxation on firms' traded quotas that restores cost effectiveness without driving the dominant firm's net demand to zero. Achieving cost effectiveness with market power and quota taxation implies some costs in terms of tax revenue that, however, can be justified by the corresponding reduction of compliance costs. Moreover, we see that there may be cases where all firms result to be better off after the implementation of corrective taxation.

The importance of regret minimization in the choice for renewable energy programmes: Evidence from a discrete choice experiment

- Energy Economics---2017---Marco Boeri, Alberto Longo

This study provides a methodologically rigorous attempt to disentangle the impact of various factors – unobserved heterogeneity, information and environmental attitudes – on the inclination of individuals to exhibit either a utility maximization or a regret minimization behaviour in a discrete choice experiment for renewable energy programmes described by four attributes: greenhouse gas emissions, power outages, employment in the energy sector, and electricity bill. We explore the ability of different models – multinomial logit, random parameters logit, and hybrid latent class – and of different choice paradigms – utility maximization and regret minimization – in explaining people's choices for renewable energy programmes. The “pure” random regret random parameters logit model explains the choices of our respondents better than other models,

indicating that regret is an important choice paradigm, and that choices for renewable energy programmes are mostly driven by regret, rather than by rejoice. In particular, we find that our respondents' choices are driven more by changes in greenhouse gas emissions than by reductions in power outages. Finally, we find that changing the level of information to one attribute has no effect on choices, and that being a member of an environmental organization makes a respondent more likely to be associated with the utility maximization choice framework.

Energy price, regulatory price distortion and economic growth: A case study of China

- Energy Economics---2017---Xunpeng Shi, Sizhong Sun

Energy prices are often distorted by government control, which is justified on the grounds that such control will help mitigate the negative impact of price volatility from oil imports, and thus positively affect the domestic economy. In this paper, we show in a two-sector growth model, that regulatory price distortion can negatively affect the economy, and then, based on the model, we empirically estimate the impact of the price distortion on output growth in China, using monthly, time series data from 2005M1 to 2012M12. In contrast to the usual argument for regulatory control to mitigate price volatility, we find that regulatory price distortion negatively affects output growth in China during both the short and long term, because it is robust to different measures of output and price distortion. Hence, the argument that using price regulation to protect economic growth is undermined, and subsequently, this study lends its support to energy price deregulation. A market oriented energy price regime may improve the resilience of the domestic economy to global oil price shocks.

OPEC's kinked demand curve

- Energy Economics---2017---Marc H. Vatter

Asymmetric effects of oil prices on the macroeconomy imply multiple equilibrium prices for OPEC. I estimate

world demand for crude oil, non-OPEC supply, and the effects of changes in price on world GDP using quarterly data covering 1973 to 2010. If OPEC's marginal cost is \$20/bbl in 2014:III, and its discount rate is zero, estimated equilibrium prices are \$44–88/bbl. Multiple equilibria incent OPEC to tolerate unstable prices, which, because of the asymmetry, lower world GDP. Both policies that increase responsiveness to price and policies that lower net demand to OPEC narrow and lower the range of equilibrium prices, but the former are more effective at doing so. OPEC responds to changes in the discount rate in the opposite way from competitive producers, so policies that secure oil-related property rights in OPEC countries and other policies that lower OPEC's discount rate narrow and lower the range of equilibrium prices. Monetary policy is more effective at accelerating or slowing macroeconomic activity the larger is OPEC's market share.

Estimating the potential for electricity savings in households

- Energy Economics---2017---Nina Boogen

Improving efficiency in the use of energy is an important goal for many nations since end-use energy efficiency can help to reduce CO₂ emissions. Furthermore, since the residential sector in industrialised countries requires around one third of the end-use electricity, it is important for policy makers to estimate the scope for electricity saving in households to reduce electricity consumption by using appropriate steering mechanisms. We estimate the level of technical efficiency in the use of electricity using data from a Swiss household survey. We find an average inefficiency in electricity use by Swiss households of around 20 to 25%. Bottom-up economic-engineering models estimate the potential in Switzerland to be around 15%. In this paper we use a sub-vector input distance frontier function based on economic foundations. Our estimates lie at the upper end of the electricity saving potential estimated by the afore-mentioned economic-engineering approach.

A rough multi-factor model of electricity spot prices

- Energy Economics---2017---Mikkel Bennedsen

We introduce a new continuous-time mathematical model of electricity spot prices which accounts for the most important stylized facts of these time series: seasonality, spikes, stochastic volatility, and mean reversion. Empirical studies have found a possible fifth stylized fact, roughness, and our approach explicitly incorporates this into the model of the prices. Our setup generalizes the popular Ornstein–Uhlenbeck-based multi-factor framework of Benth et al. (2007) and allows us to perform statistical tests to distinguish between an Ornstein–Uhlenbeck-based model and a rough model. Further, through the multi-factor approach we account for seasonality and spikes before estimating – and making inference on – the degree of roughness. This is novel in the literature and we present simulation evidence showing that these precautions are crucial for accurate estimation. Lastly, we estimate our model on recent data from six European energy exchanges and find statistical evidence of roughness in five out of six markets. As an application of our model, we show how, in these five markets, a rough component improves short term forecasting of the prices.

Investigating diesel market integration in France: Evidence from micro data

- Energy Economics---2017---Jeisson Cardenas Rubio, Luis Gutiérrez, Jesus Otero

We use station-level daily price observations collected over a period of eight years to study the extent of diesel market integration in France. The empirical analysis starts off by examining the time-series properties of diesel price ratios, and then assesses how geographical separation and petrol station characteristics affect the speed of adjustment of prices to exogenous shocks. Our findings reveal that the great majority of diesel price ratios maintain stable long run relationships. We also find that while price ratios take longer to adjust for

pairs of petrol stations that are farther apart, adjustment is quicker when pairs of petrol stations provide the same range of services, and when they belong to the same owner.

Analyzing light fuel demand elasticities in Brazil using cointegration techniques

- Energy Economics---2017---Luciano Rodrigues,Mirian Rumenos Piedade Bacchi

This study is intended to assess the sensitivity of demand for light fuels in Brazil to changes in prices and income, considering the unique characteristics of the Brazilian fleet, the lack of convergence across studies available for the domestic market and its importance in discussions on climate change and national security, among others. For this purpose, the short- and long-term price and income elasticities of light fuel demand were estimated using cointegration techniques, based on an empirical model that incorporates the unique features of the internal market. Despite the characteristics of the Brazilian fleet, the results showed that the elasticities found for the national market are similar to those seen in other countries. The conceptual framework and empirical analysis that were used also allowed for a better understanding of the differences between the results of studies on demand for gasoline, ethanol or natural gas in Brazil and those found in the international literature, providing key players in the sector with crucial information for designing public policies and business strategies.

Can an emission trading scheme promote the withdrawal of outdated capacity in energy-intensive sectors? A case study on China's iron and steel industry

- Energy Economics---2017---Lei Zhu,Xiao-Bing Zhang,Yuan Li,Xu Wang,Jianxin Guo

Outdated capacity and substantial potential for energy conservation are the two main features of energy-intensive sectors in developing countries. Such countries also seek to implement market-based options to further control domestic carbon emissions as well as

to promote the withdrawal of outdated capacity and upgrade production level. This paper presents a quantitative assessment of the emission trading scheme (ETS) for China's iron and steel industry. The diverse array of normal and outdated capacities was modeled in a two-country, three-good partial equilibrium model. Simulation results show that the abatement potential can be underestimated if the energy-saving effects that result from emission abatement are not considered. In the scenario analysis, we demonstrated that the free allocation of allowances can cause a competitiveness distortion among domestic normal and outdated capacities. Given the government's intention to promote outdated capacity withdrawal and production-level upgrading, an output-based allocation approach is strongly suggested for China's iron and steel sector.

The use of nonlinear hedging strategies by US oil producers: Motivations and implications

- Energy Economics---2017---Mohamed Mnasri,Georges Dionne,Jean-Pierre Gueyie

This paper investigates the motivations and value effect of nonlinear hedges. Using a new dataset on the hedging activities of 150 U.S. oil producers, we present empirical evidence that nonlinear hedging strategies are motivated by sensitivities of firm's investment expenditures and revenues to oil price fluctuations, and quantity-price correlation. We also find a non-monotonic relationship between the use of nonlinear hedges and financial constraints. Investment opportunities, production uncertainty, and changes in oil prices and volatilities also play a significant role in hedging strategy choice. Controlling for bias related to omitted variables and self-selection in the estimation of marginal treatment effects of hedging strategy choice, we find that oil producers with a higher propensity to use pure nonlinear hedging strategies tend to have higher marginal firm value.

Per capita carbon dioxide emissions across U.S. states by sector and fossil fuel source: Evidence from club convergence tests

- Energy Economics---2017---Nicholas Apergis,James Payne

This study extends the literature on the convergence of per capita carbon dioxide emissions by examining the 50 U.S. states including the District of Columbia in the aggregate, by sector, and by fossil fuel source using the Phillips-Sul club convergence approach for the period 1980 to 2013. The results indicate multiple convergence clubs in the aggregate, by sector (residential, commercial, industrial, transport, and electric power), and for two of the three fossil fuel sources (natural gas and coal) with full panel club convergence in the case of petroleum. The presence of multiple equilibria suggests that environmental policies should recognize the distinctive convergence paths associated with each cluster of states.

Adaptation of thermal power plants: The (ir)relevance of climate (change) information

- Energy Economics---2017---Christian W.J. Bogmans, Gerard P.J. Dijkema, Michelle T.H. van Vliet

When does climate change information lead to adaptation? We analyze thermal power plant adaptation by means of investing in water-saving (cooling) technology to prevent a decrease in plant efficiency and load reduction. A comprehensive power plant investment model, forced with downscaled climate and hydrological projections, is then numerically solved to analyze the adaptation decisions of a selection of real power plants. We find that operators that base their decisions on current climatic conditions are likely to make identical choices and perform just as well as operators that are fully ‘informed’ about climate change. Where electricity supply is mainly generated by thermal power plants, heat waves, droughts and low river flow may impact electricity supply for decades to come.

Dynamic spillover effects among crude oil, precious metal, and agricultural commodity futures markets

- Energy Economics---2017---Sang Hoon Kang, Ron McIver, Seong-Min Yoon

This paper examines spillover effects among six commodity futures markets – gold, silver, West Texas Intermediate crude oil, corn, wheat, and rice – by employing the multivariate DECO-GARCH model and the spillover index. Specifically, we investigate the dynamics of return and volatility spillover indices to reveal the intensity and direction of transmission during the recent global financial and European sovereign debt crises. Our empirical results are as follows. First, we estimate a positive equicorrelation between commodity futures market returns and find that it increased sharply during the crises. This effect can persist during periods of economic and financial turmoil, diminishing the benefits of international portfolio diversification for investors. Second, we identify bidirectional return and volatility spillovers across commodity futures markets, and find more pronounced trends in their levels in the post-crisis period. This indicates the strong impact of spillovers during crisis periods. Third, both gold and silver are information transmitters to other commodity futures markets, while the remaining four commodity futures investigated were receivers of spillovers during recent periods of financial stress. Finally, we analyse the optimal portfolio weights and time-varying hedge ratios between metal and other commodities futures markets. Overall, our findings provide new insights into channels of information transmission, which may improve investment decisions and inform portfolio investors’ trading strategies.

The role of rare earth prices in renewable energy consumption: The actual driver for a renewable energy world

- Energy Economics---2017---Emmanuel Apergis, Nicholas Apergis

This study examines, for the first time in the energy issues literature, the long-run relationship between rare

earth prices and the consumption of energy from renewables. The study applies standard time series econometric methodologies and monthly data in relevance to regional and income classification groups of countries, spanning the period 2004–2016. The empirical findings indicate the presence of a long-run relationship between these variables, but for certain rare earths and regions. The findings survive a multivariate robustness test, while they are expected to be of substantial importance for the world community, given that a few countries have control of those materials. The importance is lying on the need to establish a global green energy environment.

The long-run price sensitivity dynamics of industrial and residential electricity demand: The impact of deregulating electricity prices

- Energy Economics---2017---Philip Adom

This study examines the demand-side of Ghana's electricity sector. We test two important related hypotheses: (1) deregulation of electricity price does not promote energy conservation, and (2) demand-price relationship is not an inverted U-shaped. The Stock and Watson dynamic OLS is used to address the so-called second-order bias. The result showed that, deregulation of electricity price in Ghana has induced behaviours that are more consistent with energy conservation improvements. The demand-price relationship is an inverted U, which suggests that there is a price range that end-users can tolerate further price rise and still increase their consumption of electricity. However, the degree of price tolerability is higher for residential consumers than industrial consumers. The simulation results showed that, further economic growth is likely to compromise energy conservation but more in the industrial sector than the residential sector. On the other hand, future crude oil price is likely to deteriorate energy conservation in the initial years after 2016, but this trend is likely to reverse after the year 2020. Pricing mechanisms are potent to induce energy conservation but inadequate. The results suggest that they should be complemented with other stringent policies such as a mandatory energy reduction

policy, investment in renewables, and personalization of energy efficiency programs.

Oil price shocks and China's economy: Reactions of the monetary policy to oil price shocks

- Energy Economics---2017---Won Joong Kim,Shawkat Hammoudeh,Jun Seog Hyun,Rangan Gupta

The paper empirically analyzes the effect of positive oil price shocks on China's economy, having special interest in the response of the Chinese interest rate to those shocks. Using different econometric models, i) a time-varying parameter structural vector autoregression (TVP SVAR) model with short-run identifying restrictions, ii) a structural VAR (SVAR) model with the short-run identifying restrictions, and iii) a VAR model with ordering-free generalized impulse response VAR (GIR VAR), we find that the response of the Chinese interest rate to the oil price shocks is not only time-varying but also showing quite different signs of responses. Specifically, in the earlier sample period (1992:4–2001:10), the interest rate shows a negative response to the oil price shock, while in the latter period (2001:11–2014:5) it shows a positive response to the shock. Given the negative response of the world oil production to an oil price shock in the earlier period, the shock is identified as a negative supply shock or a precautionary demand shock as suggested by Kilian (2009), thereby the negative response of the interest rate to the oil price shock is deemed as economy-boosting. The positive response of the interest rate to the oil price shock in the later period, given that this shock is identified as a positive world oil demand shock, gives evidence that stabilization of inflation is one of the main objectives of China's monetary authority, even though the current main objective of the monetary policy is characterized as “maintaining the stability of the value of the currency and thereby promoting economic growth.” Finally, the variance decomposition results reveal that the oil price shock becomes an increasingly important source in the volatility of China's interest rate.

Measuring energy performance with sectoral heterogeneity: A non-parametric frontier approach

- Energy Economics---2017---H. Wang,B.W. Ang,Q.W. Wang,P. Zhou,Qunwei Wang

Evaluating economy-wide energy performance is an integral part of assessing the effectiveness of a country's energy efficiency policy. Non-parametric frontier approach has been widely used by researchers for such a purpose. This paper proposes an extended non-parametric frontier approach to studying economy-wide energy efficiency and productivity performances by accounting for sectoral heterogeneity. Relevant techniques in index number theory are incorporated to quantify the driving forces behind changes in the economy-wide energy productivity index. The proposed approach facilitates flexible modelling of different sectors' production processes, and helps to examine sectors' impact on the aggregate energy performance. A case study of China's economy-wide energy efficiency and productivity performances in its 11th five-year plan period (2006–2010) is presented. It is found that sectoral heterogeneities in terms of energy performance are significant in China. Meanwhile, China's economy-wide energy productivity increased slightly during the study period, mainly driven by the technical efficiency improvement. A number of other findings have also been reported.

The relationship between global oil price shocks and China's output: A time-varying analysis

- Energy Economics---2017---Jamie Cross,Bao H. Nguyen

We employ a class of time-varying Bayesian vector autoregressive (VAR) models on new standard dataset of China's GDP constructed by Chang et al. (2015) to examine the relationship between China's economic growth and global oil market fluctuations between 1992Q1 and 2015Q3. We find that: (1) the time varying parameter VAR with stochastic volatility provides a better fit as compared to its constant counterparts; (2) the impacts of intertemporal global oil price shocks

on China's output are often small and temporary in nature; (3) oil supply and specific oil demand shocks generally produce negative movements in China's GDP growth whilst oil demand shocks tend to have positive effects; (4) domestic output shocks have no significant impact on price or quantity movements within the global oil market. The results are generally robust to three commonly employed indicators of global economic activity: Kilian's global real economic activity index, the metal price index and the global industrial production index, and two alternative oil price metrics: the US refiners' acquisition cost for imported crude oil and the West Texas Intermediate price of crude oil.

Price discrimination in Australia's retail electricity markets: An analysis of Victoria & Southeast Queensland

- Energy Economics---2017---Paul Simshauser,Patrick Whish-Wilson

When capital-intensive monopoly industries are restructured and deregulated, consumer prices commence a natural drift from regulated uniform 'average cost' tariffs to competitive differential prices, and this can raise problems for policymakers. Deep discounts are welcomed, high Standing Offers are not. But price discrimination is unremarkable in economics. Indeed, in industries where fixed & sunk costs represent a significant portion of total cost, discriminatory pricing is usually welfare enhancing. Conversely, theory predicts and empirical evidence confirms that regulatory efforts to cherry-pick differential prices in asymmetric markets will damage consumer welfare. In this article, we analyse differential retail electricity offer prices in the Australian States of Victoria and Queensland and contrast these with industry average total cost and the marginal cost of retail supply. We find deregulated Victoria displays high price dispersion with Standing Offer tariffs 10% above industry average total cost and marginal offers at break-even prices (i.e. 20% below average total cost). In the semi-regulated Southeast Queensland market where a regulated price-cap exists, there is lower dispersion but marginal offers include a 6.7% retail mark-up. Efficient pricing requires the

marginal unit produced to be priced at marginal cost and Victoria meets this criteria – but we identify an episode of inter-consumer misallocation due to high Standing Offers. We conclude policy initiatives designed to help firms shift vulnerable households from Standing Offer tariffs is desirable.

A literature study for DEA applied to energy and environment

- Energy Economics---2017---Toshiyuki Sueyoshi,Yan Yuan,Mika Goto

This study systematically summarizes previous research efforts on Data Envelopment Analysis (DEA) applied to energy and environment in the past four decades, including concepts and methodologies on DEA environmental assessment. Industrial developments are very important for all nations in terms of their economic prosperities. A problem is that the development produces various pollutions on air, water and other types of contaminations, all of which are usually associated with our health problems and climate changes. Thus, it is necessary for us to consider how to make a balance between economic success and pollution mitigation to maintain a high level of social sustainability in the world. It is widely considered that DEA is one of the methodologies to examine the level of sustainability. This study examines a recent research trend on DEA applications from 1980s to 2010s. Nowadays, many researchers have paid serious attention on how to combat various difficulties in the areas of energy and environment. As a result, the number of articles on DEA applications on energy and environment has dramatically increased, particularly after 2000s. However, it is true that DEA has strengths and drawbacks in the applications. Therefore, it is very important for us to carefully use DEA for guiding large policy issues and business strategies such as the global warming and climate change. An underlying premise of this study is that technology innovation in engineering and natural science may solve various problems by linking it with political and managerial efforts. The use of DEA provides a methodological linkage among them, so enhancing the practicality in mitigating problems

due to climate change and environmental pollutions. This literature study, along with a summary on conceptual and methodological developments, provides us with guidelines for our future research works on DEA on energy and environment issues.

Economic assessment of virtual power plants in the German energy market — A scenario-based and model-supported analysis

- Energy Economics---2017---Martin Loßner,Diana Böttger,Thomas Bruckner

The energy transition (“Energiewende”) in Germany will result in a substantial transformation of the energy supply system. Virtual power plants are expected to be important components of the new intelligent energy infrastructure. They aggregate beside different types of distributed generation units also active consumers and storage technologies in order to integrate these in a profit-maximising, system-stabilising, and sustainable way. The assessment of the economic performance of virtual power plants requires a scenario-based and model-supported analysis. In this relation, future energy market conditions are simulated using the scenario methodology. Starting from the year 2015, three scenarios have been identified that illustrate alternative energy developments in Germany by 2030. Based on these scenarios, the additional revenues potential of the modeled virtual power plant is identified when compared to an independent and non-market-oriented operation mode of distributed energy resources. According to the model results, revenues of the VPP can increase by 11% up to 30% in the analyzed scenarios in 2030 due to the market-oriented operation mode. Nevertheless, the amount and composition vary depending on technology-specific subsidies, temporary nature of power demand and price structures in the energy market. Fluctuating renewable energies are expected to benefit from the market-oriented operation mode in the virtual power plant, especially through the EEG direct marketing. The selective and regulated shutdown of renewable energies in times of negative electricity prices may lead to further cost savings. The utilization of temporary price fluctuations in the spot

market and the demand-oriented provision of control power offer high additional revenue potential for flexible controllable technologies such as battery storage, biomethane as well as combined heat and power units. Finally, the determination of the long-term profitability of a virtual power plant still requires a full-scale cost–benefit analysis. For this holistic approach, the model results provide a reliable scientific basis.

Joint price and volumetric risk in wind power trading: A copula approach

- Energy Economics---2017---A. Pircalabu,T. Hvolby,J. Jung,E. Høg

This paper examines the dependence between wind power production and electricity prices and discusses its implications for the pricing and the risk distributions associated with contracts that are exposed to joint price and volumetric risk. We propose a copula model for the joint behavior of prices and wind power production, which is estimated to data from the Danish power market. We find that the marginal behavior of the individual variables is best described by ARMA–GARCH models with non-Gaussian error distributions, and the preferred copula model is a time-varying Gaussian copula. As an application of our joint model, we consider the case of an energy trading company entering into longer-term agreements with wind power producers, where the fluctuating future wind power production is bought at a predetermined fixed price. We find that assuming independence between prices and wind power production leads to an underestimation of risk, as the profit distribution becomes left-skewed when the negative dependence that we find in the data is accounted for. By performing a simple static hedge in the forward market, we show that the risk can be significantly reduced. Furthermore, an out-of-sample study shows that the choice of copula influences the price of correlation risk, and that time-varying copulas are superior to the constant ones when comparing actual profits generated with different models.

The dynamic linkages between crude oil and natural gas markets

- Energy Economics---2017---Jonathan Batten,Cetin Ciner,Brian M. Lucey

The time varying price spillovers between natural gas and crude oil markets for the period 1994 to 2014 are investigated. Contrary to earlier research, we show that in a large part of our sample the natural gas price leads the price of crude oil with price spillover effects lasting up to two weeks. This result is robust to a battery of tests including out-of-sample forecasting exercises. However, after 2006, we detect little price dependencies between these two energy commodities. These findings arise due to a conjunction of both demand and supply-side shocks arising from both natural and economic events, including Hurricane Katrina, the Tohoku earthquake and the Global Financial Crisis, as well as infrastructure and technological improvements. The increased use of new technologies such as hydraulic fracking for the extraction of gas and oil in particular affected supply in the latter part of the study. We conclude that the long term relation present in the early part of the sample has decoupled, such that price determination of these two energy sources is now independent.

Employment impacts of upstream oil and gas investment in the United States

- Energy Economics---2017---Mark Agerton,Peter Hartley,Kenneth B. Medlock,Ted Temzelides

We use dynamic panel methods at the state level to understand how the increase in exploration and production of oil and natural gas since the mid-2000s has impacted employment. We find robust statistical support for the hypothesis that changes in drilling do, in fact, have an economically meaningful and positive impact on employment. The strongest impact is contemporaneous, though months later in the year also experience statistically and economically meaningful growth. Once dynamic effects are accounted for, we estimate that an additional rig count results in the creation of 31 jobs immediately and 315 jobs in the

long run. Robustness checks suggest that these multipliers could be even bigger. Our results imply that the national impact of upstream investment remains small, perhaps due to the sector's small size and inter-state migration.

Forecasting oil and stock returns with a Qual VAR using over 150years off data

- Energy Economics---2017---Rangan Gupta,Mark Wohar

The extant literature suggests that oil price, stock price and economic activity are all endogenous and the linkages between these variables are nonlinear. Against this backdrop, the objective of this paper is to use a Qualitative Vector Autoregressive (Qual VAR) to forecast (West Texas Intermediate) oil and (S&P500) stock returns over a monthly period of 1884:09 to 2015:08, using an in-sample period of 1859:10–1884:08. Given that there is no data on economic activity at monthly frequency dating as far back as 1859:09, we measure the same using the NBER recession dummies, which in turn, can be easily accommodated in a Qual VAR as an endogenous variable. In addition, the Qual VAR is inherently a nonlinear model as it allows the oil and stock returns to behave as nonlinear functions of their own past values around business cycle turning points. Our results show that, for both oil and stock returns, the Qual VAR model outperforms the random walk model (in a statistically significant way) at all the forecasting horizons considered, i.e., one- to twelve-months-ahead. In addition, the Qual VAR model, also outperforms the AR and VAR models (in a statistically significant manner) at long-run horizons for oil returns, and short- to medium-run horizons for stock returns.

Eco-driving training and fuel consumption: Impact, heterogeneity and sustainability

- Energy Economics---2017---Philippe Barla,Mathieu Gilbert-Gonthier,Marco Antonio Lopez Castro,Luis Miranda-Moreno

In this paper, we assess the impact of an eco-driving training session on fuel consumption using panel data.

A random coefficient model is estimated to measure the effect of the course over a ten-month period, controlling for confounding factors and individual heterogeneity. We find that eco-driving training induced average city and highway fuel consumption reductions of 4.6% and 2.9% respectively. The effects are highly heterogeneous between individuals, with standard deviations of about 5%. Drivers' socio-demographic characteristics are not helpful to explain these discrepancies but we find that drivers of vehicles with manual transmissions achieve significantly larger reductions: 10% on city roads and 8% on highways. Finally, we show that reductions faded gradually after the course. City reductions go from 4.6% to 2.5% within ten months. Highway fuel use decreases average 3.5% in the first ten weeks after the course but become statistically insignificant after about thirty weeks. Overall, the average impact translates into an annual fuel saving cost of about 60\$ per driver.

Using the competitive storage model to estimate the impact of ethanol and fueling investment on corn prices

- Energy Economics---2017---Wei Zhou,Bruce Babcock

The impact of biofuel mandates on the prices of commodities used to produce food continues to be a major consideration by policy makers. More recently concern about high compliance costs of oil companies due to mandates led to reductions in US biofuel mandates. To gain insights into the policy impacts of mandates on agricultural commodity prices and compliance costs requires development of dynamic models that can capture the fact that many agricultural commodities used to produce biofuels can be stored and that flexible compliance mechanisms allow for banking and borrowing of tradable permits. US biofuel mandates are enforced using a system of tradable permits, called RINs. RIN market dynamics are important because RINs can be banked for the future or borrowed from the future. Corn is the primary U.S. biofuel feedstock and is storable. Rational expectations competitive storage models are well suited to capture the dynamic behavior of commodity markets. Such a model is de-

veloped here for corn and RIN markets to estimate the impacts of alternative future ethanol mandate levels. The model considers corn use for ethanol, storage and all other uses in each period, accounting for two random variables: oil prices and corn yields. Borrowing and banking provisions of the Renewable Fuels Standard mandate are explicitly integrated into the model. We use the model to provide estimates of the impact on corn prices, corn plantings and ethanol production under two ethanol mandate scenarios for six marketing years from 2016/17. Our scenarios are a combination of volume requirements and infrastructure investment. The first scenario is one in which corn ethanol mandates stay the same as required in the current and proposed RFS and additional E85 stations are introduced that allow for compliance with higher mandates. The second scenario is one in which no investment occurs and the Environmental Protection Agency reduces the mandate to 13.87billiongal, a level that can just be met with 10 percent ethanol blends. Comparing the results for two scenarios, we find that average corn prices are about 5 to 6% lower with the reduced mandates or about 22 to 30 cents per bushel, while average RIN prices drop from around 60 to 40 cents per RIN.

Historical energy price shocks and their changing effects on the economy

- Energy Economics---2017---Dirk Jan van de Ven,Roger Fouquet

The purpose of this paper is to identify the changes in the impact of energy shocks on economic activity — with an interest in assessing if an economy’s vulnerability and resilience to shocks improved with economic development. Using data on the United Kingdom over the last three hundred years, the paper identifies supply, aggregate demand and residual shocks to energy prices and estimates their changing influence on energy prices and GDP. The results suggest that the impacts of supply shocks rose with its increasing dependence on coal, and declined with its partial transition to oil. However, the transition from exporting coal to importing oil increased the negative impacts of demand shocks. More

generally, the results indicate that improvements in vulnerability and resilience to shocks did not progress systematically as the economy developed. Instead, the changes in impacts depended greatly on the circumstances related to the demand for and supply of energy sources. If these experiences are transferable to future markets, a transition to a diversified mix of renewable energy is likely to reduce vulnerability and increase resilience to energy price shocks.

Determinants of energy productivity in 39 countries: An empirical investigation

- Energy Economics---2017---Tarek Atalla,Patrick Bean

This paper uses three types of analysis to investigate the drivers of energy productivity changes occurring in 39 countries during 1995–2009. We find that increases in sectoral energy productivity were the primary driver behind economy-wide energy productivity improvements. Structural economic shifts away from industry and towards service-oriented sectors played a lesser role in aggregate energy productivity improvements. Nations with similar demographic and economic characteristics showed similar levels of energy productivity and rates of improvement. Most notably, former communist countries and nations undergoing economic liberalization exhibited the highest rate of improvement —although they are still less energy productive than developed nations. Moreover, the econometric analysis reinforces the long-standing hypothesis that higher levels of income per capita and higher energy prices are associated with greater energy productivity, while a greater share of output from industry is associated with lower energy productivity levels. In particular, higher energy prices and income levels are associated with improvements in sectoral energy productivity.

Time-frequency contained co-movement of crude oil and world food prices: A wavelet-based analysis

- Energy Economics---2017---Debdatta Pal,Subrata K. Mitra

This paper evaluates the association between crude oil prices and world food price indices, first within general space and time, and then within the combined time-frequency sphere. Monthly price data spanning from January 1990 to February 2016 were used for the analysis. The Johansen cointegration test conducted within the time domain confirmed the statistically significant cointegrated relationship between crude oil prices and the price indices of food and its sub-categories, such as dairy, cereals, vegetable oil, and sugar; however, frequency information was not accounted for. To incorporate both the time and frequency features of the data, we used a wavelet method that has shown that the world food prices, along with the prices of cereals, vegetable oils, and sugar, co-move with and are led by crude oil prices, results that remain relevant from the short-run policy perspective. The outcome of Toda–Yamamoto causality confirmed the spillover of crude oil price changes to the world food price index also in the long run. The paper ends with the policy implications of these results.

Is there a price premium for energy efficiency labels? Evidence from the Introduction of a Label in Korea

- Energy Economics---2017---Ju Young Park

This study examines the price premium from Korea's Energy Efficiency Grade Label. The Korean government recently began energy certification of televisions, providing a setting to analyze a possible price effect of the new label. Hedonic regression results seem to show that a price premium exists for products with the Energy Efficiency Grade Label. However, potential unobserved heterogeneity is a concern. Difference-in-difference and fixed-effects models are used to capture the net effect of the label by controlling for time and product differences. The results suggest that any price premium does not result from the energy efficiency label itself. Instead, energy-efficient products already had higher prices before the introduction of the energy efficiency label. The finding turns our attention to the importance of careful design of labeling programs.

Rebound effect of improved energy efficiency for different energy types: A general equilibrium analysis for China

- Energy Economics---2017---Yingying Lu, Yu Liu, Meifang Zhou

This paper explores the rebound effect of different energy types in China based on a static computable general equilibrium model. A one-off 5% energy efficiency improvement is imposed on five different types of energy, respectively, in all the 135 production sectors in China. The rebound effect is measured both on the production level and on the economy-wide level for each type of energy. The results show that improving energy efficiency of using electricity has the largest positive impact on GDP among the five energy types. Inter-fuel substitutability does not affect the macroeconomic results significantly, but long-run impact is usually greater than the short-run impact. For the exports-oriented sectors, those that are capital-intensive get big negative shock in the short run while those that are labour-intensive get hurt in the long run. There is no “backfire” effect; however, improving efficiency of using electricity can cause negative rebound, which implies that improving the energy efficiency of using electricity might be a good policy choice under China's current energy structure. In general, macro-level rebound is larger than production-level rebound. Primary energy goods show larger rebound effect than secondary energy goods. In addition, the paper points out that the policy makers in China should look at the rebound effect in the long term rather than in the short term. The energy efficiency policy would be a good and effective policy choice for energy conservation in China when it still has small inter-fuel substitution.

Testing the transport energy-environmental Kuznets curve hypothesis in the EU27 countries

- Energy Economics---2017---M.P. Pablo-Romero, Luís Cruz, Eduardo Barata

Transport activities are essential for economic and social development. Nevertheless, the transport sector

has also shown the fastest growth in energy consumption in the European Union and its contribution to increasing greenhouse gas emissions merits the thorough attention of academics and policy makers. In this paper we analyze the relationship of economic growth and transport activities with transport final energy consumption. Energy Kuznets curves are estimated for a panel data set covering the EU27 countries in the period 1995–2009 for total transport energy use, household transport energy use, and productive transport energy use (all three in absolute and per capita energy use terms). The productive transport energy use and gross value added relationship are further considered as per hour worked. Finally, the control variables of energy prices and differences in the economic structures are tested. Empirical results show that the elasticity of transport energy use with respect to gross value added in per capita terms decreases from a threshold for the three transport energy consumption variables, but the turning point of improved environmental quality is not reached in any instance.

Does renewable energy generation decrease the volatility of electricity prices? An analysis of Denmark and Germany

- Energy Economics---2017---Tuomas Rintamäki,Afzal S. Siddiqui,Ahti Salo

Although variable renewable energy (VRE) technologies with zero marginal costs decrease electricity prices, the literature is inconclusive about how the resulting shift in the supply curves impacts price volatility. Because the flexibility to respond to high peak and low off-peak prices is crucial for demand-response applications and may compensate for the losses of conventional generators caused by lower average prices, there is a need to understand how the penetration of VRE affects volatility. In this paper, we build distributed lag models with Danish and German data to estimate the impact of VRE generation on electricity price volatility. We find that in Denmark wind power decreases the daily volatility of prices by flattening the hourly price profile, but in Germany it increases the volatility because it has a stronger impact on off-peak prices. Our

analysis suggests that access to flexible generation capacity and wind power generation patterns contribute to these differing impacts. Meanwhile, solar power decreases price volatility in Germany. By contrast, the weekly volatility of prices increases in both areas due to the intermittency of VRE. Thus, policy measures for facilitating the integration of VRE should be tailored to such region-specific patterns.

Is shale development drilling holes in the human capital pipeline?

- Energy Economics---2017---Dan Rickman,Hongbo Wang,John Winters

Using the Synthetic Control Method (SCM) and a novel method for measuring changes in educational attainment we examine the link between educational attainment and shale oil and gas extraction for the states of Montana, North Dakota, and West Virginia. The three states examined are economically-small, relatively more rural, and have high levels of shale oil and gas reserves. They also are varied in that West Virginia is intensive in shale gas extraction, while the other two are intensive in shale oil extraction. We find significant reductions in high school and college attainment among all three states' initial residents because of the shale booms.

Welfare implications of the renewable fuel standard with an integrated tax-subsidy policy

- Energy Economics---2017---Tristan Skolrud,Gregmar I. Galinato

This paper derives the optimal integrated tax-subsidy policy where one input is taxed and revenues are used to subsidize the use of a substitute input to reduce greenhouse gas emissions given the existing policies under the Renewable Fuel Standard policies. We measure the welfare effects and impact on cellulosic ethanol production after implementing the tax-subsidy policy using a general equilibrium model. A revenue-neutral integrated tax-subsidy scheme leads to a small positive tax rate for crude oil and a large positive subsidy for

cellulosic ethanol because the former has a larger emissions coefficient than the latter. The overall welfare effects of an integrated tax subsidy scheme are less than a 1% increase for the economy but the growth in the cellulosic ethanol industry could range from 28% to 238% because the revenues from taxing crude oil are directly used to subsidize cellulosic ethanol production.

Willingness to pay for emissions reduction:

Application of choice modeling under uncertainty and different management options

- Energy Economics---2017---Galina Williams, John Rolfe

This paper presents the results of a choice modeling survey of households in Queensland, Australia to assess values for reductions in national greenhouse emissions by 2020. The study is novel in two main ways. First, labeled alternatives were used to assess whether the types of management options for reducing net emissions (green power, energy efficient technologies or carbon capture) are significant in understanding preferences for reducing emissions. Second, the importance of the level and type of uncertainty involved in reductions is tested. The types of uncertainty include (1) the uncertainty of achieving emissions reduction and (2) the uncertainty of international participation as the percentage of total global emissions covered by international agreements. The results of this survey identified how choice responses vary when the level of uncertainty associated with emissions reduction options is included within choice alternatives.

Assessing contagion risk from energy and non-energy commodity markets

- Energy Economics---2017---Bernardina Algieri, Arturo Leccadito

The aim of this study is to investigate contagion risk from commodity markets towards the whole economy and across sectors. Indeed, the financialization and integration of commodity markets expose the economy to potential contagion risks i.e., adverse shocks hitting one or more commodity markets spread to the

entire economic system. To this purpose, we use the delta Conditional Value-at-Risk (Δ CoVaR) approach based on quantile regression to identify a measure of contagion risk for energy, food and metals commodity markets. This novel methodology allows us to detect whether the risk contribution for a given market is significant, while distinguishing between tail events driven by financial factors, economic fundamentals or both. Furthermore, it permits us to assess whether the contagion risk of one market is significantly larger than the one of another market. The results show that commodity markets generate contagion risks which are mainly triggered by financial factors for energy and metal markets and by financial and economic fundamentals for food markets. Oil market contributes more to contagion than metal and food markets. Moreover, it emerges that there are spillovers from energy to food markets and oil is also more important than biofuel in affecting food markets.

Oil shocks and stock markets revisited: Measuring connectedness from a global perspective

- Energy Economics---2017---Dayong Zhang

This paper contributes to the large volume of empirical studies on the relationship between oil shocks and stock markets from a new systemic perspective. The method of measuring connectedness proposed by Diebold and Yilmaz (2009, 2012, 2014) is adopted to study the relationship between oil shocks and returns at six major stock markets around the world. It is shown that the contribution of oil shocks to the world financial system is limited. Oil price changes, however, can be explained by information on the financial system. Furthermore, a rolling windows analysis finds that oil shocks can occasionally contribute significantly to stock markets, and it is also proved that only large shocks matter.

Introduction: Symposium on Energy Sector Convergence

- Energy Economics---2017---Nicholas Apergis, Bradley Ewing, James Payne

Economy-wide and manufacturing energy productivity transition paths and club convergence for OECD and non-OECD countries

- Energy Economics---2017---Steven Parker, Brantley Liddle

This work aims at developing a further understanding of the transition dynamics of energy productivity for a sample of 33 countries – including 23 low to middle income non-OECD countries – over the period 1971 to 2008. The focus of this work is on economy-wide and manufacturing energy productivities. We employ two steps of analysis, a preliminary step using simple methods consisting of sigma and gamma convergence and a second step employing a recent clustering algorithm that sorts countries into clubs. That clustering algorithm identified four clubs for economy-wide energy productivity and six clubs for manufacturing energy productivity. The newly industrializing countries and OECD countries were members of the better performing clubs.

Energy intensity and convergence in Swedish industry: A combined econometric and decomposition analysis

- Energy Economics---2017---Amin Karimu, Runar Brännlund, Tommy Lundgren, Patrik Söderholm

How to reduce the carbon footprint associated with energy use is still a major concern for most decision-makers. Against this background, a better understanding of energy intensity—the ratio of energy use to output and its convergence could be important in the design of policies targeting the reduction in the carbon footprint related to energy use. This paper analyzes the determinants of energy intensity and tests for energy intensity convergence across 14 Swedish industrial sectors. This analysis builds on a nonparametric regression analysis of an intensity index constructed at the industry sector level as well as indices constructed from a decomposition of this index. The latter isolates two key determinants of changes in energy intensity and convergence patterns: the efficiency channel—fundamental improvement in the use of energy and

activity channel—structural shifts in the economy. The empirical analysis relies on a detailed sectorial dataset covering the period 1990–2008. The findings indicate that input prices, including the price of energy, have been significant determinants of energy intensity in the Swedish industrial sectors. This effect can primarily be attributed to the efficiency channel and with a less profound influence from the activity channel. We also find evidence of energy intensity convergence among the industrial sectors, and this primarily stems from the activity channel rather than from the efficiency channel.

The convergence of U.S. state-level energy intensity

- Energy Economics---2017---James Burnett, Jessica Madariaga

This study extends a neoclassical growth model to include the accumulation of physical capital and energy consumption within a panel of fifty states (plus the District of Columbia) in the U.S. The theoretical model allows us to examine the implications for convergence in economic growth and energy intensity. From the theoretical model, we formulate an empirical approach using a dynamic panel model that is estimated using a general method of moments framework to test the conditional rates of convergence. The empirical results indicate convergence in energy intensity, and our estimates accurately predict both the growth in and convergence of energy intensity across our entire sample. Consistent with other findings in the literature, our results imply that energy use, over the past four decades, plays a small and positive role in state-level, per capita economic growth and convergence. Based on these results, we discuss policy implications for state-level income growth and energy consumption.

Residential energy consumption: A convergence analysis across Chinese regions

- Energy Economics---2017---Maria Jesus Herreiras, Carlos Aller, Javier Ordóñez

The process of urbanization and the raise of living

standards in China have led an increasing trend in the patterns of residential consumption. Projections for the population growth rate in urban areas do not paint a very optimistic picture for energy conservation policies. In addition, the concentration of economic activities around coastal areas calls for new prospects to be formulated for energy policy. In this context, the objective of this paper is twofold. First, we analyse the effect of the urbanization process of the Chinese economy in terms of the long-run patterns of residential energy consumption at national level. By using the concept of club convergence, we examine whether electricity and coal consumption in rural and urban areas converge to the same long-run equilibrium or whether in fact they diverge. Second, the impact of the regional concentration of the economic activity on energy consumption patterns is also assessed by source of energy across Chinese regions from 1995 to 2011. Our results suggest that the process of urbanization has led to coal being replaced by electricity in urban residential energy consumption. In rural areas, the evidence is mixed. The club convergence analysis confirms that rural and urban residential energy consumption converge to different steady-states. At the regional level, we also confirm the effect of the regional concentration of economic activity on residential energy consumption. The existence of these regional clusters converging to different equilibrium levels is indicative of the need of regional-tailored set of energy policies in China.

Stochastic convergence in per capita fossil fuel consumption in U.S. states

- Energy Economics---2017---James Payne,Maruška Vizek,Junsoo Lee

This study examines the stochastic convergence of per capita fossil fuel consumption across U.S. states (including the District of Columbia) utilizing LM and RALS-LM unit root tests with allowance for endogenously determined structural breaks. Our results indicate that with the exception of Nevada, the evidence from two-break and one-break LM and RALS-LM unit root tests rejects the null hypothesis of a unit root in

the relative per capita fossil fuel consumption in the U.S. This finding indicates the presence of stochastic convergence in relative per capita fossil fuel consumption in the U.S. states.

Conditional convergence in Australia's energy consumption at the sector level

- Energy Economics---2017---Vinod Mishra,Russell Smyth

We examine the convergence of energy consumption per capita at the sector level in Australia over the period 1973–74 to 2013–14. To do so, we employ recently developed LM and RALS-LM unit root tests that accommodate up to two endogenously determined structural breaks. We find support for energy consumption per capita convergence for six of seven sectors in Australia.

Convergence in energy consumption per capita across the US states, 1970–2013: An exploration through selected parametric and non-parametric methods

- Energy Economics---2017---Hassan Mohammadi,Rati Ram

Noting the paucity of studies of convergence in energy consumption across the US states, and the usefulness of a study that shares the spirit of the enormous research on convergence in energy-related variables in cross-country contexts, this paper explores convergence in per-capita energy consumption across the US states over the 44-year period 1970–2013. Several well-known parametric and non-parametric approaches are explored partly to shed light on the substantive question and partly to provide a comparative methodological perspective on these approaches. Several statements summarize the outcome of our explorations. First, the widely-used Barro-type regressions do not indicate beta-convergence during the entire period or any of several sub-periods. Second, lack of sigma-convergence is also noted in terms of standard deviation of logarithms and coefficient of variation which do not show a decline between 1970 and 2013, but show slight upward

trends. Third, kernel density function plots indicate some flattening of the distribution which is consistent with the results from sigma-convergence scenario. Fourth, intra-distribution mobility (“gamma convergence”) in terms of an index of rank concordance suggests a slow decline in the index. Fifth, the general impression from several types of panel and time-series unit-root tests is that of non-stationarity of the series and thus the lack of stochastic convergence during the period. Sixth, therefore, the overall impression seems to be that of the lack of convergence across states in per-capita energy consumption. The present inter-state inequality in per-capita energy consumption may, therefore, reflect variations in structural factors and might not be expected to diminish.

Integration of regional electricity markets in Australia: A price convergence assessment

- Energy Economics---2017---Nicholas Apergis,Fulvio Fontini,Julian Inchauspe

From an electricity market design perspective, it is relevant and practical to know which market structures allow for price convergence, and how long this takes to achieve. This study employs the Phillips and Sul (2007, 2009) methodology to test for the convergence of wholesale electricity prices across the Australian States. We identify a long-run, common price growth pattern that applies to a cluster formed by three Eastern States that share common market characteristics and limited physical interconnection. We also find another cluster with less competitive market structures that, although not interconnected, strongly converge towards their own trend. These findings confirm theoretical expectations while quantifying the rate of convergence. Finally, we also investigate the role that the carbon tax regime has played in the convergence process, with new empirical showing that the previous results are not affected, with the notable exception being the case of South Australia.

Estimating the speed of adjustment to target levels: The case of energy prices

- Energy Economics---2017---Seema Narayan,Paresh Kumar Narayan

In this paper, we propose a model that estimates the speed of energy price adjustment to its target level. We also explain the source of price adjustment. Moreover, we extract energy price bubbles and show that bubbles help explain price adjustment. Since ours is the first paper that develops an energy price adjustment model and links it to bubbles, several avenues for future research have emerged from our analysis. The first is to provide a theoretical framework for the bubbles and price adjustment mechanism. The second direction of research will be to continue the search for other potential determinants of price adjustment.

Price volatility and residential electricity decisions: Experimental evidence on the convergence of energy generating source

- Energy Economics---2017---Eric Cardella,Bradley Ewing,Ryan B. Williams

The recent trend in most developed countries has been toward greater reliance on renewable or “green” energy sources. This paper investigates how price volatility in residential electricity rates impacts consumers’ preferences for green power. Using a choice-based experiment, we present respondents with choice scenarios that feature two electric utility plans: (i) a conventional plan where electricity is generated from either coal or natural gas, and (ii) a green plan where electricity is generated renewably from either wind or solar. We then systematically vary the monthly price volatility of each plan across choice scenarios. Our results suggest that price volatility in monthly rates significantly impacts respondents’ plan choices and, specifically, their decision to adopt the green power plan. In particular, increased volatility in the green power plan reduces the likelihood of respondents choosing the green plan, while increased volatility in the conventional plan increases the likelihood of respondents choosing the green plan. Moreover, the documented effects of price volatility are

robust across different price premiums for the green power plan.

Consumer preferences for second-generation bioethanol

- Energy Economics---2017---Tongzhe Li,Jill McCluskey

This study investigates the consumer responses toward fuel from second-generation, nature-inspired lignocellulose processing systems. Data was collected via in-person consumer surveys across in three major U.S. cities with two different information treatments. A dichotomous-choice contingent valuation methodology is utilized to estimate consumers' willingness to pay for this product and analyze factors that affect consumer choice. The results suggest that the average respondent was willing to pay an 11% premium for second-generation nature-inspired bioethanol compared to conventional fuel. The willingness to pay was the highest in Portland, Oregon (17%), followed by Minneapolis (9%) and then Boston (8%). Driving distance was found to have a negative effect on consumer willingness to pay. Consumers who purchase more organic foods were more willing to pay a premium for the product. Risk attitude had heterogeneous effects in different locations. The effect of information regarding the second-generation, nature-inspired lignocellulose process was found to be significantly positive.

The changing of the relationships between carbon footprints and final demand: Panel data evidence for 40 major countries

- Energy Economics---2017---María del P. Pablo-Romero,Antonio Sánchez-Braza

Global warming and environmental pollution have led many countries to begin to implement measures to reduce the use of fossil fuels. However, emissions reductions may have been reached because of the displacement of emissions intensive production. The objective of this study is to analyze the relationships between the emissions caused by countries from a demand point of view, the carbon footprints and the demand for

goods and services in these countries, and especially in the European countries. With this aim, a two-step process was carried out. Firstly, carbon footprints were calculated during the 1995–2009 period. Secondly, the EKC hypothesis between these carbon footprints and the total final demands were tested by using panel data and a multilevel mixed-effects model. The results show that the EKC hypothesis is not supported when considering carbon footprints with respect to final demand. It is also shown that carbon footprints are slightly increasing with respect to final demand beyond proportionality. The carbon footprint elasticities are different between countries, their values increasing with the final demand per capita of countries.

Distributional effects of subsidy removal and implementation of carbon taxes in Mexican households

- Energy Economics---2017---Jorge Alberto Rosas-Flores,Mohcine Bakhat,Dionicio Rosas-Flores,José Luis Fernández Zayas

This paper presents a microsimulation using data from the National Households Income and Expenditure Survey (NHIES) from 1994 to 2010 to determine the distributional effects of the price changes arising from energy and environmental policies and their impact on Mexican households.

Nudges from school children and electricity conservation: Evidence from the “Project Carbon Zero” campaign in Singapore

- Energy Economics---2017---Sumit Agarwal,Satyanarain Rengarajan,Tien Foo Sing,Yang Yang

Can children effectively nudge their parents to change their energy consumption behavior? This study sets up a quasi-experiment using the “Project Carbon Zero” campaign, an energy-saving contest in Singapore, to empirically test the effectiveness of school children nudges in bringing electricity conservation messages home and influencing behaviors of their families and

neighbors. Based on the 2km (km) home–school distance as an identification, our results show that families living within 2km from participating schools (treatment group) used 1.8% less electricity at the block level than other families outside the 2km school zone (control group) during the contest period. The electricity savings effects are persistent with an estimated marginal savings 1.6% in the post-campaign months. The results imply that policy makers and advocates for energy conservation could use school children nudges in public campaigns, instead of pecuniary interventions, to drive home behavioral changes in electricity conservation of families.

Oil prices and stock markets: Does the effect of uncertainty change over time?

- Energy Economics---2017---Young C. Joo,Sung Y. Park

This paper investigates empirical marginal effects of uncertainty measured by conditional variance of the stock and crude oil prices on their returns using stock index prices for U.S., Japan, Korea, and Hong Kong over the period 1996–2015. A time-varying parameter model with a dynamic conditional correlation (DCC) bivariate GARCH-in-Mean specification is considered to investigate time-varying marginal effects of uncertainty on the stock and crude oil returns. The empirical findings show that there exist significant negative time-varying effects of uncertainty on the returns over some sub-periods.

The impact of resource tax reform on China's coal industry

- Energy Economics---2017---Huihui Liu,Zhan-Ming Chen,Jianliang Wang,Jihong Fan

Contributing to approximately two-thirds of primary energy consumption, coal usage is the focus of China's energy policies. To regulate the resource taxation system and reduce the burden of coal enterprises, the Chinese government launched a reform of its resource tax system in 2014 for coal, introducing the ad valorem system to replace the volume-based system that had

been in place for the preceding thirty years. To assess the impact of the tax reform, this paper constructs two-stage dynamic game models by taking the coal and coal-fired power industries as the players. The market situations of shortage and oversupply are investigated separately. Empirical data are collected to estimate the model parameters for numerical simulations. The model results suggest that the tax reform will reduce both coal prices and the coal industry profitability if the tax levied on each ton of coal is maintained at the same level as before the reform, regardless of whether the market is in a shortage or an oversupply situation. However, the increased buyer's power will amplify the effect of the tax reform. The numerical simulations also provide an estimation of the tax rate of the ad valorem system that maintains the profit of the coal industry. Considering the demand and supply situations in China's coal market, policy recommendations are provided to guide further reform of China's resource tax system.

Financing clean energy projects through domestic and foreign capital: The role of political cooperation among the EU, the G20 and OECD countries

- Energy Economics---2017---Sudharshan Reddy Paramati,Nicholas Apergis,Malles Ummalla

There is a growing concern among both individuals and policy makers in relevance to increasing CO₂ emissions across the world. As a result, international organizations have started to pressurize economies to minimize their carbon emissions by increasing the share of clean energy consumption in total energy use. Hence, the goal of this paper is to empirically explore to what extent both domestic (stock market) and foreign (FDI inflows) capital affect clean energy uses across the EU, the G20, and OECD, spanning the period 1993–2012. The results of long-run elasticities document that both FDI and stock market developments play a significant role in promoting clean energy uses across all three-country groups. The results also suggest that clean energy consumption has a considerable positive and negative effect on economic output and CO₂ emissions,

respectively, while the political globalization has a substantial negative impact on carbon emissions across the EU, the G20 and OECD economies.

Common cycles and common trends in the stock and oil markets: Evidence from more than 150years of data

- Energy Economics---2017---Mehmet Bal-cilar,Rangan Gupta,Mark Wohar

This paper investigates the role of permanent and transitory shocks, within the framework of common cycles and common trends, in explaining stock and oil prices. We perform a multivariate variance decomposition analysis of monthly data on the West Texas Intermediate (WTI) oil price and the S&P 500. The dataset used in the study spans a long period of 150years and therefore contains a rich history to examine both the short- and long-run comovement properties of oil and stock prices. Given that the oil and stock markets might comove both in the short- and long-run, it is of interest to see the relative impacts of transitory and permanent shocks on both variables. We find that (log) oil price and (log) S&P 500 share a common stochastic trend for our full sample of September 1859 to July 2015, but a common cycle only exists during the post-WW II period. Full and post-WW II samples have quite different common feature estimates in terms of the impact of permanent and transitory shocks as measured by the impulse responses and forecast error variance decompositions. We also find that in the short-run oil is driven mostly by cycles (transitory shocks) and stock market is mostly driven by permanent shocks. But, permanent shocks dominate in the long-run.

Optimal over installation of wind generation facilities

- Energy Economics---2017---Celine McInerney,Derek W. Bunn

This paper evaluates the economic benefits to over-installing turbines on capacity-constrained wind farm sites in order to capture more energy at low wind speeds. Although this implies curtailment at high wind speeds,

we show that over installing generation facilities can increase returns to investors and reduce system costs. A detailed model-based analysis is developed using British data, with variations in the range of over installation, the renewable policy support systems (fixed feed-in tariffs or green certificate premia to wholesale energy prices) and the extent of replacement of fossil generation in the technology mix with wind. In the cases of premia to market prices, we use agent-based, computational learning and risk simulation to model market prices. Not only is over installation beneficial under fixed feed-in tariffs, but is more so under premia to market prices and increasingly so as wind replaces fossil generation.

Energy demand, substitution and environmental taxation: An econometric analysis of eight subsectors of the Danish economy

- Energy Economics---2017---Niels Møller

This research contains an econometric analysis of energy demand in trade and industry which allows for substitution between electricity and other energy carriers when relative prices change. The presence of substitution suggests that taxation can be a means of changing the energy input mix in a more environmental-friendly direction. For eight subsectors of the Danish economy, time series (1966–2011) are modeled by means of partial Cointegrated VARs. Long-run demand relations are identified for all subsectors and robust price elasticities are supported in five cases. The results are used in a small impulse–response experiment which suggests a potential for taxation to induce substitution of electricity for fossil-based energy.

Blending under uncertainty: Real options analysis of ethanol plants and biofuels mandates

- Energy Economics---2017---Hamed Ghoddusi

The value of a representative ethanol producer, that benefits from both low and high gasoline prices in the short-run, is modeled. Ethanol producers make a modest competitive profit in the mandate-induced region of production. A low price of gasoline increases

the demand for blend ethanol and consequently increases the profit of ethanol producers. On the other hand, when gasoline becomes costlier than ethanol, the capacity constraints of the biofuels sector bind and ethanol producers gain large quasi-monopoly margins. This is an interesting example of a market where two commodities are complement up to a point and then substitute after that. We postulate the value of an ethanol producer as a strangle option consisting of two real options: the option to substitute gasoline at times of expensive crude oil and the option to expand supply of blend at times of cheap gasoline. Using a dynamic model we show that the higher volatilities of crude oil and ethanol costs increase biofuels firms' value. We also find non-monotonic relationships between the value of an ethanol plant and several underlying variables, including gasoline price level. We estimate the value provided by a 10% blend mandate to be around \$150,000,000 for a representative ethanol unit. Our results offer a novel view of oil and feedstock price risks in contrast to the common belief that considers those risks as a negative factor for the biofuels sector.

Energy-growth long-term relationship under structural breaks. Evidence from Canada, 17 Latin American economies and the USA

- Energy Economics---2017---Carlos Vladimir Rodríguez-Caballero, Daniel Ventosa-Santaulària, Carlos Vladimir Rodríguez Caballero

We study the relationship and the causal link between Electric Power Consumption, EPC, and Gross Domestic Product, GDP (both per capita) for 17 countries in Latin America, Canada and the USA. Considering that many of these economies underwent important economic crises in the last three decades, we therefore model the EPC-GDP relationship through a VEC specification that allows for structural breaks, along with a robust testing methodology of causal links based on the concepts of weak and super exogeneity, rather than Granger causality. Evidence favorable to the growth hypothesis ($EPC \rightarrow GDP$) is found for eight countries, while data of three countries support the conservation hypothesis ($GDP \rightarrow EPC$). For three countries evidence

is favorable to the neutrality hypothesis, but should be considered with caution. As for the remaining five countries the evidence is not conclusive.

Do petrol prices increase faster than they fall in market disequilibria?

- Energy Economics---2017---Chew Chua, Chamaka De Silva, Sandy Suardi

This paper tests the idea that petrol prices respond more quickly to price increases than to decreases. We show that the results previously documented in the literature for Australia are spurious due to failure to establish the stationarity property of the price series, and the co-integration relationship between retail and wholesale prices when neglecting to account for a regime shift in the data. Using a robust approach involving a threshold error correction model, we find little evidence to support the contention that retail petrol price reverts asymmetrically to long-run equilibrium. Asymmetric adjustments in retail prices are found only in four of the twenty-eight retail gas stations in Queensland. These results cast doubt on the previously reported pervasiveness of this asymmetric price response phenomenon in Australia. We further caution on erroneous inference with the use of weekly rather than daily data, and when failing to account for a regime shift in the data.

Sources of change in the demand for energy by Indonesian households: 1980–2002

- Energy Economics---2017---Joyce Chen, Mark M. Pitt

This paper describes the energy transition in Indonesia and examines the determinants of energy demand, by fuel. The key innovation of this paper is the documentation of how these relationships have evolved over time. We present a new method to combine econometric analysis and index decomposition analysis to examine household energy transition. This approach also allows us to consider a broad range of demographic and structural factors, while providing a clear and concise

representation of our findings. We find that the composite indices mask important underlying patterns. In particular, our results indicate that energy transition in Indonesia cannot be confidently attributed to any one index. Rather, it has been driven predominantly by the triple interaction of demographics, income growth, and change in demand/supply parameters. Our findings point to the importance of utilizing time-series data in studying both the characteristics and determinants of energy transition in developing countries.

The impact of crude oil prices on financial market indicators: copula approach

- Energy Economics---2017---Derya Ezgi Kayalar,Cumhur Küçüközmen,A. Sevtap Selcuk-Kestel

Oil price changes have varying impacts on the financial indicators of global markets and economies. This study aims to explore the dependence structure between crude oil prices and stock market indices, as well as the exchange rates in a number of economies categorized with respect to their status as developing/emerging markets, and oil importer/exporter countries. Dependence structures in this study are evaluated in considerable depth using copula models. The broad time period covered allows the investigation of the effect of global financial crisis on the mentioned dependence structure. An additional feature of this study is the inclusion of 1 to 30-day analysis to capture the variation of dependence on duration change. To serve these aims, as well as ARIMA and GARCH models, various copula measures are used to illustrate the level of the association. Additionally, a special focus on the Turkish case is given to illustrate its sensitivity to oil prices. We find that exchange rates and stock indices of most oil exporter countries show higher oil price dependency, whereas, emerging oil importer markets are less vulnerable to price fluctuations. Considerable impacts were found for the global crisis and the continuing recent sharp decrease in oil prices.

Discovery of natural resources: A class of general equilibrium models

- Energy Economics---2017---Paulo Henrique Vaz

When is the discovery of natural resources a curse for a country's industrialization and when is it a blessing? A large literature on economic development has collected evidence on both directions. This paper discusses a class of general equilibrium models that deals with natural resource discoveries and evaluates its potential to accommodate both successful and unsuccessful resource-based industrialization experiences, under different model settings. Particularly, it analyzes the importance of disentangling price and quantity effects. It illustrates that in closed model economies (or large open economies), with vertical integration between manufacturing and energy sectors, the long-run effect on the production of manufacturing goods will depend mainly on the equilibrium price of the natural resource good. Moreover, the strength of the vertical integration, even for small open economies, determines the limits to accommodate blessing or curse type of theories.

Assessing farmers' willingness to supply biomass as energy feedstock: Cereal straw in Apulia (Italy)

- Energy Economics---2017---Giacomo Giannocco,Bernardo C. de Gennaro,Emilio De Meo,Maurizio Prospero

Cereal straw currently has end-uses such as animal bedding and feeding, but there are no official statistics regarding the fraction of straw that is not used. Although cereal straw is an abundant source of biomass still largely unexploited for energy purposes, the feedstock market interplay with current straw uses (e.g. animal bedding and feeding) and on-farm practices (e.g. chopped and incorporated) is still unknown. This research used farmers' stated preferences to assess the supply curve (i.e. amount and price) of cereal straw for bio-energy purposes. In addition, we performed an econometric regression on the straw price demanded by farmers (willingness to accept). A sample of data gathered in 2014 from 203 cereal growers in Apulia region

(southern Italy) was used, and the results show that more than half of respondents would sell their cereal straw on the feedstock market, and that the preferred sales method is in-swath. The price requested would be higher (15.15EURha⁻¹) than that currently applied on the local straw market (12.00EURha⁻¹). Explanatory factors refer to farmers who currently burn stubble on-field, farmers involved in Agro-Environmental Schemes or contract provision, farmers with off-farm employment and farms with larger areas dedicated to cereals.

Taxing income in the oil and gas sector — Challenges of international and domestic profit shifting

- Energy Economics---2017---Sebastian Beer,Jan Loeprick

This paper provides specific estimates on the scale of profit shifting among hydrocarbon MNEs. We estimate a semi-elasticity of reported Earnings Before Interest and Taxes (EBIT) to sector specific income taxation of 1.68. Observed effects are larger when using Profit and Loss before Taxes, allowing for debt shifting. We find no profit-shifting among entities that are majority-owned by a national government. We also observe a higher vulnerability of non-OECD economies in our sample, which consists of 294 domestic and multinational parents and subsidiaries during the period from 2004 to 2012. To assess the importance of domestic profit-shifting channels, we take advantage of domestic tax differentials among hydrocarbon producers facing additional rent taxes and find that domestic profit shifting accounts for about one third of total income concealed.

Energy rebound effect in China's Industry: An aggregate and disaggregate analysis

- Energy Economics---2017---Yue-Jun Zhang,Hua-Rong Peng,Bin Su

Considering the crucial role of industrial sectors in energy conservation, this paper investigates the impact of output growth on energy consumption in China's

industrial sectors with an index decomposition model and the energy rebound effect in the industrial sectors with a panel data model using the annual data during 1994–2012. The empirical results indicate that: first, industrial output growth is proved to be the major factor in promoting industrial energy consumption, while energy intensity reduction and structure shifts across industrial sub-sectors play the dominant roles in slowing down industrial energy consumption. Second, there does exist energy rebound effect in China's aggregate Industry, which ranges from 20% to 76% during 1995–2012 (or 39% on average). In particular, the energy rebound effect in Manufacturing is relatively smaller during the sample period (i.e., 28% on average). Finally, the energy rebound effect in both China's aggregate Industry and Manufacturing exhibit an overall decreasing trend over time.

Spillovers from the oil sector to the housing market cycle

- Energy Economics---2017---Luca Agnello,Vitor Castro,Shawkat Hammoudeh,Ricardo Sousa

We assess the spillovers from the oil sector to the housing market cycle using quarterly data for 20 net oil-exporting and -importing industrial countries, and employing continuous- and discrete-time duration models. We do not uncover a statistically significant difference in the average duration of booms and normal times in the housing markets of those net oil-importers and net oil-exporters. Similarly, the degree of exposure to commodity price fluctuations does not seem to significantly affect the housing market cycle. However, we find that housing booms are shorter when oil prices increase than housing busts when oil prices decrease. We also show that the net oil-importers are more vulnerable to protracted housing slump episodes than the net-oil exporters.

Trade openness–carbon emissions nexus: The importance of turning points of trade openness for country panels

- Energy Economics---2017---Muhammad Shahbaz,Samia Nasreen,Khalid Ahmed,Shawkat Ham-

This paper explores the relationship between trade openness and CO₂ emissions by incorporating economic growth as an additional and potential determinant of this relationship for three groups of 105 high, middle and low income countries. We apply the Pedroni (1999) and Westerlund (2007) panel cointegration tests and find that the three variables are cointegrated in the long run. Trade openness impedes environmental quality for the global, high income, middle and low income panels but the impact varies in these diverse groups of countries. The panel VECM causality results highlight a feedback effect between trade openness and carbon emissions at the global level and the middle income countries but trade openness Granger causes CO₂ emissions for the high income and low income countries. Policy implications are also provided.

Fuel cost uncertainty, capacity investment and price in a competitive electricity market

- Energy Economics---2017---Nurit Gal,Irena Milstein,Asher Tishler,C.K. Woo

This paper studies the effect of natural-gas fuel cost uncertainty on capacity investment and price in a competitive electricity market. Our model has a two-stage decision process. In the first stage, an independent power producer (IPP) builds its optimal capacity, conditional on its perceived uncertainties in fuel cost and electricity demand. In the second stage, equilibrium prices and quantities are determined by IPPs competing in a Cournot market. Under the empirically reasonable assumption that per MWh fuel costs are log-normally distributed, we find that a profit-maximizing IPP increases its capacity in response to rising fuel cost volatility. Consequently, the expected profit of the IPP and expected consumer surplus increase with volatility, rejecting the hypothesis that rising fuel cost uncertainty tends to adversely affect producers and consumers. Expected consumer surplus further increases if the IPP hedges the fuel cost risk. However, the IPP's optimal strategy is not to do so. The policy implication of these results is that the government should not intervene to reduce the price volatility of a well-functioning

spot market for natural gas, chiefly because such intervention can have the unintended consequence of discouraging generation investment, raising electricity prices, and harming consumers.

Wavelet-based test of co-movement and causality between oil and renewable energy stock prices

- Energy Economics---2017---Juan Reboredo,Miguel A. Rivera-Castro,Andrea Ugolini

We studied co-movement and causality between oil and renewable energy stock prices using continuous and discrete wavelets, firstly, to obtain information on dynamic correlations over time and for different time scales from wavelet coherence and, secondly, to obtain information on linear and non-linear Granger causality in the time-frequency domain. For general and sectoral renewable energy indices for the period 2006–2015, our findings indicate that dependence between oil and renewable energy returns in the short run was weak but gradually strengthened towards the long run, mainly for the period 2008–2012. Our causality tests provide evidence against linear causality at higher frequencies and in favour of unidirectional and bidirectional linear causality at lower frequencies. In contrast, we found consistent evidence of non-linear causality running from renewable energy indices to oil prices at different time horizons and mixed evidence of causality running from oil to renewable energy prices. These results have potential implications for investors in terms of hedging and for policymakers in terms of policy support decisions regarding the development of renewable energy.

Strategic oil stockpiling for energy security: The case of China and India

- Energy Economics---2017---Xiao-Bing Zhang,Ping Qin,Xiaolan Chen

Compared with the developed countries, the developing countries could be more vulnerable to oil supply disruptions due to their lack of strategic petroleum reserves (SPRs). Several developing countries, including

China and India, are establishing their SPRs to ensure energy security. In the common world oil market, one country's SPR decisions can be affected by the decisions of other countries. This paper investigates the SPR policies of China and India, two of the largest developing countries, in a game-theoretic framework, where the interactions between the two countries are taken into account. The results show that players' equilibrium stockpiling strategies and total expected costs could vary significantly with the initial oil market state, stockpile acquisition capacity and the probabilities for disruptions to persist.

The multi-factor energy input–output model

- Energy Economics---2017---Zeus Guevara,Tiago Domingos

Energy input–output analysis (EIO analysis) is a noteworthy tool for the analysis of the role of energy in the economy. However, it has relied on models that provide a limited description of energy flows in the economic system and do not allow an adequate analysis of energy efficiency. This paper introduces a novel energy input–output model, the multi-factor energy input–output model (MF-EIO model), which is obtained from a partitioning of a hybrid-unit input–output system of the economy. This model improves on current models by describing the energy flows according to the processes of energy conversion and the levels of energy use in the economy. It characterizes the vector of total energy output as a function of seven factors: two energy efficiency indicators; two characteristics of end-use energy consumption; and three economic features of the rest of the economy. Moreover, it is consistent with the standard model for EIO analysis, i.e., the hybrid-unit model. This paper also introduces an approximate version of the MF-EIO model, which is equivalent to the former under equal energy prices for industries and final consumers, but requires less data processing. The latter is composed by two linked models: a model of the energy sector in physical units, and a model of the rest of the economy in monetary units. In conclusion, the proposed modelling framework improves EIO analysis and extends EIO applications to

the accounting for energy efficiency of the economy.

The role of oil prices in the forecasts of South African interest rates: A Bayesian approach

- Energy Economics---2017---Rangan Gupta,Kevin Kotze

This paper considers whether the use of real oil price data can improve upon the forecasts for the nominal interest rate in South Africa. We employ Bayesian vector autoregressive models that make use of various measures of oil prices and compare the forecasting results of these models with those that do not make use of this data. The real oil price data is also disaggregated into positive and negative components to establish whether this would improve upon the forecasting performance of the model. The full dataset includes quarterly measures of output, consumer prices, exchange rates, interest rates and oil prices, where the initial in-sample period extends from 1979q1 to 1997q4. We then perform recursive estimations and one- to eight-step ahead forecasts over the out-of-sample period 1998q1 to 2014q4. The results suggest that the models that include information relating to oil prices outperform the model that does not include this information, when comparing their out-of-sample properties. In addition, the model with the positive component of oil price tends to perform better than other models over the short to medium horizons. Then lastly, the model that includes both the positive and negative components of the oil price, provides superior forecasts over longer horizons, where the improvement is large enough to ensure that it is the best forecasting model on average. Hence, not only do real oil prices matter when forecasting interest rates, but the use of disaggregate oil price data may facilitate additional improvements.

Carbon dioxide, income and energy: Evidence from a non-linear model

- Energy Economics---2017---Yi-Bin Chiu

This study applies the panel smooth transition regression (PSTR) model to explore the impacts of real

income, energy, and investment on the CO₂-income nexus for 99 countries covering the period from 1971 to 2010. We find that in the full sample, as real income rises, CO₂ emissions rapidly increase first, and then their increasing rate starts to slow down, while the environmental Kuznets curve (EKC) hypothesis for CO₂ emissions is supported from the composite results of three income groups. Our results show that decreasing energy usage, improving energy efficiency, and enhancing clean energy usage could effectively ease the impacts of real income on CO₂ emissions. Moreover, countries with different energy trade conditions and income levels have different CO₂-income correlations, indicating that one size does not fit all.

Asymmetric effects of the business cycle on carbon dioxide emissions

- Energy Economics---2017---Tamara Sheldon

Long-term carbon dioxide emissions forecasts rely on the assumption that the economic growth rate is constant over long time horizons and exclude the business cycle, thereby ignoring a fundamental component of the macroeconomy. This paper considers how the business cycle affects emissions forecasts and shows the implicit assumption in current forecasts, that the elasticity of emissions is constant with respect to GDP, is wrong. In the United States, emissions fall more sharply when GDP declines than they rise when GDP increases. This is partly due to a decrease in industrial energy intensity as GDP declines. A simulation shows that accounting for the business cycle results in 5% lower cumulative emissions through 2050 relative to the baseline forecast.

Ownership and environmental regulation: Evidence from the European electricity industry

- Energy Economics---2017---Stefano Clo,Matteo Ferraris,Massimo Florio

The paper investigates how ownership affects the environmental performance in developed countries where environmental regulation is introduced in the form

of market-based instrument. By looking at a cross-country panel dataset of 29 power markets around Europe over the period 1990–2012, we find empirical evidence that an increase of public ownership, as measured by the OECD ETCR index, is associated with a reduction of both greenhouse gas emissions and carbon intensity. We also find that the implementation of the European Emissions Trading Scheme (ETS) had a limited impact on emissions' reduction due to lax allocation of allowances. The positive effect of public ownership on environmental performance has been significant even after the introduction of the ETS, giving additional incentives to mitigate emissions when the ETS cap was not stringent enough. This evidence suggests that government control over power companies in Europe can have created idiosyncratic incentives to improve environmental quality, complementing environmental regulation in the achievement of environmental goals when the latter was absent or sub-optimal.

Risk management of energy system for identifying optimal power mix with financial-cost minimization and environmental-impact mitigation under uncertainty

- Energy Economics---2017---S. Nie,Y.P. Li,J. Liu,Charley Z. Huang

An interval-stochastic risk management (ISRM) method is launched to control the variability of the recourse cost as well as to capture the notion of risk in stochastic programming. The ISRM method can examine various policy scenarios that are associated with economic penalties under uncertainties presented as probability distributions and interval values. An ISRM model is then formulated to identify the optimal power mix for the Beijing's energy system. Tradeoffs between risk and cost are evaluated, indicating any change in targeted cost and risk level would yield different expected costs. Results reveal that the inherent uncertainty of system components and risk attitude of decision makers have significant effects on the city's energy-supply and electricity-generation schemes as well as system cost and probabilistic penalty. Results also disclose that import electricity as a recourse action

to compensate the local shortage would be enforced. The import electricity would increase with a reduced risk level; under every risk level, more electricity would be imported with an increased demand. The findings can facilitate the local authority in identifying desired strategies for the city's energy planning and management in association with financial-cost minimization and environmental-impact mitigation.

International oil price uncertainty and corporate investment: Evidence from China's emerging and transition economy

- Energy Economics---2017---Yong Wang, Erwei Xiang, Adrian (Wai-Kong) Cheung, Wenjuan Ruan, Wei Hu

We develop and estimate a dynamic model of investment to investigate the impact of international oil price uncertainty on corporate investment expenditures in China's emerging and transition economy. We further examine whether state ownership affects the relationship between oil price uncertainty and corporate investment. Consistent with the model's prediction, the main finding is that oil price uncertainty exerts a negative impact on corporate investment expenditures. In addition, compared with state-owned listed companies, the negative influence of oil price uncertainty on corporate investment is more significant for non-state-owned listed companies. Our further analysis, using the market-oriented reform of refined oil pricing in 2008 as a quasi-natural event, shows the variation between the low-degree marketization period and the high-degree one in terms of the relationship between international oil price uncertainty, state ownership and corporate investment expenditures.

Low natural gas prices and the financial cost of ramp rate restrictions at hydroelectric dams

- Energy Economics---2017---Jordan D. Kern, Gregory W. Characklis

Peaking hydroelectric dams that employ variable, stop-start reservoir releases can have adverse impacts on downstream river ecosystems. Efforts to mitigate these

impacts have relied predominantly on the use of ramp rate restrictions, which limit the magnitude of hour-to-hour changes in reservoir discharge. Ramp rate restrictions shift hydropower production towards less valuable off-peak hours, imposing a financial penalty on dam owners that is a function of the "spread" (difference) between peak and off-peak electricity prices. This study examines how low natural gas prices in the U.S. have reduced the cost of implementing ramp rate restrictions at dams by narrowing the peak/off-peak price spread. Significantly lower costs of ramp rate restrictions could open new opportunities for improving environmental flows at dams, including the "purchase" of more natural streamflow patterns by downstream stakeholders, a type of arrangement for which there is growing precedent. We also explore the role that uncertainty in the cost of ramp rate restrictions could play in precluding downstream stakeholders from forming these types of agreements with dam owners. Results suggest that financial "collar" contracts could mostly eliminate inter-annual variability in the net cost of restrictions and provide those purchasing more natural flows with greater certainty.

I can hear my neighbors' fracking: The effect of natural gas production on housing values in Tarrant County, TX

- Energy Economics---2017---Andrew T. Balthrop, Zackary Hawley

In this study we estimate the effect of hydraulically fractured natural gas wells on residential real estate prices. We exploit variation in distance to nearby gas wells in home sale prices to estimate this effect. In contrast to previous studies, we focus on a relatively densely populated area, a section of the Dallas-Ft. Worth-Arlington urban area. Using a dataset of 127,556 observations from Tarrant County, Texas over the period 2005-2011, we find robust evidence that increased proximity to a well leads to reduced home sale prices. Existence of wells within 3500ft of a property reduces property values by approximately 1.5-3%. We demonstrate that the reduction seems to be driven by unconventional

rather than conventional wells, and that well construction causes an added 1–2% reduction in home value.

Explosive oil prices

- Energy Economics---2016---Marc Gronwald

Spectacular oil price increases occur on a regular basis; the most recent one is dated July 2008. This paper puts forward the notion that extreme oil price movements of this type can be described as temporary explosive. The paper applies a forward recursive unit root tests and finds evidence of explosive behavior in the following periods: 1990/1991, 2005/2006, and 2007/2008. Currently existing oil price models are not capable of appropriately describing this type of behavior. A thorough discussion of the underlying reasons of these price hikes indicates these oil price episodes — even though extreme — are mainly fundamentally explained. This finding is insufficiently acknowledged in the literature on speculative oil price bubbles. Thus, policy interventions as response to extreme movements of this kind need to be very carefully thought through.

Potential gains from expanding regional electricity trade in South Asia

- Energy Economics---2016---Govinda R. Timilsina, Michael Toman

The South Asia region is lagging behind many regions in regional electricity trading despite the huge potential for trade. Using an electricity system optimization model, this study quantifies the benefits of unrestricted cross-border electricity trade in South Asia during the 2015–2040 period. The study finds that the unrestricted electricity trade provision would save US\$226 billion (US\$9 billion per year) of electricity supply costs over the period (~ \$100 billion when discounted at 5% rate). The ratio of benefits, in the form of reduction of fuel and other operating costs, to increased costs of generation and interconnection investment would be more than 5:1. The provision would reduce regional power sector carbon dioxide emissions by 8%, mainly through substitution of coal-based generation with hydro-based generation, although regional emissions would be well

above current levels absent other policy interventions because of rapidly growing demand. To achieve these benefits, the region would need to add 95 GW of new cross-border transmission interconnection capacity; but at the same time it would avoid 36 GW of additional interconnection capacity between the regional grids within India.

An analysis of the driving factors of energy-related CO2 emission reduction in China from 2005 to 2013

- Energy Economics---2016---Tianyu Qi, Yuyan Weng, Xiliang Zhang, Jiankun He

The identification of the driving factors of China's energy-related emissions in the past years is very important to inform the policy design for China's future emission mitigations. Although this topic has been widely discussed in the literature, this paper provides the most recent overall estimation of the emission mitigation factors from both the production side and the consumption side taking into account China's recent energy and economic transformation. This study adopts China's most recent revised energy and economic data from 2005 to 2013 and analyzes it with a logarithmic mean Divisia index (LMDI) decomposition model. We find that the primary emission mitigation contributor is the improvement of energy productivity in the industry sectors, which contributes 72% of the total reduction; household contributes 8.3%. The economic transitions in 2013 are still in an early stage, and the expected economic structure effect is moderately on emission reduction. In the future, China needs to improve the energy productivity in production sectors further by both enforcing energy conservation and promoting industry upgrading. Economic restructure will play a more important role in future emission reduction.

Technology adoption under time-differentiated market-based instruments for pollution control

- Energy Economics---2016---Michael Craig, Elena McDonald-Buller, Mort Webster

Peak concentrations of ground-level ozone pose health

risks to millions of U.S. citizens across the U.S. In order to reduce peak ozone concentrations, nitrogen oxide (NO_x) emissions from the power sector, among others, have been regulated with technology-based standards or, more commonly in recent years, market-based instruments such as cap-and-trade programs. However, the lack of temporal flexibility in current designs of these market-based instruments limits their cost-effectiveness on days forecasted to have the highest levels of pollution, including ozone precursors such as NO_x, and as further emission reductions are sought, the marginal cost of these approaches increases dramatically. In this paper, we compare three regulatory schemes for reducing NO_x emissions on high-ozone days: time-differentiated pricing, which prices NO_x emissions only on days with high-ozone concentrations; undifferentiated pricing, which represents current NO_x emission regulations; and technology-based standards. We develop a novel model that captures for the first time both the short- and long-term response of generators, through redispatching and control technology adoption, to a dynamic pricing scheme such as time-differentiated pricing. Unlike prior studies on time-differentiated pricing, the heart of our model, a unit commitment model, accounts for inter-temporal constraints on power generation that may be crucial to accurately capturing the response of generators to a transient price signal. We apply this model to the Texas power system and find that while control technology adoption (specifically selective catalytic reduction) does occur at very high time-differentiated prices, time-differentiated pricing mainly affects emissions and costs through redispatching of gas- for coal-fired generation. Furthermore, we show that time-differentiated pricing, due to its targeted pricing mechanism, provides a more cost-effective approach than undifferentiated pricing or technology-based standards for reducing NO_x emissions on high-ozone days, but is not cost-effective at reducing summer-wide NO_x emissions. Our results illustrate the trade-offs between these regulatory approaches and suggest that states should consider dynamic pricing schemes such as time-differentiated pricing for achieving further reductions in peak ozone concentrations.

Forecasting spot oil price in a dynamic model averaging framework — Have the determinants changed over time?

- Energy Economics---2016---Krzysztof Drachal

This paper is aimed on the analysis of monthly spot oil prices (WTI) between 1986 and 2015. The methodology is based on Dynamic Model Averaging (DMA) and Dynamic Model Selection (DMS) framework. The important feature of DMA method is an allowance for both time-varying coefficients and large state space model (i.e., the set of oil price determinants can change in time). Within this framework it was explicitly shown how the significance of oil price determinants vary in time. These determinants itself were chosen with respect to some previous studies. Contrary to the currently reported DMA applications in some other fields, no significant evidence was found that DMA is superior over, for example, ARIMA model. However, DMA could also not been rejected as a significantly worse model due to certain statistical tests. The performed DMA analysis was checked for robustness on various model parameters and for certain computational issues.

A method to estimate the costs and benefits of undergrounding electricity transmission and distribution lines

- Energy Economics---2016---Peter H. Larsen

There has been a general shortfall of peer-reviewed literature identifying methods to estimate the costs and benefits of strategies employed by electric utilities to improve grid resilience. This paper introduces—for the first time—a comprehensive analysis framework to estimate the societal costs and benefits of implementing one strategy to improve power system reliability: undergrounding power transmission and distribution lines. It is shown that undergrounding transmission and distribution lines can be a cost-effective strategy to improve reliability, but only if certain criteria are met before the decision to underground is made.

Commodity dynamics: A sparse multi-class approach

- Energy Economics---2016---Luca Barbaglia, Ines Wilms, Christophe Croux

The correct understanding of commodity price dynamics can bring relevant improvements in terms of policy formulation both for developing and developed countries. Agricultural, metal and energy commodity prices might depend on each other: although we expect few important effects among the total number of possible ones, some price effects among different commodities might still be substantial. Moreover, the increasing integration of the world economy suggests that these effects should be comparable for different markets. This paper introduces a sparse estimator of the Multi-class Vector AutoRegressive model to detect common price effects between a large number of commodities, for different markets or investment portfolios. In a first application, we consider agricultural, metal and energy commodities for three different markets. We show a large prevalence of effects involving metal commodities in the Chinese and Indian markets, and the existence of asymmetric price effects. In a second application, we analyze commodity prices for five different investment portfolios, and highlight the existence of important effects from energy to agricultural commodities. The relevance of biofuels is hereby confirmed. Overall, we find stronger similarities in commodity price effects among portfolios than among markets.

Ranking Bertrand, Cournot and supply function equilibria in oligopoly

- Energy Economics---2016---Flavio Delbono, Luca Lambertini

We show that the standard argument according to which supply function equilibria rank intermediate between Bertrand and Cournot equilibria may be modified. We prove this result within a static oligopolistic game in which both supply function competition and Cournot competition yield a unique Nash equilibrium, whereas price setting yields a continuum of Nash equilibria. There are parameter regions in which Bertrand

profits are higher than Cournot ones, with the latter being higher than in the supply function equilibrium. Such permutation of the typical ranking occurs when price-setting mimics collusion. We then show that the modification in the ranking of profits is responsible for a permutation in the welfare performance of the industry, for any structure of the latter. Regulation may then be needed even under price competition and free entry.

Common long-range dependence in a panel of hourly Nord Pool electricity prices and loads

- Energy Economics---2016---Yunus Emre Erge-men, Niels Haldrup, Carlos Vladimir Rodríguez-Caballero, Carlos Vladimir Rodríguez Caballero

Equilibrium electricity spot prices and loads are often determined simultaneously in a day-ahead auction market for each hour of the subsequent day. Hence daily observations of hourly prices take the form of a periodic panel rather than a time series of hourly observations. We consider novel panel data approaches to analyse the time series and the cross-sectional dependence of hourly Nord Pool electricity spot prices and loads for the period 2000–2013. Hourly electricity prices and load data are characterized by strong serial long-range dependence in the time series dimension in addition to strong seasonal periodicity, and along the cross-sectional dimension, i.e. the hours of the day, there is a strong dependence which necessarily has to be accounted for in order to avoid spurious inference when focusing on the time series dependence alone. The long-range dependence is modelled in terms of a fractionally integrated panel data model and it is shown that both prices and loads consist of common factors with long memory and with loadings that vary considerably during the day. Due to the competitiveness of the Nordic power market the aggregate supply curve approximates well the marginal costs of the underlying production technology and because the demand is more volatile than the supply, equilibrium prices and loads are argued to identify the periodic power supply curve. The estimated supply elasticities are estimated from fractionally co-integrated relations

and range between 0.5 and 1.17 with the largest elasticities being estimated during morning and evening peak hours.

Government policy uncertainty and stock prices: The case of Australia's uranium industry

- Energy Economics---2016---Andrew Ferguson, Peter Lam

We investigate effects of government policy uncertainty on stock prices, reflecting tension between ‘private interest’ (economic benefits) and ‘public interest’ arguments over uranium mining. Using a sample of Australian-listed uranium firms from January 2005 through June 2008, we document a positive contemporaneous correlation between stock returns and volatility and two measures of government policy uncertainty, proxied by the spread in voters’ opinion polls between the two major political parties and a news-based sentiment index. Event-study results show significant stock price reactions to key uranium-related policy events, with cross-sectional variation in event returns predicted by models incorporating firm- and project-level characteristics. Our research design and findings may inform future research on the capital market effects of government policy uncertainty in other regulated industries.

A spatial-temporal decomposition approach to performance assessment in energy and emissions

- Energy Economics---2016---B.W. Ang, Bin Su, H. Wang

There has been growing interest among researchers and policymakers in comparing or benchmarking countries on the basis of their performance in energy consumption or energy-related CO₂ emissions. Such studies allow variations among countries to be revealed, the contributing factors identified, and the scope for improvement better understood. At the same time, tracking changes or quantifying improvements in energy use or emissions over time in a country have long been a focus area of researchers and policy makers. To provide a fuller picture on country performance in a

multi-country study over time, it would be of interest to integrate the above-mentioned spatial and temporal analyses in a single analysis framework. This paper deals with this issue using the technique of index decomposition analysis. A spatial-temporal approach is introduced and two application cases are presented to illustrate how the approach can be applied. The first analyzes variations and changes in the aggregate CO₂ intensity of electricity production for ten countries from 1990 to 2010, and the second deals with variations and changes in the aggregate energy intensity for eight economic regions of China from 2002 to 2012. In addition, two different ways of presenting the results are introduced. Our study shows that the proposed approach can supplement studies which are conducted purely on a spatial or temporal basis.

Explaining Demand for Green Electricity Using Data from All U.S. Utilities

- Energy Economics---2016---Marc Conte, Grant D. Jacobsen

Green electricity programs enable households to voluntarily contribute to the development of renewable electricity by purchasing green electricity through their local utility. Using a dataset of all utilities in the United States, this paper explores the utility, consumer, and program characteristics that influence participation levels in green electricity, as well as whether a utility chooses to offer a program. Among other results, we find that the key determinants of program participation are the education of the consumer base and the affordability of the green electricity program. Our results enhance understanding of private provision of environmental public goods and could aid in ex ante evaluations of whether a green electricity program is likely to cover its administrative costs or be a cost-effective way of improving environmental quality.

Environmental regulation and productivity: The case of electricity generation under the CAAA-1990

- Energy Economics---2016---Pedro Hancevic

This paper measures the impact of the 1990 Clean Air Act Amendments on coal-fired boilers' productivity and output. The Act led to generating units adopting a number of different pollution abating behaviors, one of which was an input change to lower SO₂ emitting coal. A key feature of the production technology is that each boiler is designed to burn a particular variety of coal, with significant deviations from the targeted coal characteristics resulting in productivity losses. Using data for the 1985–1999 period, I present empirical evidence of the policy impact. The main findings are that productivity declined between 1% and 2.5%, on average, and output losses ranged from 1% to 6% for affected boilers, varying across regions and over time.

How well do degree days over the growing season capture the effect of climate on farmland values?

- Energy Economics---2016---Emanuele Massetti, Robert Mendelsohn, Shun Chonabayashi

Farmland values have traditionally been valued using seasonal temperature and precipitation but degree days over the growing season offer a more compact alternative. We find that degree days and daily temperature are interchangeable over the growing season. However, the impact of degree days in spring and summer is quite different. Climate effects outside the growing season are also significant. Cross sectional evidence suggests seasonal temperature and precipitation are very important whereas temperature extremes have relatively small effects.

Regional woody biomass supply and economic impacts from harvesting in the southern U.S

- Energy Economics---2016---Lixia He, Burton English, Robert J. Menard, Dayton Lambert

Demand for woody biomass from the southern United States (US) is increasing because of its reliability in supply, recent developments in co-firing and biofuel conversion technologies, overseas pellet demand, and the expected economic impacts from reorienting the forestry sector towards energy feedstock production.

This research examines the interaction between a set of woody biomass harvesting sources (logging residue, non-merchantable, and merchantable roundwood) and wood types (hardwood, planted softwood, and natural softwood), and the impacts harvest costs have on the extraction of these materials in the southern US. The expected woody biomass availability and its geographic distribution are determined with a cost minimizing linear programming model. The marginal cost of woody biomass supply is determined for different energy production targets, subject to satisfying conventional wood demand. Given derived industry supply curves, the economic impacts of the sector are analyzed using the IMPLAN model at the Bureau of Economic Analysis (BEA) level. The results suggest that forest biomass for energy production is projected to be available over a much wider price range with logging, residue, and non-merchantable and merchantable roundwood in these regions. Supply of hardwood and softwood biomass from merchantable roundwood is expected to increase if these materials can be harvested for non-conventional uses. Development of harvesting woody biomass from logging residue, non-merchantable, and merchantable timber has positive effects on local economies, bringing with it employment opportunities to some BEA regions.

Motivations for market restructuring: Evidence from U.S. electricity deregulation

- Energy Economics---2016---J. Dean Craig

The purpose of this paper is to examine whether electricity restructuring was brought about due to the Public Interest Theory (that regulatory changes are undertaken to benefit society) or the Interest Group Theory (that groups hoping to gain from deregulation lobby for regulatory changes). From 1996 to 2002 eighteen states developed restructuring programs targeted at improving efficiency through the use of increased wholesale trading, abolition of 'cost of service' regulation, measures to open electricity production to non-utility entities, and the unbundling of transmission and distribution. Results indicate some evidence

of the Public Interest Theory and strong evidence of the Interest Group Theory.

Oil prices and real estate investment trusts (REITs): Gradual-shift causality and volatility transmission analysis

- Energy Economics---2016---Saban Nazlioglu,N. Alper Gormus,Ugur Soytaş

According to literature, oil price shocks and volatility can have sector-specific impacts in the market. While these studies include most asset groups, the dynamic relationship between the oil market and Real Estate Investment Trusts (REITs) has not been tested. This study examines the role of oil price shocks and volatility on six REIT categories: Residential, Hotel, Healthcare, Retail, Mortgage and Warehouse/Industrial REITs for the January 2005–December 2013 period. In addition, a new causality approach is proposed by augmenting the Toda–Yamamoto method with a Fourier approximation. This approach is capable of capturing gradual or smooth shifts and does not require a prior knowledge regarding the number, dates, and form of structural breaks. The so-called Fourier Toda–Yamamoto causality (mean spillover) test finds uni-directional causality running from oil prices to all REITs, except for the mortgage REITs. In the latter case, the causality is reversed. In addition, the relatively new and simple causality-in-variance test shows that there is bi-directional volatility transmission between the oil market and all REITs. Our results have important implications for REIT managers and investors.

FTR allocations to ease transition to nodal pricing: An application to the German power system

- Energy Economics---2016---Friedrich Kunz,Karsten Neuhoﬀ,Juan Rosellon

A shift from zonal to nodal pricing improves the efficiency of system operation. However, resulting price changes also shift surplus across generation and loads at different locations. As individual actors can lose,

they might oppose any reform. We explore how allocation of financial transmission rights can be used to mitigate the distributional impact. The fundamental effects with regard to reference node/hub for FTRs, the share of FTRs to be freely allocated and the metric to determine the proportion of rights allocated are explored. We test the results in a setting based on the hourly modeling of the German power system at nodal representation.

Support schemes for renewable electricity in the European Union: Producer strategies and competition

- Energy Economics---2016---Luisa Dressler

Current discussion about how to reform European support schemes for renewable electricity neglects certain risks of market power in wholesale electricity markets. In a stylized Cournot model of interacting spot and forward electricity markets, I analyze how different price-based support schemes affect producer strategies and, ultimately, competition in the wholesale market. I compare the strategic behavior of renewable and conventional producers in terms of electricity production and forward market sales in the presence of two different price-based support schemes: feed-in tariffs and feed-in premiums. I show that the feed-in premium, which is the European Commission’s current scheme of choice, may enhance market power and favor conventional electricity production. It may also reduce the likelihood of achieving the political objective to increase production from renewable energy sources.

Doing good but not that well? A dilemma for energy conserving homeowners

- Energy Economics---2016---Marie H. Wahlström

In this paper the issue of market capitalization of energy efficient buildings is addressed by considering single-family housing in Sweden and through analyzing as to what extent the market price for a house is influenced by its energy performance. Are Swedish homeowners doing well by doing good?

A new approach to modeling the effects of temperature fluctuations on monthly electricity demand

- Energy Economics---2016---Yoosoon Chang, Chang Sik Kim, J. Miller, Joon Y. Park, Sungkeun Park

We propose a novel approach to measure and analyze the short-run effect of temperature on monthly sectoral electricity demand. This effect is specified as a function of the density of temperatures observed at a high frequency with a functional coefficient, in contrast to conventional methods using a function of monthly heating and cooling degree days. Our approach also allows non-climate variables to influence the short-run demand response to temperature changes. Our methodology is demonstrated using Korean electricity demand data for residential and commercial sectors. In the residential sector, we do not find evidence that the non-climate variables affect the demand response to temperature. In contrast, we show conclusive evidence that the non-climate variables influence the demand response in the commercial sector. In particular, commercial consumers are less responsive to cold temperatures when controlling for the electricity price relative to city gas. They are more responsive to the price when temperatures are cold. The estimated effect of the time trend suggests that seasonality of commercial demand has increased in the winter but decreased in the summer.

Measuring the effects of natural gas pipeline constraints on regional pricing and market integration

- Energy Economics---2016---Roger Avalos, Timothy Fitzgerald, Randal R. Rucker

Natural gas pipeline capacity sets physical limits on the quantity of gas that can be moved between regions, with attendant price effects. We find support for the hypothesis of integrated regional markets. Using data on daily pipeline flows and capacities in Florida and Southern California, we estimate reduced-form price effects of capacity constraints. We find that pipeline

congestion increased realized citygate prices by at least 11% over the mean in Florida and by 6% over the mean in Southern California. We attribute the difference in price effects to more binding capacity constraints in the Florida pipeline network. Our estimates provide guidance for interstate pipeline investments.

Disentangling temporal patterns in elasticities: A functional coefficient panel analysis of electricity demand

- Energy Economics---2016---Yoosoon Chang, Yongok Choi, Chang Sik Kim, J. Miller, Joon Y. Park

We introduce a panel model with a nonparametric functional coefficient of multiple arguments. The coefficient is a function both of time, allowing temporal changes in an otherwise linear model, and of the regressor itself, allowing nonlinearity. In contrast to a time series model, the effects of the two arguments can be identified using a panel model. We apply the model to the relationship between real GDP and electricity consumption. Our results suggest that the corresponding elasticities have decreased over time in developed countries, but that this decrease cannot be entirely explained by changes in GDP itself or by sectoral shifts.

How natural gas tariff increases can influence poverty: Results, measurement constraints and bias

- Energy Economics---2016---Alexander Krauss

Energy tariff increases are generally essential to address environmental and fiscal concerns but they can also push households into poverty. This paper estimates the expected poverty and distributional effects of a significant natural gas tariff reform in the context of Armenia that increased the country's residential tariff by about 40%. It is the first paper in the literature on energy tariff reforms to simultaneously try and control for substitution between all major energy sources (not just some), to take into account the seasonality of consumption over the full annual cycle, and to apply different methods to assess changes in household

consumption on natural gas and shifts in natural gas between main and supplementary heating sources. Existing papers thus generally overestimate the potential effects of energy price increases on household welfare. The results here – which face, like any statistical study, a set of important methodological constraints – suggest nonetheless that this significant tariff increase led to an estimated 8% of households shifting away from gas, mainly towards wood, as their heating source. It consequently resulted in an estimated 2.8% of households falling below the national poverty line, while likely also influencing non-monetary human welfare that cannot be well captured econometrically. Finally, methodological assumptions and limitations in assessing these relationships, as well as potential policy implications are outlined.

Modeling and forecasting multivariate electricity price spikes

- Energy Economics---2016---Hans Manner,Dennis Türk,Michael Eichler

We consider the problem of forecasting the occurrence of extreme prices in the Australian electricity markets from high frequency spot prices. In particular, we are interested in the simultaneous occurrence of such so-called spikes in two or more markets. Our approach is based on a novel dynamic model for multivariate binary outcomes, which allows the latent variables driving these observed outcomes to follow a vector autoregressive process. Furthermore the model is constructed using a copula representation for the joint distribution of the resulting innovations. This has several advantages over the standard multivariate probit model. First, it allows for nonlinear dependence between the error terms. Second, the distribution of the latent errors can be chosen freely. Third, the computational burden can be greatly reduced making estimation feasible in higher dimensions and for large samples. The model is applied to spikes in half-hourly electricity prices in four interconnected Australian markets. The multivariate model provides a superior fit compared to single-equation models and generates better forecasts for spike probabilities. Furthermore, evidence of

spillover dynamics between the markets is revealed.

Simultaneity modeling analysis of the environmental Kuznets curve hypothesis

- Energy Economics---2016---Adel Ben Youssef,Shawkat Hammoudeh,Anis Omri

The environmental Kuznets curve (EKC) hypothesis has been recognized in the environmental economics literature since the 1990's. Various statistical tests have been used on time series, cross section and panel data related to single and groups of countries to validate this hypothesis. In the literature, the validation has always been conducted by using a single equation. However, since both the environment and income variables are endogenous, the estimation of a single equation model when simultaneity exists produces inconsistent and biased estimates. Therefore, we formulate simultaneous two-equation models to investigate the EKC hypothesis for fifty-six countries, using annual panel data from 1990 to 2012, with the end year is determined by data availability for the panel. To make the panel data analysis more homogeneous, we investigate this issue for a three income-based panels (namely, high-, middle-, and low-income panels) given several explanatory variables. Our results indicate that there exists a bidirectional causality between economic growth and pollution emissions in the overall panels. We also find that the relationship is nonlinear and has an inverted U-shape for all the considered panels. Policy implications are provided.

Decoupling CO2 emissions and industrial growth in China over 1993–2013: The role of investment

- Energy Economics---2016---Xingrong Zhao,Xi Zhang,Shuai Shao

Since industrial sector is a leading energy consumer and CO2 emitter in China, the degree of the decoupling of CO2 emissions and industrial growth plays a critical role in realizing the energy-conservation and emission-reduction goals of China. This is the first study to present a specific investigation on the decoupling of CO2 emissions and industrial growth in

China from 1993 to 2013. Using an extended logarithmic mean Divisia index (LMDI) model focusing on both energy-related and process-related CO₂ emissions and introducing three novel investment factors, i.e., investment scale, investment share, and investment efficiency, we highlight and explore the remarkable role of investment in the mitigation and decoupling of CO₂ emissions with industrial growth. The results show that China's industrial sector experienced the weak decoupling during 1993–2013. The investment scale is the most important factor responsible for the increase in CO₂ emissions and the inhibition of the decoupling. The investment efficiency effect has a volatile trend and overall, it plays the most significant role in reducing CO₂ emissions, followed by the energy intensity effect and process carbon intensity effect, whereas the energy mix, carbon coefficient, and investment share have marginal effects. Among 36 industrial sub-sectors, the seven factors of RCMCP (raw chemical materials and chemical products), NMP (nonmetal mineral products), and SPFM (smelting and pressing of ferrous metals) have significant effects on the decoupling. Thus, the three sub-sectors should be among the top concerns for abating CO₂ emissions. Finally, we provide policy recommendations considering both conventional and investment factors for China's industrial sector to realize emission reduction targets.

Fast charging stations: Simulating entry and location in a game of strategic interaction

- Energy Economics---2016---Valeria Bernardo,Joan-Ramon Borrell,Jordi Perdiguer

This paper uses a game of strategic interaction to simulate entry and location of fast charging stations for electric vehicles. It evaluates the equilibria obtained in terms of social welfare and firm spatial differentiation. Using Barcelona mobility survey, demographic data and the street graph we find that only at an electric vehicle penetration rate above 3% does a dense network of stations appear as the equilibrium outcome of a market with no fiscal transfers. We also find that price competition drives location differentiation measured not only in Euclidean distances but also in consumer

travel distances.

Labor market impacts of U.S. tight oil development: The case of the Bakken

- Energy Economics---2016---Dragan Miljkovic,David Ripplinger

There has been a recent boom in natural gas and oil production in the US due to high energy prices and technological advances in hydraulic fracturing and horizontal drilling. While North Dakota oil production has increased significantly since 2005 with the development of Bakken formation, the impact on the rest of the economy including agriculture, historically the largest industry in North Dakota, has received little attention. We employ a variant of the Corden-Neary resource development model to test the impact of the oil boom in North Dakota caused by technical change on employment and wages in two tradable sectors of the state economy: agriculture and energy, alongside the rest of the state's economy, using a Vector Error Correction (VEC) model marking the very first use of the dynamic vector autoregression (VAR) analysis in this theoretical framework.

What can we learn about commodity and credit cycles? Evidence from African commodity-exporting countries

- Energy Economics---2016---Zied Ftiti,Akassi Kablan,Khaled Guesmi

This study analyzes the relationship between commodity prices and credit to the private sector in commodity-exporting developing countries, particularly three nations in Sub-Saharan Africa. In this regard, we extend the findings of non-empirical studies dealing with this issue for the case of African countries and complement the literature on the methodological side by investigating this relationship using wavelet analysis. This frequency approach is appropriate, as it takes into account investor heterogeneity and the time-variant characteristic of the studied relationship. Further, it explains the lead-lag relationship between the studied series. First, we observe that credit and commodities

are strongly related over long timescales, suggesting that the credit market reacts strongly to long-term change in commodity markets and thus tends to be sensitive to persistent commodity shocks. Second, for medium and short timescales, the interaction is high and significant only during periods of turmoil. In terms of the lead–lag relationship, our results also show that the commodity market causes fluctuations in the credit market.

Macroeconomic performance of oil price shocks: Outlier evidence from nineteen major oil-related countries/regions

- Energy Economics---2016---Keyi Ju,Bin Su,Dequn Zhou,Junmin Wu,Lifan Liu

As a special energy commodity, oil price shocks can affect not only the energy market but also the performance of the macroeconomy. This research provides complementary explanations for nineteen major oil-related countries/regions' macroeconomic effects caused by unexpected oil price changes. It focuses on the macroeconomic performance of oil price shocks from outlier perspective, investigating the inner hidden factors of co-movements between oil price shocks and macroeconomy. Three methods called Empirical Covariance (EC) method, Robust Covariance (RC) method and one-class Support Vector Machine (SVM) method are used in the outlier detection. Empirical results show that: (a) one-class SVM method has the best environmental adaptability for detecting the outlier performance of the co-movements between oil price shocks and macroeconomy, followed by EC and RC methods; (b) according to the time axis, the outlier performances of gross domestic production, consumer price index and unemployment rate are all concentrated in 2005–2014, which is highly consistent with the oil price shock process; and (c) according to the spatial axis (countries), four categories with similar outlier performances are obtained. Outlier performance of macroeconomy of oil-related country/region in lower levels seems to be worse than that of the country/region in higher levels, which can be attributed to more attentions paid by higher-leveled oil-related countries on the

oil price shock response system to relieve the severe macroeconomic impacts caused by oil price shocks.

Imperfect cartelization in OPEC

- Energy Economics---2016---Samuel J. Okullo,Frédéric Reynès

A model of global oil production is applied to study cartelization by OPEC countries. We define a measure for the degree of cooperation, analogous to the market conduct parameter of Cyert et al. (1973), Geroski et al. (1987), Lofaro (1999), and Symeonidis (2000). This parameter is used to assess the incentives of different OPEC members to collude. We find that heterogeneity in OPEC and the supplies of the non-OPEC fringe create strong incentives against collusion. More specifically, OPEC's supply strategy, although observed to be substantially more restrictive than that of a Cournot–Nash oligopoly, is found to still be more accommodative than that of a perfect cartel. The strategy involves allocating larger than proportionate quotas to smaller and relatively costlier producers, as if to bribe their participation in the cartel. This is in contrast to predictions of the standard cartel model that such producers should be allocated relatively more stringent quotas. Furthermore, we demonstrate that cartel collusion is more likely to be sustained for elastic than for inelastic demand. Since global oil demand is well known to be inelastic, this observation provides another structural explanation for why OPEC behavior is inconsistent with that of a perfect cartel. Our study points to multiple headwinds that limit OPEC's ability to mark up the oil price.

Economic growth, fossil fuel and non-fossil consumption: A Pooled Mean Group analysis using proxies for capital

- Energy Economics---2016---John Asafu-Adjaye,Dominic Byrne,Maximiliano Alvarez

This study employs a Pooled Mean Group estimator to examine the nexus between economic growth and fossil and non-fossil fuel consumption for 53 countries

between 1990 and 2012. The global sample was divided into four categories: developed exporters, developed importers, developing exporters and developing importers. The purpose of these categories was to observe whether factors unique to these countries influence the relationship between energy consumption and economic growth. With the exception of developing importers, evidence of bi-directional causality between fossil fuel consumption and real GDP across all subsamples is observed. This leads to the conclusion that efforts to directly conserve fossil fuels may harm economic growth. In terms of non-fossil fuel use, the results are more diverse. Bi-directional causality between non-fossil fuel use and real GDP is found in the long and short run for developed importers; bi-directional causality only in the long run for developed exporters; negative long-run causality from real GDP to non-fossil fuels for developing exporters; and long-run causality from non-fossil fuel use to real GDP for developing importers. These results lead to the conclusion that other factors have been responsible for the progress seen in non-fossil fuel use. Thus it is concluded that economic growth on its own is insufficient to promote clean energy development. There is a need for policy makers to create an environment conducive to renewable energy investment.

Bayesian interval robust optimization for sustainable energy system planning in Qiqihar City, China

- Energy Economics---2016---Cong Dong,Guohe Huang,Yanpeng Cai,Guanhui Cheng,Qian Tan

Old industrial bases in Northeastern China have been experiencing a series of problems such as energy scarcity, economic slack and environmental pollution due to lack of scientific planning of energy systems. Effective energy system management is desirable for avoiding occurrence of these problems in the following decades under the national policy of revitalizing these industrial bases. This task is challenged by system complexity, data unavailability, and inaccurate demand forecasting which can hardly be resolved in existing studies. For improving energy system man-

agement in Qiqihar City, a representative industrial base in Northeastern China, under these challenges, a large-scale and fine-resolution Bayesian interval robust energy system optimization (BIRESO) approach is developed in this study. In detail, the structure, characteristics, problems and complexities of the energy system in this city are identified and analyzed. Based on these efforts, a series of optimized energy system management schemes are generated through construction of a BIRESO model and development of a solution algorithm. The obtained solutions can be ensured to remain robust when input data changes through controlling the degree of solution conservatism in accordance with probabilistic bounds on constraint violation. Furthermore, Bayesian estimation method was employed for effectively achieving dynamic forecast of energy demands. The tradeoff among energy security, economic development and environmental conservation under multiple uncertainties is revealed, and the optimal balance among them is identified. A scenario analysis approach is used to quantify the effects of economic growth on energy system schemes based on several developed scenarios. Results show that the BIRESO approach is capable of providing scientific support for energy supply planning, renewable energy development, technological advancement, facility expansion, energy allocation, pollution control, economic impacts assessment, and other energy related activities in Qiqihar City.

Valuing an offshore oil exploration and production project through real options analysis

- Energy Economics---2016---José Guedes,Pedro Santos

To be useful to project managers, real option analysis (ROA) needs to capture the unique characteristics of individual projects and, at the same time, remain tractable and intuitive. That is a challenge since actual projects are often complex, featuring multiple sources of uncertainty as well as multiple investment and operating options. To meet the challenge, ROA has to take a clinical approach to project management and valuation, tailoring its framework to the specifics of

each individual project to reflect its main sources of flexibility without becoming overly complex. This paper undertakes a ROA of an offshore oil development project of an integrated oil and gas company. The sequence and interconnections of available real options – exploration options, appraisal options, scaling options and abandonment options – as well as the calibration of the model’s parameters, are developed in close collaboration with the Exploration and Production (E&P) division of the company, to assure realism and adherence to what management believes are the key sources of investment flexibility in a typical offshore project. The project assumes that there is joint uncertainty about reserve size and the price of oil. While the first source of uncertainty is resolved through exploration and appraisal activities the second is resolved through a diffusion model. The available real options add a substantial value to the project, with the option to abandon being the most valuable.

Economic impacts of debottlenecking congestion in the Chinese coal supply chain

- Energy Economics---2016---Bertrand Rioux, Philipp Galkin, Frederic Murphy, Axel Pierru

The fast pace of development in China’s coal industry created bottlenecks in its transportation infrastructure. These bottlenecks likely affected not only China’s domestic coal market, but also global coal markets. In this paper, we estimate the costs and consequences of these bottlenecks using a production and multimodal transportation model. We find that coal transportation inefficiencies increased the price of Chinese domestic coal at coastal locations and thereby influenced global seaborne coal prices. According to our model results, the resulting extra costs of coal supplied to the Chinese economy totaled 228 billion renminbi (RMB) in 2011 and 105 in 2013. The subsequent debottlenecking, on the other hand, has reduced the price of Chinese domestic coal delivered to coastal regions and contributed to the reduction in global seaborne coal prices since 2011. Our analysis also suggests that current tariffs for coal transport, with their embedded taxes to cover

investments in rail capacity, result in economic efficiencies similar to charging marginal transportation costs and that planners have not introduced distortions that impose significant additional costs on the Chinese economy. Many projects that expanded transport capacity delivered strongly positive rates of return. However, some have poor or negative rates of return, which can reflect either overinvestment or preinvestment in future needs.

Introduction: North American natural gas markets in transition

- Energy Economics---2016---Hillard Huntington

Over many decades, energy markets have seen a variety of new technologies with the potential of replacing existing practices for providing conventional fossil fuels. Unlike synthetic fuels during the 1970s or hydrogen during the 2000s, however, hydraulic fracturing for producing natural gas shale resources has had a dramatic impact because it has been cost effective. This article describes a model-comparison effort organized by Stanford’s Energy Modeling Forum and provides a brief overview of the principal findings by individual modeling teams that participated in the study.

North American natural gas and energy markets in transition: insights from global models

- Energy Economics---2016---Sonia Yeh, Yiyong Cai, Daniel Huppman, Paul Bernstein, Sugandha Tuladhar, Hillard Huntington

This modeling comparison exercise looks at the global consequences of increased shale gas production in the U.S. and increased gas demand from Asia. We find that differences in models’ theoretical construct and assumptions can lead to divergences in their predictions about the consequences of U.S. shale gas boom. In general, models find that U.S. High Shale Gas scenario leads to increased U.S. production, lower global gas prices, and lower gas production in non-U.S. regions. Gas demand in Asia alone has little effects on U.S. production; but together with the shale gas boom, the U.S. can have a large export advantage. Overall, models

find U.S. exports level range from 0.06 to 13.7 trillion cubic feet (TCF) in 2040. The comparison of supply, demand, and price changes in response to shocks reveals important differences among models. First is how the demand shocks were implemented and how the model responds to shocks: static and elastic within each time period vs. endogenous to the long-term gross domestic product (GDP) growth. Second is how the supply response is expressed through fuel/technology substitutions, particularly the flexibility of cross-fuel substitution in the power sector. Identifying these differences is important in understanding the model's insights and policy recommendations.

The national and international impacts of coal-to-gas switching in the Chinese power sector

- Energy Economics---2016---Vipin Arora,Yiyong Cai,Ayaka Jones

We evaluate the national and international impacts—on energy consumption and production, trade, and economic activity—of Chinese coal-to-gas switching in the electric power sector. We find that assumptions about growth rates in electricity generation from renewables are the key determinant in evaluating the economic consequences for coal-to-gas switching in China. The ability to supplement natural gas generation with renewables leads to smaller reductions in Chinese and global economic activity than the alternatives.

Economics of U.S. natural gas exports: Should regulators limit U.S. LNG exports?

- Energy Economics---2016---Paul Bernstein,Sugandha D. Tuladhar,Mei Yuan

This study assesses the level and destination of U.S. LNG exports, using a global natural market model under a wide range of EMF 31 scenarios. The scenarios reflect different U.S. natural gas resource outlooks, market conditions, changing U.S. environmental regulations, and possible changes in geopolitical conditions that affect the global natural gas demand and supply. U.S. LNG exports respond to market conditions under

each scenario and are free from any artificial limits. In the near-term, U.S. LNG exports are uncompetitive in the Reference case and in the long-run U.S. LNG exports are significant when U.S. natural gas resources are plentiful. However under demand shocks (increase demand in Asia) or supply shocks (reduction in Russian supplies) or persistence of oil-indexed pricing cases, U.S. LNG exports become competitive to varying degrees. U.S. exports depend not only on U.S. economics but also on how U.S. prices change relative to price changes in other regions of the world. We conclude that limiting U.S. LNG exports is inconsistent with simulated uncertainties, and it should be left to the market to determine the levels and destination of exports.

Variation in outcomes and leakage potential across Clean Power Plan compliance designs

- Energy Economics---2016---Evelyn Wright,Amit Kanudia

This paper presents results from a “modeler's choice” suite of runs that model the US Environmental Protection Agency's proposed Clean Power Plan (CPP) regulating carbon dioxide emissions from existing power plants under Section 111d of the Clean Air Act more closely than does the core EMF 31 Technology Performance Standard (TPS) case. While the TPS case imposed a national emissions rate standard for the power sector, the CPP imposes its budgets at the state level and provides states a great deal of flexibility in designing their implementation approaches. States may convert their CPP rate targets to a mass basis, and they may join with other states in multi-state trading plans. Under the proposed rule, EPA also left open the question of how new gas units were to be treated under the CPP. This design flexibility leads to a range of possible outcomes when it comes to the impacts of the proposed CPP on emissions, policy costs, electricity generation patterns, and gas markets. We analyzed 40 CPP scenarios in the Framework for Analysis of Climate-Energy-Technology Systems (FACETS), permuting these three design dimensions along with energy efficiency and low shale resource scenarios.

What is the fuel of the future? Prospects under the Clean Power Plan

- Energy Economics---2016---Martin T. Ross, Brian C. Murray

EPA proposed the Clean Power Plan (CPP) to regulate CO₂ emissions from existing power plants. The CPP establishes state-by-state emission rate goals for affected fossil units, largely existing coal and natural gas combined cycle generators. A key element of the proposal is its flexibility mechanisms, including the ability of states to trade obligations with other states and to convert to mass-based targets. How states decide to take advantage of this flexibility may have significant impacts on fuel markets of the future. This analysis uses the DIEM economy/electricity model to examine the consequences of a range of these alternative choices for fuel demands across the United States. Key findings for the June 2014 proposal include: the CPP tends to continue an ongoing shift in fuel consumption by electricity generators from coal to natural gas, a rate-based approach to CPP leads to more gas use in the early years than a mass-based approach but the effect disappears over time as new more-efficient gas units are constructed, and there may be substantial regional variation and stresses in fuel markets, especially over the next five years.

Role of natural gas in meeting an electric sector emissions reduction strategy and effects on greenhouse gas emissions

- Energy Economics---2016---Carol Lenox, P. Ozge Kaplan

With advances in natural gas extraction technologies, there is an increase in the availability of domestic natural gas, and natural gas is gaining a larger share of use as a fuel in electricity production. At the power plant, natural gas is a cleaner burning fuel than coal, but uncertainties exist in the amount of methane leakage occurring upstream in the extraction and production of natural gas. At higher leakage levels, the additional methane emissions could offset the carbon dioxide emissions reduction benefit of switching from coal to natural

gas. This analysis uses the MARKAL linear optimization model to compare the carbon emissions profiles and system-wide global warming potential of the U.S. energy system over a series of model runs in which the power sector is required to meet a specific carbon dioxide reduction target across a number of scenarios in which the availability of natural gas changes. Scenarios are run with carbon dioxide emissions and a range of upstream methane emission leakage rates from natural gas production along with upstream methane and carbon dioxide emissions associated with production of coal and oil. While the system carbon dioxide emissions are reduced in most scenarios, total carbon dioxide equivalent emissions show an increase in scenarios in which natural gas prices remain low and, simultaneously, methane emissions from natural gas production are higher.

Implications of a US electricity standard for final energy demand

- Energy Economics---2016---Stephen Healey, Mark Jaccard

This paper analyzes the emissions impact of an emissions intensity standard (metric tons of CO₂ per MWh of electricity) for the US power sector on US final energy demand — i.e. the manufacturing, residential, commercial, and transportation sectors. An emissions intensity standard, although geared towards the power sector, will have implications for these other sectors of the economy through its effect on economy-wide energy prices. Using a hybrid energy-economy simulation model (CIMS), we find the effect on aggregate emissions from final demand to mostly be small. However, after disaggregating final demand, we find significant changes in CO₂e emissions for several of sub-sectors. Given that emissions reductions in final energy demand are needed alongside power sector reductions for the US to achieve deep emissions cuts, our findings provide needed insight as to whether these eventual reductions will be helped or hindered by a US electricity standard.

The impacts of meeting a tight CO2 performance standard on the electric power sector

- Energy Economics---2016---Donald Hanson,David Schmalzer,Christopher Nichols,Peter Balash

This paper presents innovative modeling of complex interactions among gas-fired generators, coal-fired power plants, and renewables (wind and solar) when pushed hard to reduce CO2 emissions. A hypothetical CO2 technology performance standard, giving rise to a shadow price on CO2 emissions, was specified as part of the study design. In this work we see gas generation rapidly replacing coal generation. To understand the fate of coal-based generation, it is important to examine trends at a granular level. An important feature of our model, the Electricity Supply and Investment Model (ESIM) is that it contains a unit inventory with unit characteristics and a memory of how each unit is operated over time. Cycling damages that individual coal units incur are a function of cumulative wear and tear over time. The expected remaining life of a cycled coal unit will depend on the severity of the cycling and for how many years. Deteriorating operating characteristics of a cycled unit over time results in higher operating costs, slipping down the dispatch loading order, and hence an acceleration of cycling damage, that is, a viscous circle of decline. The rate of CFPP retirements will increase for lower gas prices, higher price on CO2 emissions, and greater penetration of variable and intermittent renewables.

A view to the future of natural gas and electricity: An integrated modeling approach

- Energy Economics---2016---Wesley J. Cole,Kenneth B. Medlock,Aditya Jani

This paper demonstrates the value of integrating two highly spatially resolved models: the Rice World Gas Trade Model (RWGTM) of the natural gas sector and the Regional Energy Deployment System (ReEDS) model of the U.S. electricity sector. The RWGTM passes electricity-sector natural gas prices to the ReEDS model, while the ReEDS model returns electricity-sector natural gas demand to the

RWGTM. The two models successfully converge to a solution under reference scenario conditions. We present electricity-sector and natural gas sector evolution using the integrated models for this reference scenario. This paper demonstrates that the integrated models produced similar national-level results as when running in a stand-alone form, but that regional and state-level results can vary considerably. As we highlight, these regional differences have potentially significant implications for electric sector planners especially in the wake of substantive policy changes for the sector (e.g., the Clean Power Plan).

Teaching an old dog new tricks: Firm learning from environmental regulation

- Energy Economics---2016---Emily Galloway,Erik Paul Johnson

We examine a new mechanism by which environmental regulation can increase efficiency: intra-firm knowledge spillovers due to environmental regulation. County-level non-attainment of the National Ambient Air Quality Standards creates spatial variation in the degree of regulatory stringency, as states impose stronger environmental regulation in non-attainment counties. We use this spatial variation to examine how the efficiency of electricity generators responds to increases in regulation. We show that, in response to increased regulatory stringency, electricity generators find technical efficiency enhancements and then transfer these enhancements to other units within their fleet. We find that a change in regulatory stringency translates to within-firm spillovers of 3–4%, and that these gains occur at least 3years after the increase in regulatory stringency.

How is volatility in commodity markets linked to oil price shocks?

- Energy Economics---2016---Maryam Ahmadi,Niaz Bashiri Behmiri,Matteo Manera

This study investigates the effects of oil price shocks on volatility of agricultural and metal commodities. We decompose an oil price shock to its underlying

components, including macroeconomics and oil specific shocks. The applied method is the structural vector autoregressive (SVAR) model and the time span is from April 1983 to May 2014. The investigation is divided into two subsamples, before and after May 2006 for agriculture taking into account the 2006–2008 food crisis and change in U.S. ethanol production policy, and before and after January 2008 for metals considering the recent global financial crisis. We find that, based on impulse response functions, the response of volatility of each commodity to an oil price shock differs significantly depending on the underlying cause of the shock for the both periods. Moreover, according to variance decomposition the explanatory power of oil shocks becomes stronger after the crisis. The different responses of commodities are described in detail by investigating market characteristics in each period.

Strategic bidding and rebidding in electricity markets

- Energy Economics---2016---Adam Clements,Stan Hurn,Z. Li

Successful deregulation in electricity markets depends crucially on the ability of market regulation to promote and maintain free competition. There are, however, important physical characteristics in electricity markets, such as the constraints imposed by the physical transmission infrastructure, that have the potential to undermine competition and provide opportunities for market participants to exploit temporary positions of market power. In this paper, the regional market of Queensland, Australia is analysed. It is found that strategic behaviour by generators exists and is closely related to the occurrence of the kind of extreme price events that characterise many deregulated electricity markets. In addition, rebidding behaviour by base-load generators immediately after extreme price events is shown to have negative impacts on the operation of the market. The key message is that promotion of competition in electricity markets can have undesirable consequences unless the regulatory policy is carefully designed to counter strategic behaviour by market participants.

The distributional effects of emissions taxation in Brazil and their implications for climate policy

- Energy Economics---2016---Lucio Flavio da Silva Freitas,Luiz Carlos de Santana Ribeiro,Kênia Barreiro de Souza,Geoffrey Hewings

The emission of greenhouse gases (GHG) generated by human activity is a major cause of global warming and climate change. There is considerable debate about the choice of the best mechanism to reduce emissions under a climate policy. The aim of this paper is to measure the impact of a policy of taxing GHG emissions on the Brazilian economy as a whole and on different household groups based on income levels in 2009. The following databases were used: Supply and Use Tables, Household Budget Survey, National Household Sample Survey and emissions data from the Brazilian Ministry of Science and Technology and Innovation. A price system from a national input–output model that incorporates the intensity of GHG emissions is used, as well as a consumption vector broken down into ten representative households with different income levels. The main results indicate that this taxation system was slightly regressive and had a small negative impact on output. There were, however, significant emissions reductions.

Heterogeneity in the adoption of photovoltaic systems in Flanders

- Energy Economics---2016---Olivier De Groote,Guido Pepermans,Frank Verboven

We study the determinants of PV adoption in the region of Flanders (Belgium), where PV adoption reached high levels during 2006–2012, because of active government intervention. Based on a unique dataset at a very detailed spatial level, we estimate a Poisson model to explain the heterogeneity in adoption rates. We obtain the following findings. First, local policies have a robust and significant impact on PV adoption. Second, there is a strong unconditional income effect, implying a Matthew effect in the subsidization of PVs. Our third finding is however that this income effect is largely driven by the fact that wealthier households are more

likely to adopt because they tend to be higher users, are more frequent house owners, or own houses that are better suited for PV. In several extensions, we consider the determinants of the average size of installed PVs, and the differential impact of certain variables over time.

Crude oil and stock markets: Causal relationships in tails?

- Energy Economics---2016---Haoyuan Ding,Hyung-Gun Kim,Sung Y. Park

This paper considers the causal relationships between WTI and Dubai crude oil returns and five stock index returns (S&P 500, Nikkei, Hang Seng, Shanghai, and KOSPI) within the quantile causality framework by using daily data for a period from January 1, 1996, to October 12, 2012. The quantile causality test is useful for a comprehensive understanding of the causal relationship between two returns. The test reveals several noteworthy results. First, although WTI returns are not closely related to Asian countries, some financial markets such as Nikkei and Hang Seng Granger-cause WTI returns. Second, the significance of causality from one market to another derives only from lower and upper levels of quantiles except for the case of causality from Nikkei to WTI returns. Third, all stock index returns Granger-cause Dubai crude oil returns over almost all quantile levels except for Shanghai returns. Fourth, Dubai crude oil returns Granger-cause all Asian stock index returns except for S&P 500 returns. Finally, the results indicate asymmetric causality from Dubai crude oil returns to Shanghai returns and KOSPI returns to Dubai crude oil returns.

Unveiling heterogeneities of relations between the entire oil–stock interaction and its components across time scales

- Energy Economics---2016---Shupe Huang,Haizhong An,Xiangyun Gao,Xiaoqing Hao

The oil–stock interaction characterized by complexity and nonlinearity makes relevant research difficult; this is caused by the intricate components of the entire

market from a variety of time horizons. However, the heterogeneous influence of the multiscale market components on the entire oil–stock interaction has still been covered. Our objective is to further explore that which time scale is more essential to the integrated market interaction and the dynamic evolution of decisive time scale over time. The Brent spot oil price and the Morgan Stanley Capital International world stock index on a daily frequency were selected as the sample data, and the wavelet transform, the gray correlation, and network analyses were applied succinctly to conduct holistic and dynamical analyses. The primary findings are as follows: The wavelet-decomposed results indicate that impacts of oil price shocks on the oil–stock nexus differ in the long- and short-terms. From the holistic aspect, the growing wavelet variance with time scales demonstrates that long-term changes could lead to structure changes in trend of original market interactions. The wavelet correlation proves that short-term components are dominant in the original interaction and capture the dynamic information effectively. There are no significant lead–lag relations between the original oil–stock interaction and its components. From the dynamic perspective, it is confirmed that components from both the long and short terms are determined. The low and high transmission ability could be helpful to discover the structure changes caused by long-term components and modes controlling more information associated with the short-term components, respectively. The clustering effect limits major modes into a small amount.

Economics of modern energy boomtowns: Do oil and gas shocks differ from shocks in the rest of the economy?

- Energy Economics---2016---Alexandra Tsvetkova,Mark Partridge

The US shale boom has intensified interest in how the expanding oil and gas sector affects local economic performance. Research has produced mixed results and has not compared how energy shocks differ from equal-sized shocks elsewhere in the economy. What emerges is that the estimated impacts of energy development

vary by region, empirical methodology, as well as the time horizon that is considered. This paper captures these dimensions to present a more complete picture of energy boomtowns. Utilizing US county data, we estimate the effects of changes in oil and gas extraction employment on total employment growth as well as growth by sector. We compare this to the effects of equal-sized shocks in the rest of the economy to assess whether energy booms are inherently different. The analysis is performed separately for nonmetropolitan and metropolitan counties using instrumental variables. We difference over 1-, 3-, 6-, and 10-year time periods to account for county-fixed effects and to assess responses across different time horizons. The results show that in nonmetro counties, energy sector multiplier effects on total county employment first increase up to 6-year horizons and then decline for 10-year horizons. We also observe positive spillovers to the non-traded goods sector, while spillovers are small or negative for traded goods. In metro counties, there are no significant effects on total employment, although positive spillovers are present in some sectors. Yet, equal-sized shocks in the rest of the economy produce more jobs on average than oil and gas shocks, suggesting that policymakers should seek more diversified development.

Stationarity changes in long-run energy commodity prices

- Energy Economics---2016---Aleksandar Zaklan, Jan Abrell, Anne Neumann

Situated at the intersection of the literatures on speculative storage and non-renewable commodity scarcity, this paper considers whether changes in persistence have occurred in long-run U.S. prices of the energy commodities crude oil, natural gas and bituminous coal. We allow for a structural break when testing for a break in persistence to avoid a change in the stochastic properties of prices being confounded by an unaccounted-for deterministic shift in the price series. We find that coal prices are trend stationary throughout their evolution and that oil prices change from stationarity to non-stationarity in the decade between the late 1960s to late 1970s. The result on gas prices

is ambiguous. Our results demonstrate the importance of accounting for a possible structural shift when testing for breaks in persistence, while being robust to the exact date of the structural break. Based on our analysis we caution against viewing long-run energy commodity prices as being non-stationary and conclude in favor of modeling commodity market fundamentals as stationary, meaning that speculative storage will tend to have a dampening effect on prices. We also cannot reject that long-run prices of coal and, with some hesitation, gas follow a Hotelling-type rule. In contrast, we reject the Hotelling rule for oil prices since the late 1960s/early 1970s.

CVaR constrained planning of renewable generation with consideration of system inertial response, reserve services and demand participation

- Energy Economics---2016---Andrés Inzunza, Rodrigo Moreno, Alejandro Bernal, Hugh Rudnick

Integration of renewable generation can lead to both diversification of energy sources (which can improve the overall economic performance of the power sector) and cost increase due to the need for further resources to provide flexibility and thus secure operation from unpredictable, variable and asynchronous generation. In this context, we propose a cost-risk model that can properly plan generation and determine efficient technology portfolios through balancing the benefits of energy source diversification and cost of security of supply through the provision of various generation frequency control and demand side services, including preservation of system inertia levels. We do so through a scenario-based cost minimization framework where the conditional value at risk (CVaR), associated with costs under extreme scenarios of fossil fuel prices combined with hydrological inflows, is constrained. The model can tackle problems with large data sets (e.g. 8760 hours and 1000 scenarios) since we use linear programming and propose a Benders-based method adapted to deal with CVaR constraints in the master problem. Through several analyses, including the

Chilean main electricity system, we demonstrate the effects of renewables on hedging both fossil fuel and hydrological risks; effects of security of supply on costs, risks and renewable investment; and the importance of demand side services in limiting risk exposure of generation portfolios through encouraging risk mitigating renewable generation investment.

Dynamic analysis of the German day-ahead electricity spot market

- Energy Economics---2016---Marius Paschen

This paper analyzes the dynamic behavior of day-ahead spot prices in the German electricity spot market due to positive structural shocks in wind and solar power. It uses a dynamic structural vector autoregressive model to estimate the related structural impulse response functions. The estimates suggest that wind power shocks have a more prolonged negative effect on spot prices than solar power shocks. Significant autocorrelations of wind power for larger lags indicate these results. The total negative merit order effect of a solar power shock is larger when using a reasonable model specification. One reason might be that solar power shocks coincide with demand peaks. However, results regarding the relation of the effects of wind and solar should be dealt with carefully because these results do not hold for all specifications. Past static estimates show differences in the total average negative merit order effects. These estimates might be overstated if wind and solar power dynamics are transferred to the merit order effects.

Modeling household cooking fuel choice: A panel multinomial logit approach

- Energy Economics---2016---Yonas Alem,Abebe D. Beyene,Gunnar Köhlin,Alemu Mekonnen

We use three rounds of a rich panel data set to investigate the determinants of household cooking fuel choice and energy transition in urban Ethiopia. We observe that the expected energy transition did not occur following economic growth in Ethiopia during the decade 2000–2009. Regression results from a random effects

multinomial logit model, which controls for unobserved household heterogeneity, show that households' economic status, price of alternative energy sources, and education are important determinants of fuel choice in urban Ethiopia. The results also suggest the use of multiple fuels, or 'fuel stacking behavior'. We argue that policy makers could target these policy levers to encourage transition to cleaner energy sources.

Trade with endogenous transportation costs: The case of liquefied natural gas

- Energy Economics---2016---Atle Oglend,Tore Kleppe,Petter Osmundsen

This paper investigates the relationship between LNG shipping costs and regional natural gas price spreads. We use data on natural gas prices and shipping costs to analyze the distribution of trade benefits within the LNG value chain when shipping costs are endogenous to price spread developments. Our empirical analysis suggests that for the 2006–2014 period, the LNG shipping sector has had an implied scarcity rent on LNG shipping capacity of \$0.14/MMBtu for the EU/US spread, \$0.32/MMBtu for the Asia/EU spread, and \$0.42/MMBtu for the Asia/US spread. We highlight in a counter-factual analysis that this distributional effect is not economically negligible. We investigate how including endogenous transportation costs affects the measured degree of price convergence between regional natural gas markets. We find that price convergence is stronger when we control for variations in transportation costs rather than implicitly assuming fixed or exogenous costs.

Modelling residential electricity demand in the GCC countries

- Energy Economics---2016---Tarek N. Atalla,Lester Hunt

This paper aims at understanding the drivers of residential electricity demand in the Gulf Cooperation Council countries by applying the structural time series model. In addition to the economic variables of GDP and real electricity prices, the model accounts for

population, weather, and a stochastic underlying energy demand trend as a proxy for efficiency and human behaviour. The resulting income and price elasticities are informative for policy makers given the paucity of previous estimates for a region with particular political structures and economies subject to large shocks. In particular, the estimates allow for a sound assessment of the impact of energy-related policies suggesting that if policy makers in the region wish to curtail future residential electricity consumption they would need to improve the efficiency of appliances and increase energy using awareness of consumers, possibly by education and marketing campaigns. Moreover, even if prices were raised the impact on curbing residential electricity growth in the region is likely to be very small given the low estimated price elasticities—unless, that is, prices were raised so high that expenditure on electricity becomes such a large proportion of income that the price elasticities increase (in absolute terms).

Optimal extraction policy when the environmental and social costs of the opencast coal mining activity are internalized: Mining District of the Department of El Cesar (Colombia) case study

- Energy Economics---2016---Jorge Andrés Perdomo Calvo, Ana María Jaramillo Pérez

Several articles have confirmed the social and environmental consequences of opencast coal mining. The main purpose of this study is to simulate the optimal extraction policy of coal mining with and without the internalization of the environmental and social monetary costs that occur in the Mining District (located in the central part of the Department of El Cesar) using discrete dynamic programming (backward recursion, discrete state Markov decision model and Bellman equation). Results indicate that the private optimal of the overproduction policy for the terminal phase of the resource extraction program can be reduced once the negative externalities produced by mining practices are internalized into the cost function of the mining investment companies in Colombia. This means that if there is an increase in the total cost of extraction to offset

the environmental and social impacts generated, the negative externalities would be less than or equal to the current level. Likewise, profits would continue being positive for the mining firms at the Mining District.

Why the long-term auto-correlation has not been eliminated by arbitragers: Evidences from NYMEX

- Energy Economics---2016---Daye Li, Yusaku Nishimura, Ming Men

The efficient market hypothesis claims that market prices follow the random walk and that any predictable trend will be eliminated by arbitragers in a short period of time. However, the fractal market hypothesis disagrees, asserting that long-term memory can persist in the market. To understand why this conflict exists, we propose a method to explore the long-term market trend using the local Hurst exponent and seek to obtain the extra yield. Performance is evaluated by using both a simulation and the high frequency 5-min data and the daily data. The result indicates that the model performs well with the uni-fractal series in the simulation. However, the model shows limited predictive abilities with the data from the real market due to the multi-fractal characteristics. Although the long-term trends persist in the markets and can be identified with statistical significance, traders cannot beat the market because of the time-varying feature and because the strength of long-term memory is not strong enough to cover the transaction costs. The result reconciles the long-term auto-correlations with EMH in a quantitative manner.

Assessing market structures in resource markets — An empirical analysis of the market for metallurgical coal using various equilibrium models

- Energy Economics---2016---Stefan Lorenczik, Timo Panke

The prevalent market structures found in many resource markets consist of high concentration on the supply side and low demand elasticity. Market results

are therefore frequently assumed to be an outcome of strategic interaction between producers. Common models to investigate the market outcomes and underlying market structures are games representing competitive markets, strategic Cournot competition and Stackelberg structures that take into account a dominant player acting first followed by one or more players. We add to the literature by expanding the application of mathematical models and applying an Equilibrium Problem with Equilibrium Constraints (EPEC), which is used to model multi-leader–follower games, to a spatial market. Using our model, we investigate the prevalent market setting in the international market for metallurgical coal between 2008 and 2010, whose market characteristics provide arguments for a wide variety of market structures. Using different statistical measures to compare model results with actual market outcomes, we find that two previously neglected settings perform best: First, a setting in which the four largest metallurgical coal exporting firms compete against each other as Stackelberg leaders, while the remainders act as Cournot followers. Second, a setting with BHPB acting as sole Stackelberg leader.

The hourly income elasticity of electricity

- Energy Economics---2016---Mattias Vesterberg

Using a detailed data set on appliance-level electricity consumption at the hourly level, we provide the first estimates of hourly and end-use-specific income elasticities for electricity. Such estimates are informative about how consumption patterns in general, and peak demand in particular, will develop as households' income changes. We find that the income elasticities are highest during peak hours for kitchen and lighting, with point estimates of roughly 0.4, but insignificant for space heating.

Oil prices and global factor macroeconomic variables

- Energy Economics---2016---Ronald Ratti,Joaquin Vespignani

This paper investigates the relationship between oil

prices, global industrial production, prices, central bank policy interest rate and monetary aggregate with a global factor-augmented error correction model. We confirm the following stylized relationships: i) at global level, money, industrial production and prices are cointegrated; ii) positive innovation in global oil price is connected with global interest rate tightening; iii) positive innovation in global money, price level and industrial production is connected with an increase in oil prices; iv) positive innovations in global interest rate are associated with a decline in oil prices; and v) the U.S., Euro area and China are the main drivers of global macroeconomic factors.

A real options model for renewable energy investment with application to solar photovoltaic power generation in China

- Energy Economics---2016---M.M. Zhang,P. Zhou,D.Q. Zhou

This paper proposes a real options model for evaluating renewable energy investment by considering uncertain factors such as CO2 price, non-renewable energy cost, investment cost and market price of electricity. A phase-out mechanism is built into the model to reflect the long-term changes of subsidy policy. We apply the proposed model to empirically evaluate the investment value and optimal timing for solar photovoltaic power generation in China. Our empirical results show that the current investment environment in China may not be able to attract immediate investment, while the development of carbon market helps advance the optimal investment time. A sensitivity analysis is conducted to investigate the dynamics of investment value and optimal timing under the changes of unit generating capacity, subsidy level, market price of electricity, CO2 price and investment cost. It is found that the high investment cost and the volatility of electricity and CO2 prices, are not conducive to attract immediate investment. Instead, increasing the level of subsidy, promoting technological progress and maintaining the stability of market are useful to stimulate investment.

Dynamic structure of the spot price of crude oil: does time aggregation matter?

- Energy Economics---2016---Hajar Aghababa, William Barnett

This paper assesses nonlinear structures in the time series data generating mechanism of crude oil prices. We apply well-known univariate tests for nonlinearity, with distinct power functions over alternatives, but with different null hypotheses reflecting the existence of different concepts of linearity and nonlinearity in the time series literature. We utilize daily data on crude oil spot price for over 26years, as well as monthly data on crude oil spot price for 41years. Investigating the monthly price of crude oil along with the daily price distinguishes the approach of this paper from existing studies focusing on the time series structure of crude oil price. All the tests detect strong evidence of general nonlinear serial dependence, as well as nonlinearity in the mean, variance, and skewness functions in the daily spot price of crude oil. Since evidence of nonlinear dependence is less dramatic in monthly observations, nonlinear serial dependence is moderated by time aggregation in crude oil prices but not significantly.

Financial development and deployment of renewable energy technologies

- Energy Economics---2016---Jeayoon Kim, Kwangwoo Park

Using a unique panel data set of 30 countries for the 2000–2013 period, we examine whether financial market development promotes the deployment of renewable energy on a global scale. In particular, we conjecture that countries with well-developed financial markets experience growth in the renewable energy sector due to easier access to external financing. We find that renewable sectors that are relatively more dependent on debt and equity financing grow disproportionately faster in countries with developed financial markets. Our results support the view that financial development leads to a reduction in CO₂ emissions by addressing

the role of financial markets in deploying renewable energy.

Oil price uncertainty and the U.S. stock market analysis based on a GARCH-in-mean VAR model

- Energy Economics---2016---Zeina Alsalman

This paper uses a bivariate GARCH-in-mean VAR model to examine the effect of oil price uncertainty on the U.S. real stock returns at the aggregate and sectoral levels. Estimation results suggest that there is no statistically significant effect of oil price volatility on the U.S. stock returns. The absence of an uncertainty effect might be explained by the fact that companies are likely to hedge against fluctuations in oil prices. It could also stem from the ability of most companies to transfer the higher cost of oil to customers. Moreover, the impulse responses indicate that, accounting for oil price uncertainty, oil price increases and decreases have symmetric effects on the U.S. aggregate stock returns, in that energy price increases and decreases are estimated to have equal and opposite effects on the U.S. financial market. However, this symmetric effect doesn't hold across all the sectors studied in this paper.

On representation of temporal variability in electricity capacity planning models

- Energy Economics---2016---James H. Merrick

This paper systematically investigates how to represent intra-annual temporal variability in models of optimum electricity capacity investment. Inappropriate aggregation of temporal resolution can introduce substantial error into model outputs and associated economic insight. The mechanisms underlying the introduction of this error are shown. How many representative periods are needed to fully capture the variability is then investigated. For a sample dataset, a scenario-robust aggregation of hourly (8760) resolution is possible in the order of 10 representative hours when electricity demand is the only source of variability.

Introducing MOZLEAP: An integrated long-run scenario model of the emerging energy sector of Mozambique

- Energy Economics---2016---Gilberto Mahumane, Peter Mulder

Since recently Mozambique is actively developing its large reserves of coal, natural gas and hydropower. Against this background, we present the first integrated long-run scenario model of the Mozambican energy sector. Our model, which we name MOZLEAP, is calibrated on the basis of recently developed local energy statistics, demographic and urbanization trends as well as cross-country based GDP elasticities for biomass consumption, sector structure, vehicle ownership and energy intensity. We develop four scenarios to evaluate the impact of the anticipated surge in natural resources exploration on aggregate trends in energy supply and demand, the energy infrastructure and economic growth in Mozambique. Our analysis shows that until 2030, primary energy production is likely to increase at least six-fold, and probably much more. This is roughly 10 times the expected increase in energy demand; most of the increase in energy production is destined for export. As a result, Mozambique may well become one of the leading global producers of natural gas and coal. We discuss the opportunities and challenges that this resource wealth poses for the country.

Economies of scale and technological progress in electric power production: The case of Brazilian utilities

- Energy Economics---2016---Mauricio Marins Machado, Maria Conceição Sampaio de Sousa, Geoffrey Hewings

This paper examined the cost structure of the electricity generation companies in Brazil during the period 2000–2010 by using a translog cost function that imposes no restrictions on production technology and allows for the existence of non-homotheticity. The hypothesis that economies of scale are a typical feature of the generation market in Brazil and, in general, are not

exhausted at lower levels of production is not rejected. This result supports the vision that indivisibilities restrict efficiency gains from free-market competition in the Brazilian electricity generation and most of the last restructuring in the industry regulation was based on this assumption. Furthermore, over the sample period, technological progress led to cost reductions in electric power supply. These technological improvements take the form of both a neutral technological effect as well as a non-neutral fuel effect, which prevails over the capital and labor saving technical changes.

Volatility in electricity derivative markets: The Samuelson effect revisited

- Energy Economics---2016---Edouard Jaeck, Delphine Lautier

This article proposes an empirical study of the Samuelson effect in electricity markets. Our motivations are twofold. First, although the literature largely assesses the decreasing pattern in the volatilities along the price curve in commodity markets, it has not extensively tested the presence of such a dynamic feature in electricity prices. Second, the analysis of a non-storable commodity enriches the literature on the behavior of commodity prices. Indeed, it has been sometimes asserted that the Samuelson effect results from the presence of inventories. We examine the four most important electricity futures markets worldwide for the period from 2008 to 2014: the German, Nordic, Australian, and US markets. We also use the American crude oil market as a benchmark for a storable commodity negotiated on a mature futures market. Our analysis has two steps: i) in addition to the traditional tests, we propose and test a new empirical implication of the Samuelson effect: price shocks should spread from the physical market to the paper market, and not the reverse; ii) based on the concept of “indirect storability”, we investigate the link between the Samuelson effect and the storability of the commodity. We find evidence of a Samuelson effect in all of the electricity markets and show that storage is not a necessary condition for such an effect to appear. These results should be taken into account for the understanding of the dynamic behavior of com-

modity prices, for the valuation of electricity assets, and for hedging operations.

The spark spread and clean spark spread option based valuation of a power plant with multiple turbines

- Energy Economics---2016---R.S. Elias,M.I.M. Wahab,L. Fang

This paper offers a novel study of two key factors that affect the valuation of a natural gas-fired power plant having multiple turbines: carbon allowance prices and the ability to switch among turbines. Amid stricter environmental rules on CO₂ emissions, a power plant operator needs to be able to judge how the purchase of carbon allowances affects the plant's expected value; and whether the plant's value rises from switching among turbines. This paper presents a model analysis of a spark spread and clean spark spread option-based valuation of a power plant with multiple gas turbines — using a bivariate and a tri-variate lattice, respectively. Results demonstrate that the purchase of CO₂ allowances lowers the plant's expected value. Conversely, when operations of turbines are switched in response to price movements, the plant's value increases. This outcome has implications for plant management decisions: when to switch among turbines and how the purchase of CO₂ allowances affects the plant's value.

Estimating impact of regional greenhouse gas initiative on coal to gas switching using synthetic control methods

- Energy Economics---2016---Man-Keun Kim,Taehoo Kim

Fuel switching from coal to much cleaner natural gas in electricity generation is one of significant factors explaining the recent substantial reduction in greenhouse gas emissions in the Regional Greenhouse Gas Initiative (RGGI) region (northeastern U.S.). Coal to gas switching has been triggered by the recent shale gas revolution, which the entire U.S. has experienced, not the RGGI region alone. If RGGI as a cap-and-trade carbon program did not work effectively, the rate of

fuel switching would have been similar to that of other U.S. states. To estimate the effects of RGGI implementation in terms of the fuel switching, we use the synthetic control method for comparative case studies. Results provide a strong evidence that coal to gas switching has been actually accelerated by RGGI implementation. RGGI increases gas share in electricity generation in the RGGI region by roughly 10–15% point higher than the synthetic RGGI.

Willingness of Kansas farm managers to produce alternative cellulosic biofuel feedstocks: An analysis of adoption and initial acreage allocation

- Energy Economics---2016---Melissa K. Lynes,Jason Bergtold,Jeffery Williams,Jason E. Fewell

This paper examines the likelihood that farm managers would be willing to harvest crop residue, or grow a dedicated annual or perennial bioenergy crop. In addition, factors affecting how many initial acres adopters would be willing to plant of a dedicated annual or perennial bioenergy crop are assessed. The study finds several factors affect farm managers' decisions to harvest crop residue, or grow annual or perennial bioenergy crops, as well as their potential initial acreage allocation decisions. These factors lead to several policy implications that should be tailored to the specific type of cellulosic bioenergy crop.

The informational content of inventory announcements: Intraday evidence from crude oil futures market

- Energy Economics---2016---Shiyu Ye,Berna Karali

This paper examines the behavior of intraday crude oil futures return and volatility and how they respond to weekly inventory announcements by the American Petroleum Institute (API) and Energy Information Administration (EIA). The informational content of API reports is measured relative to market analysts' expectations collected by Reuters, whereas that of

EIA reports is measured relative to API reports. Results suggest that unexpected inventory changes in both API and EIA reports exert an immediate inverse impact on returns and a positive impact on volatility; but the duration and magnitude of EIA inventory shocks are longer and larger, with the largest impact observed when Reuters and API both err on the same side. While there are no instant asymmetric return responses to positive and negative API shocks, the return and volatility responses to cross-commodity inventory shocks in EIA reports exhibit asymmetry.

Two price zones for the German electricity market — Market implications and distributional effects

- Energy Economics---2016---Jonas Egerer,Jens Weibezahn,Hauke Hermann

We discuss the implications of two price zones (i.e., one northern and one southern bidding area) on the German electricity market. In the northern zone, continuous increases in capacity with low variable costs cause large regional supply surpluses in the market dispatch, while in the southern zone conventional capacity decreases. As the spatial imbalance of supply and load is increasing, the current single bidding area more often results in technically infeasible market results, requiring curative congestion management measures.

Country-specific oil supply shocks and the global economy: A counterfactual analysis

- Energy Economics---2016---Kamiar Mohaddes,M Pesaran

This paper investigates the global macroeconomic consequences of country-specific oil-supply shocks. Our contribution is both theoretical and empirical. On the theoretical side, we develop a model for the global oil market and integrate this within a compact quarterly model of the global economy to illustrate how our multi-country approach to modeling oil markets can be used to identify country-specific oil-supply shocks. On the empirical side, estimating the GVAR-Oil model for 27 countries/regions over the period 1979Q2 to 2013Q1,

we show that the global economic implications of oil-supply shocks (due to, for instance, sanctions, wars, or natural disasters) vary considerably depending on which country is subject to the shock. In particular, we find that adverse shocks to Iranian oil output are neutralized in terms of their effects on the global economy (real outputs and financial markets) mainly due to an increase in Saudi Arabian oil production. In contrast, a negative shock to oil supply in Saudi Arabia leads to an immediate and permanent increase in oil prices, given that the loss in Saudi Arabian production is not compensated for by the other oil producers. As a result, a Saudi Arabian oil supply shock has significant adverse effects for the global economy with real GDP falling in both advanced and emerging economies, and large losses in real equity prices worldwide.

Forecasting the volatility of crude oil futures using HAR-type models with structural breaks

- Energy Economics---2016---Fenghua Wen,Xu Gong,Shenghua Cai

We introduce sixteen HAR-type volatility models with structural breaks and estimate their parameters by applying 5-min high-frequency transaction data for WTI crude oil futures. We find significant structural breaks in the volatility of crude oil futures. Additionally, the historical realized volatility, continuous sample path variation, negative realized semivariance, signed jump, signed semi-jump and leverage components contain substantial and salient information for forecasting the volatility of crude oil futures. Then, we use loss functions to assess the forecasting performance of these sixteen new models, and finally, rank these models using the PROMETHEE II method. Our results indicate that different models exhibit different predictive power in forecasting the 1-day, 1-week and 1-month volatility of crude oil futures. Of the new HAR-type models, the new HAR-RSV model performs best at forecasting the 1-day and 1-month volatilities, whereas the new HAR-CJ best forecasts the 1-week volatility.

China's carbon emissions embodied in (normal and processing) exports and their driving forces, 2006–2012

- Energy Economics---2016---Bin Su, Elspeth Thomson

This paper constructed a time-series extended input-output dataset (2006–2012) to analyze China's carbon emissions embodied in both normal and processing exports at a detailed 135-sector level. The structural decomposition analysis (SDA) was further applied to shed light on the driving forces behind the changes in their embodied emissions over the entire time period. This empirical study confirms the importance of using the extended model for analyzing the trade-related embodiment, especially for processing exports. The embodied emissions in both normal and processing exports first increased from 2006 to 2008, then dropped during the global financial crisis (2008–2009), and then rose again after 2009. The embodied emissions as a percentage of total CO₂ emissions were quite stable before and after the global financial crisis, at around 24% over the 2006–2008 period, and 18% over the 2010–2012 period. From 2006 to 2012, emission intensity played the key role in reducing the embodied emissions (around 595Mt CO₂), while the total export effect contributed the most to the increase in embodied emissions (around 552Mt CO₂). Similar analysis can be applied to other indicators, such as energy, water, GHG emissions, pollutants and materials.

Parametric model risk and power plant valuation

- Energy Economics---2016---Karl Bannör, Rüdiger Kiesel, Anna Nazarova, Matthias Scherer

The fact that model and parameter risk are important sources of uncertainty in option pricing models and for risk management procedures has recently been recognised for financial markets, see Cont (2006); Morini (2011); Bannör and Scherer (2013). In the context of energy markets, investment decisions are often based on the valuation of fossil power plants as real options — depending on various underlying processes such as the power-, carbon emission certificate-, and gas

price. To capture parametric model risk inherent in the valuation procedure of fossil power plants, we use a methodology recently established in Bannör and Scherer (2013). As gas-fired power plants are seen as flexible and low-carbon sources of electricity, which are important building blocks in terms of the switch to a low-carbon energy generation, we consider the model risk in this asset class in detail. Our findings reveal that spike risk is by far the most important source of parametric model risk.

Electricity price forecasting using sale and purchase curves: The X-Model

- Energy Economics---2016---Florian Ziel, Rick Steinert

Our paper aims to model and forecast the electricity price by taking a completely new perspective on the data. It will be the first approach which is able to combine the insights of market structure models with extensive and modern econometric analysis. Instead of directly modeling the electricity price as it is usually done in time series or data mining approaches, we model and utilize its true source: the sale and purchase curves of the electricity exchange. We will refer to this new model as X-Model, as almost every deregulated electricity price is simply the result of the intersection of the electricity supply and demand curve at a certain auction. Therefore we show an approach to deal with a tremendous amount of auction data, using a subtle data processing technique as well as dimension reduction and lasso based estimation methods. We incorporate not only several known features, such as seasonal behavior or the impact of other processes like renewable energy, but also completely new elaborated stylized facts of the bidding structure. Our model is able to capture the non-linear behavior of the electricity price, which is especially useful for predicting huge price spikes. Using simulation methods we show how to derive prediction intervals for probabilistic forecasting. We describe and show the proposed methods for the day-ahead EPEX spot price of Germany and Austria.

Strategies against shocks in power systems – An analysis for the case of Europe

- Energy Economics---2016---Paul Nahmacher,Eva Schmid,Michael Pahle,Brigitte Knopf

Electricity systems are constantly exposed to geopolitical, techno-economic and natural uncertainties that may endanger security of supply. Therefore, it is crucial that policy makers concerned about it consider a variety of possible futures — and not only the one that is perceived as the most likely. In particular, they should account for the possibility of sudden shocks in their decisions with the goal of making the system more “robust”. However, long-term power system models which are an important pillar of policy decision making are typically designed to determine the cost-minimal power system for a specific expected future; such a system is not necessarily the most robust one. By combining the classic investment optimization approach with the tools of Robust Decision Making we analyze the viability of different strategies that may potentially increase the robustness of a power system. For the case of the European power system we pursue a dedicated analysis with the European power system model LINES-EU. Based on a total of more than 40,000 model runs, we find that strategies promoting the ability of countries to always produce at least 95% of their electricity demand domestically significantly help to reduce the loss of load in case of shocks. Such a strategy is not cost-optimal for the expected future without shocks; but the additional costs (about 0.1% of total system costs) are low compared to the benefits of significantly increasing the power system’s robustness.

The price and income elasticities of natural gas demand: International evidence

- Energy Economics---2016---Paul Burke,Hewen Yang

Natural gas contributes a growing share of the world’s energy mix. In this paper we use national-level data for a sample of 44 countries to estimate the price and income elasticities of natural gas demand. We present

both single-equation results and results instrumenting natural gas prices with proved natural gas reserves. Our instrument includes both domestic reserves and distance-weighted reserves in other countries. We obtain estimates of the average long-run price elasticity of natural gas demand of around -1.25 and of the average long-run income elasticity of natural gas demand of $+1$ and higher. We also present separate estimates for final natural gas demand by industry and households.

Contemporaneous interactions among fuel, biofuel and agricultural commodities

- Energy Economics---2016---Adrian Fernandez-Perez,Bart Frijns,Alireza Tourani-Rad

This study examines the contemporaneous interactions among energy (oil and ethanol) and agricultural commodities (corn, soybean, and wheat) in the United States during the period 1 June 2006 to 22 January 2016. Since traditional VAR analysis is not able to capture the contemporaneous interactions among these commodities, we employ a structural VAR analysis in combination with the identification through heteroskedasticity approach. The empirical results indicate that i) the contemporaneous interactions are important, asymmetric, and have implications for impulse response functions; ii) crude oil has a unidirectional contemporaneous impact on the agricultural commodities, and the agricultural commodities (corn and soybean) – mostly used in the biofuel production – have a unidirectional contemporaneous impact on ethanol; and finally, iii) these contemporaneous relations depend on the price level of crude oil in that there are stronger effects from crude oil (agricultural commodities) to agricultural commodities (ethanol) in high crude oil price states.

Can market power in the electricity spot market translate into market power in the hedge market?

- Energy Economics---2016---Gabriel Godofredo Fiuza de Bragança,Toby Daglish

Electricity is a non-storable commodity frequently traded in complex markets characterized by oligopolis-

tic structures and uniform-price auctions. Electricity prices have idiosyncratic patterns not addressed by the usual commodity pricing literature. This paper develops an electricity market model that allows for oligopoly, vertical integration, and a uniform-price auction mechanism. It derives a linear equilibrium relationship between spot prices and state variables affecting firms' costs and demand. It then applies a two-factor forward pricing model over the equilibrium spot price process, and shows that forward prices can be positively affected by spot market power. An empirical estimation of the model follows, using NZEM data.

Sugarcane industry's socioeconomic impact in São Paulo, Brazil: A spatial dynamic panel approach

- Energy Economics---2016---Leandro Gilio,Márcia Azanha Ferraz Dias de Moraes

This study assesses the socioeconomic development impacts of the recent sugarcane industry expansion on municipalities in the Brazilian state of São Paulo over seven years, from 2005 through 2011. It was used as socioeconomic development indicator the Index of Municipal Development (IFDM), provided by the Federation of the State of Rio de Janeiro Industries (FIRJAN). A dynamic spatial panel model was built using the System Generalized Method of Moments (GMM-SYS) to assess the impacts of the sugarcane industry, caused by the expansion of both the cultivated area and the presence of ethanol and sugar processing plants. We found that the presence of a processing plant has a positive effect in the socioeconomic development of the municipality where the plant is located and in neighboring municipalities. Besides, we found a small negative relationship between increases in the amount of area devoted to sugarcane cultivation in a municipality and the IFDM value for that municipality, which can be explained by job losses in the farming sector, most likely by the recent mechanization process of sugarcane harvesting.

Energy efficiency in the manufacturing sector of the OECD: Analysis of price elasticities

- Energy Economics---2016---Steven Parker,Brantley Liddle

We examine the role prices have on energy efficiency in the OECD manufacturing sector between 1980 and 2009. We employ a two-step procedure; first, we decompose manufacturing energy intensity change into two driving effects—efficiency and structural change. The second step uses panel time series regression techniques to estimate the impacts of prices on the effects driving manufacturing energy intensity. The advantage of using these techniques is that they account for heterogeneity and cross-section dependence in the data, something recent energy intensity research has emphasised. The results from this decomposition support existing findings that efficiency is the major driver for observed reduction in energy intensity. Further, the second stage results indicate that rising prices improve efficiency; importantly these effects vary across countries.

Oil price volatility forecast with mixture memory GARCH

- Energy Economics---2016---Tony Klein,Thomas Walther

We expand the literature of volatility and Value-at-Risk forecasting of oil price returns by comparing the recently proposed Mixture Memory GARCH (MMGARCH) model to other discrete volatility models (GARCH, RiskMetrics, EGARCH, APARCH, FIGARCH, HYGARCH, and FIAPARCH). We incorporate an Expectation-Maximization algorithm for parameter estimation of the MMGARCH and find different structures in volatility level as well as shock persistence. MMGARCH is also able to cover asymmetric and long memory effects. Furthermore, a dissimilar memory structure in variance of WTI and Brent crude oil prices is observed which is supported by additional tests. Parameter estimation and comparison of the models reveal significant long memory and asymmetry in oil price returns. In regard of variance forecasting

and Value-at-Risk prediction, it is shown that MM-GARCH outperforms the aforementioned models due to its dynamic approach in varying the volatility level and memory of the process. We find MMGARCH superior for application in risk management as a result of its flexibility in adjusting to variance shifts and shocks.

Land requirements, feedstock haul distance, and expected profit response to land use restrictions for switchgrass production

- Energy Economics---2016---Amadou Gouzaye, Francis Epplin

Energy crop production has been proposed for land of poor quality to avoid competition with food production and negative indirect land use consequences. The objective of this study was to determine the land area requirements, biomass transportation distance, and expected profit consequences of restricting switchgrass biomass production, for use as biofuel feedstock, to marginal land relative to unrestricted land use. The USA soils capability classification system was used to differentiate between high quality land and land of marginal quality. Fifty years of historical weather data were used in combination with a biophysical simulation model to estimate switchgrass biomass yield distributions for land of different quality for counties in the case study region. A mathematical programming model was designed and solved to determine the economic consequences. For the levels of biofuel price considered (\$0.50, \$0.75 and \$1.00/L), and a 262.5ML/year biorefinery modeled, restricting land use to marginally productive capability Class IV soils, increases the quantity of land optimally leased by 42 to 52%; increases biomass trucking total transportation distance by 115 to 116%; and reduces the expected net returns by \$11 to \$15M/year compared to when land use is unrestricted. In the absence of government restrictions, for-profit companies are not likely to limit energy crop production to land of marginal quality.

Short-run fuel price responses: At the pump and on the road

- Energy Economics---2016---Nolan Ritter, Christoph Schmidt, Colin Vance

We provide evidence that motorists respond to short-run fluctuations in fuel prices at the gas pump and not on the road. Employing variants of censored panel regression to control for censoring of the dependent variable, we find that the fuel price has a negative impact on the quantity of fuel purchased, but no consistently significant impact on the subsequent distance driven until the next refill. Over the short run, drivers thus appear to cope with high fuel prices by adjusting fuel purchases with each visit to the filling station, but without altering their daily mileage.

Modeling biomass procurement tradeoffs within a cellulosic biofuel cost model

- Energy Economics---2016---Alicia Rosburg, John Miranowski, Keri Jacobs

We develop a long-run cellulosic biofuel cost model that minimizes feedstock procurement and processing costs per gallon. The distinguishing feature of the model is that it accounts for the procurement tradeoff between the intensive margin (biomass producers' participation rate) and extensive margin (biomass capture region). To investigate the extent to which this procurement tradeoff affects processors' cost-minimizing decisions, we apply the model to switchgrass ethanol production in U.S. crop reporting districts. Results suggest that location characteristics will determine the extent to which processors can reduce their total procurement costs by offering a higher biomass price to increase participation near the plant and reduce transportation costs.

Long term oil prices

- Energy Economics---2016---Erik Haugom, Ørjan Mydland, Alois Pichler

In this paper we propose a model to estimate and simulate long term oil prices. Our model is based on

properties of demand and supply for oil and it is able to reproduce historical real oil prices well. We use the model to estimate and simulate future real oil price scenarios. The results show that if we are not able to significantly increase demand elasticity, the yearly real oil price change can reach 12% in the years following the peak production level without taking a scarcity rent into account. Until peak production level is reached, the long term real oil price changes stemming from fundamental supply and demand changes are expected to be negative. Our simulation results based on an expected peak production year of 2020 and a scarcity rent of 3% suggest an expected real crude oil price of \$169/bbl in 2040. For comparison the EIA outlook predicts a real oil price of \$141/bbl for the same year. We also provide an on-line Appendix that allows the readers to change the assumptions underlying our analysis and see the results immediately.

Limited trading of emissions permits as a climate cooperation mechanism? US–China and EU–China examples

- Energy Economics---2016---Claire Gavard,Niven Winchester,Sergey Paltsev

Recent multilateral climate negotiations have underlined the importance of international cooperation and the need for support from developed to developing countries to address climate change. This raises the question of whether carbon market linkages could be used as a cooperation mechanism. Policy discussions surrounding such linkages have indicated that, should they operate, a limit would be set on the amount of carbon permits that could be imported by developed regions from developing countries. This paper analyzes the impact of limited carbon trading between an ETS in the EU or the US and a carbon market covering Chinese electricity and energy intensive sectors using a global economy-wide model. We find that the limit results in different carbon prices between China and Europe or the US. Although the impact on low-carbon technologies in China is moderate, global emission reductions are deeper than in the absence of international trading due to reduced carbon leakage. If China cap-

tures the rents associated with limited permit trading, we show that it is possible to find a limit threshold that makes both regions better off relative to carbon markets operating in isolation.

Have U.S. power plants become less technically efficient? The impact of carbon emission regulation

- Energy Economics---2016---Yishu Zhou,Ling Huang

We estimate directional distance functions to measure the impact of carbon emission regulation, the Regional Greenhouse Gas Initiative (RGGI) in particular, on U.S. power plants' technical efficiency. The model shows that the average technical efficiency scores for coal and natural gas plants are 88.70% and 83.14% respectively, indicating a very technically efficient industry. We find no evidence of technical efficiency changes due to the RGGI regime in the RGGI area. In the same area, relatively less efficient coal plants exited the market and slightly more efficient natural gas plants entered, compared to the incumbent plants. In addition, some evidence of a spillover effect is found. Using a counterfactual analysis, the RGGI regulation leads to a 1.48% decline in the average technical efficiency for coal plants within neighboring states of RGGI during 2009–2013.

Free cash flows and overinvestment: Further evidence from Chinese energy firms

- Energy Economics---2016---Dayong Zhang,Hong Cao,David G. Dickinson,Ali M. Kutan

In the recent years, Chinese energy firms have accumulated significant free cash flows due to higher energy prices and government subsidies and also have invested heavily. An important empirical question is whether the Chinese energy firms tend to misallocate resources due to growing free cash flows. In this paper, we test whether they make some sub-optimal investment decisions following the well-established free cash flow problem in the finance literature, originally identified by Jensen (1986) for the US oil sector. Using a dynamic

panel model for the period 2001–2012 for the Chinese energy-related public listed firms, we find evidence supporting the free cash flow hypothesis, suggesting overinvestment problems in the Chinese energy sector. In addition, we observe that firm size and corporate governance structure are important determinants of the Chinese energy firms' investment decisions.

On the dynamic links between commodities and Islamic equity

- Energy Economics---2016---Ruslan Nageyev, Mustafa Disli, Koen Inghelbrecht, Adam Ng

This paper investigates whether commodities offer potential diversification benefits for Islamic equity index investors in light of possible financialization of commodity markets. Using MGARCH-DCC and Wavelet Coherence analyses, our findings reveal that correlations between commodity markets and the Dow Jones Islamic Market World Index are time-varying and highly volatile throughout the January 1999–April 2015 period. A substantial and persistent increase was observed in the return correlations between commodities and Islamic equity at the onset of the 2008 financial crisis. However, trends in the recent two years suggest that this association is heading towards its pre-crisis levels, offering again diversification benefits for Islamic equity holders. These benefits vary across different commodities in various time scales. Overall, gold, natural gas, soft commodities, grains and livestock are better portfolio diversifiers than oil and other metals. Relative to medium-to-long term investors, short-term investors (less than 32 days horizon) gained better diversification benefits in most commodities during bullish, bearish and market recovery periods. These findings have implications for investors who are heterogeneous in risk tolerance and time preference as well as for policymakers who are concerned with market stability.

The role of federal Renewable Fuel Standards and market structure on the growth of the cellulosic biofuel sector

- Energy Economics---2016---Tristan Skolrud, Gregmar Galinato, Suzette Galinato, C. Richard Shumway, Jonathan K. Yoder

This article examines the effect of the Renewable Fuel Standards and market power on the growth of the cellulosic biofuel sector. We develop a sectoral model to show how changes in the regulations governing cellulosic fuel production affect the equilibrium quantity of cellulosic ethanol. Based on model calibration for Washington State, we find that existing low-cost waivers purchased by obligated parties in lieu of cellulosic fuel production negate the effectiveness of the Renewable Fuel Standard to induce the production and consumption of cellulosic biofuels. However, raising waiver price slightly relative to the status quo significantly increases the equilibrium quantity of cellulosic ethanol. The high cost of cellulosic ethanol production is often cited as the cause of the lack of cellulosic ethanol production, which is used to justify low waiver prices. Our policy message is the converse: the low current waiver price significantly contributes to the cellulosic ethanol market stagnation in the context of the current biofuel policy.

Modeling realized volatility on the Spanish intra-day electricity market

- Energy Economics---2016---Aitor Ciarreta, Ainhoa Zarraga

This paper models the realized volatility of the hourly prices from the six sessions of the Spanish intra-day electricity market for the period 2002–2014. Based on the sequential organization of the market, a model in which realized volatility depends on its own past and that of the other sessions is specified and then modified in two ways. On the one hand, total variation is decomposed into jump and non-jump components and on the other hand EGARCH innovations are considered. Estimation results show significant volatility transmissions between the sessions. Out-of-sample forecast criteria

select EGARCH innovations for sessions 1 and 2, while simpler models with no EGARCH innovations and no jump distinction are preferred for sessions 5 and 6. We argue how results are driven by the market structure, the market design and the regulation of renewable generation.

Interprovincial migration and the stringency of energy policy in China

- Energy Economics---2016---Xiaohu Luo,Justin Caron,Valerie J. Karplus,Da Zhang,Xiliang Zhang

Interprovincial migration flows involve substantial relocation of people and productive activity, with implications for regional energy use and greenhouse gas emissions. In China, these flows are not explicitly considered when setting energy and environmental targets for provinces, and their potential impact on the effectiveness of policy alternatives is ignored. We analyze how migration affects outcomes under energy intensity targets and energy caps. While both policies are part of the nation's Twelfth Five Year Plan (2011–2015) and imposed at the provincial level, only the intensity targets are binding at present. We estimate a migration model, integrate it into a general equilibrium model that resolves each province in China, and simulate the effect of migration on energy use and economic activity. We find that although both types of policies are affected by uncertain migration flows, energy intensity targets (energy use indexed to economic output) are more robust than absolute caps. They are also more cost effective, placing less burden on the relatively clean in migration provinces. Our findings also underscore the value of moving from provincial targets to an integrated national trading system targeting emissions of energy-related CO₂, given that the choice of abatement strategies will adjust endogenously to labor relocation.

Investment risks in power generation: A comparison of fossil fuel and renewable energy dominated markets

- Energy Economics---2016---Oliver Tietjen,Michael Pahle,Sabine Fuss

Due to their high capital intensity, weather dependent renewable energies (RES) such as solar and wind face considerable investment risks in power markets. In addition, their uncertain production volumes also affect the investment risks of other plant types through the impact on power prices and residual demand. Increasing RES shares thus potentially increase overall investment risks in power markets, which many analysts consider to be a potential problem. Against this background, this paper compares investment risks of different technologies in markets with increasing shares of variable RES. It further analyses how generation mixes are affected by these investment risks if the risks are evaluated on a stand-alone basis or in a plant portfolio context of a private firm. For this purpose, a stylized investment and dispatch model is used to conduct Monte Carlo simulations from which risk measures are derived. The results show that capital intensive RES face the highest stand-alone risks, since their profits are most affected by the power price risk. However, the results further indicate that the stand-alone risks of variable RES decrease with their share in the market because of a negative correlation of output and price risk. In addition, RES have a risk benefit in firm plant portfolios in terms of constituting a hedge against losses of fossil fuel plants. This positive portfolio effect, however, rapidly decreases and becomes negative with increasing RES shares in the market.

The impact of the North Atlantic Oscillation on electricity markets: A case study on Ireland

- Energy Economics---2016---John Curtis,Muireann Lynch,Laura Zubieta

The North Atlantic Oscillation (NAO) is a large-scale atmospheric circulation pattern driving climate variability in north-western Europe. As the deployment of wind-powered generation expands on electricity networks across Europe, the impacts of the NAO on the electricity system will be amplified. This study assesses the impact of the NAO, via wind-power generation, on the electricity market considering thermal generation costs, wholesale electricity prices and wind generation

subsidies. A Monte Carlo approach is used to model NAO phases and generate hourly wind speed time-series data, electricity demand and fuel input data. A least-cost unit commitment and economic dispatch model is used to simulate an island electricity system, modelled on the all-island Irish electricity system. The impact of the NAO obviously depends on the level of wind capacity within an electricity system. Our results indicate that on average a switch from negative to positive NAO phase can reduce thermal generation costs by up to 8%, reduce wholesale electricity prices by as much as €1.5/MWh, and increase wind power generators' revenue by 12%.

Understanding the energy-GDP elasticity: A sectoral approach

- Energy Economics---2016---Paul Burke,Zsuzsanna Csereklyei

This paper uses per capita data for 132 countries over 1960–2010 to estimate elasticities of sectoral energy use with respect to national gross domestic product (GDP). We estimate models in both levels and growth rates and use our estimates to sectorally decompose the aggregate energy-GDP elasticity. Our estimates show that residential energy use is very inelastic to GDP if primary solid biofuels are counted in energy use tallies, especially at low income levels. Residential use of electricity is more tightly linked to GDP, as is energy use by the transportation, industrial, and services sectors. Agriculture typically accounts for a small share of energy use and has a modest energy-GDP elasticity. The aggregate energy-GDP elasticity tends to be higher for countries at higher income levels, in large part because traditional use of primary solid biofuels is less important. Gasoline prices, winter temperature, population, and land area are among other factors influencing sectoral energy use.

Evaluating energy security of resource-poor economies: A modified principle component analysis approach

- Energy Economics---2016---Yingzhu Li,Xunpeng Shi,Lixia Yao

This study proposes to aggregately measure energy security performance with the principal component analysis. In its application of the methodology to four resource-poor yet economically advanced island economies in East Asia—Singapore, South Korea, Japan, and Taiwan, this study establishes a novel framework to conceptualize energy security. The framework incorporates three dimensions: vulnerability, efficiency, and sustainability, three indicators being allocated to each dimension. The study finds that all the three dimensions are critical for the resource-poor economies but have different weights in each of them. An urgent task for these four economies is to implement energy efficiency and conservation measures. Liberalization of electricity sector can be a helpful tool to reduce energy consumption and increase efficiency. All of them have been committed to promoting renewable energy development, which shall be further expanded in these economies.

Household-level effects of electricity on income

- Energy Economics---2016---Brandon A. Bridge,Dadhi Adhikari,Matías Fontenla

This paper studies the effect of electricity on income, using the Nepal Living Standards Survey-III (NLSSIII), carried out in the years 2010–11. To account for endogeneity issues, we use a Two Stage Probit Least Squares (2SPLS) model. We find that causality runs both ways. That is, income explains whether a household is connected to electricity, but also, a household being connected to electricity has a very large and significant effect on income.

The economic value of transmission lines and the implications for planning models

- Energy Economics---2016---Alberto Lamadrid,Surin Maneevitjit,Timothy D. Mount

Many connections between economic efficiency, regulation, the environment and energy markets are evident in the planning for transmission upgrades in an electricity network. Transmission owners have to make decisions about investing in new assets while facing

uncertainty in the generation plans, regulatory and environmental constraints, and current system endowments. In this paper, we demonstrate an analytical method for determining the economic value of individual transmission lines in a meshed network by calculating the total welfare effects for the system. While many regulators believe that traditional congestion rents provide the correct incentives for investing in transmission upgrades, we show that the uncertainty in system conditions breaks down this paradigm. The analysis uses an existing Security Constrained Optimal Power Flow (SCOPF) model and a test network to demonstrate how the method can be used to determine the welfare effects of changing the capacity of selected transmission lines. The results show that a substantial portion of the economic benefits for an individual line may come from maintaining system reliability when equipment failures occur. Furthermore, these benefits can change dramatically when inherently intermittent sources of renewable generation are added to a network, and the changes in benefits are not captured effectively by changes in the expected congestion rents.

Fossil fuel price uncertainty and feedstock edible oil prices: Evidence from MGARCH-M and VIRF analysis

- Energy Economics---2016---Akram Hasanov,Hung Xuan Do,Mohammed Sharaf Shaiban

This paper focuses on examining the impact of crude oil price volatility on the price changes of major edible oils (rapeseed, soybean, and sunflower), which are the main feedstock for the biodiesel industry in the European Union. For this purpose, a four-variate version of non-diagonal GARCH-in-mean model that allows for asymmetry in the variance-covariance matrix is used. An important conclusion that emerges from this study is that the crude oil price uncertainty appears to be responsible for a significant decline in price returns of major feedstock edible oils considered in this study. The volatility impulse response analyses support the conclusion that the conditional variances of both edible and crude oil and covariances between them are generally highly responsive to historical shock. However,

the size of the impacts is mainly commodity specific. Finally, we investigate the causality from crude oil price volatility to edible oil prices and the effects of oil price shocks on edible oil prices by using the Granger causality test and generalized impulse response function analysis, respectively. The empirical results show that there is strong evidence of causality from crude oil price volatility to all edible oil prices under study, and generalized impulse response analysis shows that the edible oil markets significantly respond to the shocks in oil prices.

Co-movement of major energy, agricultural, and food commodity price returns: A time-series assessment

- Energy Economics---2016---Francesca de Nicola,Pierangelo De Pace,Manuel Hernandez

Using monthly data between 1970 and 2013, we provide a comprehensive analysis of the extent of co-movement (measured by correlation coefficients) among the nominal price returns of 11 major energy, agricultural, and food commodities. We study the degree and the time evolution of unconditional and conditional correlations using a uniform-spacings estimation and testing approach, multivariate dynamic conditional correlation models, and a rolling regression procedure. We find that (1) the price returns of energy and agricultural commodities are highly correlated; (2) the overall level of co-movement among commodities increased in recent years, especially between energy and agricultural commodities, and in particular in the cases of maize and soybean oil, which are important inputs in the production of biofuels; and (3) the stock market volatility is positively associated with the co-movement of price returns across markets, especially after 2007.

Impacts of OPEC's political risk on the international crude oil prices: An empirical analysis based on the SVAR models

- Energy Economics---2016---Hao Chen,Hua Liao,Bao-Jun Tang,Yi-Ming Wei

The impacts of OPEC's political risk on the fluctuations of international crude oil prices have caused widespread concern and analyzing the impacts is of great significance to the investment decisions and risk aversion strategies in the crude oil markets. Therefore, using the International Country Risk Guide (ICRG) index as a proxy for the countries' political risk situation, we empirically investigate the impacts of OPEC's political risk on the Brent crude oil prices, based on several Structural Vector Autoregression (SVAR) models. The main empirical results indicate that: (1) The political risk of OPEC countries does have a significant and positive influence on Brent crude oil prices in the sample period from January 1998 to September 2014, and the most significant positive influences appear in about one and a half year and last about a year. (2) OPEC's integrated political risk contributes to 17.58% of the oil price fluctuations in the sample period, which is only lesser than that of the oil demand shocks (34.64%). (3) Compared with the political risk of OPEC countries in North Africa and South America, the political risk of OPEC countries in the Middle East contributes most to the oil price fluctuations. (4) Among the eight components of the political risk in OPEC, the internal conflicts contribute most to the oil price fluctuations in the sample period.

Marcellus Shale and structural breaks in oil and gas markets: The case of Pennsylvania

- Energy Economics---2016---Todd B. Potts,David Yergler

This paper first documents the rapid increase in Pennsylvania's share of U.S. natural gas production from ongoing development of the Marcellus Shale formation. It does stand to reason that the Marcellus Shale boom has made Pennsylvania natural gas production far more influential on aggregate oil and gas markets than before, but does such a differential effect appear in the data? Can we say, unequivocally, that the Marcellus Shale boom caused Pennsylvania's natural gas output to move the needle on national natural gas prices more so than before the boom occurred? These questions are investigated utilizing a threshold VAR model based

on Tsay's (1998) test for unknown break points to investigate how, if at all, Pennsylvania's rapidly growing share of national natural gas production has altered the linkages between Pennsylvania's natural gas production and overall oil and gas prices. Findings indicate a structural break in the impact of Pennsylvania's natural gas production on natural gas prices occurring in early 2009, a date that matches well with the onset of the state's rapid production growth. Pre-break, there is minimal evidence that changes in Pennsylvania's production had a significant effect on the aggregate U.S. natural gas market; but when post-break data is included, an increase in Pennsylvania's production leads to a lower average national price of natural gas, which is transitory and lasts for only a few months. These results provide statistical support to the notion that Pennsylvania has become a substantial component of the U.S. natural gas market at least in the short-run.

Hedging strategy for ethanol processing with copula distributions

- Energy Economics---2016---Iddrisu Awudu,William Wilson,Bruce Dahl

It has become important for ethanol producers to hedge input and output price risks. The purpose of this paper is to analyze an ethanol-producing firm's strategy to reduce price risks for inputs and outputs. Corn is the primary input, and the outputs are ethanol, corn oil, distillers' dried grains (DDGs), and renewable identification numbers (RINs). A theoretical model is developed including margins and risk is measured using value at risk (VaR). An empirical model is developed and extended to VaR using copulas to analyze the marginal distribution and dependence structure for input and output prices on margins. Efficient frontier curves analyzing VaR with and without copula are discussed. The results compare varying risk-strategy measures for long corn, short corn, and combining short and long corn. Sensitivity analyses are conducted for functional changes in the margin as a result of ethanol price changes.

Hydropower externalities: A meta-analysis

- Energy Economics---2016---Matteo Mattmann,Ivana Logar,Roy Brouwer

This paper presents a meta-analysis of existing research related to the economic valuation of the external effects of hydropower. A database consisting of 81 observations derived from 29 studies valuing the non-market impacts of hydropower electricity generation is constructed with the main aim to quantify and explain the economic values for positive and negative hydropower externalities. Different meta-regression model specifications are used to test the robustness of significant determinants of non-market values, including different types of hydropower impacts. The explanatory and predictive power of the estimated models is relatively high. Whilst controlling for sample and study characteristics, we find significant evidence for public aversion towards deteriorations of landscape, vegetation and wildlife caused by hydropower projects. There is however only weak evidence of willingness to pay for mitigating these effects. The main positive externality of hydropower generation, the avoidance of greenhouse gas emission, positively influences welfare estimates when combined with the share of hydropower in national energy production. Sensitivity to scope is detected, but not linked to specific externalities or non-market valuation methods.

The directional volatility connectedness between crude oil and equity markets: New evidence from implied volatility indexes

- Energy Economics---2016---Aktham I. Maghyreh,Basel Awartani,Elie Bouri

In this paper, we use a set of newly introduced implied volatility indexes to investigate the directional connectedness between oil and equities in eleven major stock exchanges around the globe from 2008 to 2015. The inference on the oil–equity implied volatility relationships depends on Diebold and Yilmaz (2012, 2014, 2015) who proposed a set of directional measures that enable the dynamic and directional characterization of the relationships among financial variables. We find uniform results across the sample countries indicating

that the connectedness between oil and equity is established by the bi-directional information spillovers between the two markets. However, we find that the bulk of association is largely dominated by the transmissions from the oil market to equity markets and not the other way around. The pattern of transmissions is varying over the sample period; however most of the linkages between oil and equities are established from the mid of 2009 to the mid of 2012 which is a period that witnessed the start of global recovery.

A difficult road ahead: Fleet fuel economy, footprint-based CAFE compliance, and manufacturer incentives

- Energy Economics---2016---Darin F. Ullman

Using detailed vehicle specifications, this paper analyzes the impact identifiable vehicle characteristics and technological progress has on fleet fuel economy by vehicle type and class. The results suggest manufacturers will face a difficult task complying with the new footprint-based CAFE standards if compliance is met by only changing identifiable vehicle characteristics. I find evidence that the stringent footprint-based standards create a manufacturer incentive to increase vehicle size to lower the burden of compliance. This undermines the standards' potential to create expected fuel savings and lower emissions levels.

Impact of a carbon tax on the Chilean economy: A computable general equilibrium analysis

- Energy Economics---2016---José Miguel García Benavente

In 2009, the government of Chile announced their official commitment to reduce national greenhouse gas emissions by 20% below a business-as-usual projection by 2020. Due to the fact that an effective way to reduce emissions is to implement a national carbon tax, the goal of this article is to quantify the value of a carbon tax that will allow the achievement of the emission reduction target and to assess its impact on the economy.

What the investors need to know about forecasting oil futures return volatility

- Energy Economics---2016---Yudong Wang, Li Liu, Feng Ma, Chongfeng Wu

In this paper, we evaluate the usefulness of GARCH-class models in forecasting densities of crude oil futures from an investor perspective. Volatility forecasts are taken as the key inputs in calculating predictive densities. We find that FIEGARCH accommodating both long memory and asymmetric effect provides more accurate density forecasts than the other GARCH-class models most of the time. GARCH-based dynamic trading strategies perform significantly better than the benchmark of the static strategy even after accounting for the transaction cost. The gains of utility of GARCH-based strategies over the benchmark strategy are as high as 18%–20% p.a.

Oil price shocks, competition, and oil & gas stock returns — Global evidence

- Energy Economics---2016---Kartick Gupta

Extant literature suggests that oil price shocks have a strong impact on the macroeconomy and the stock market. However, relatively less is known about the effect of country-level determinants, competition, and asymmetrical relationship in affecting the oil & gas stock return at the firm-level. Using a comprehensive firm-level monthly data from 70 countries spanning 1983 to 2014, we find: (i) macroeconomic stress negatively impact firm-level returns; (ii) oil price shocks positively impact firm-level returns; (iii) firms located in high oil producing countries are more sensitive to global uncertainty and oil price shocks; (iv) firms located in non-competitive industries are less sensitive to oil price shocks; and (v) firms located in non-competitive industries are less affected by the drop in oil price, as compared to firms that are located in highly competitive industries. Our results remain qualitatively similar using a battery of robustness checks.

Oil curse and finance–growth nexus in Malaysia: The role of investment

- Energy Economics---2016---Ramez Abubakr Badeeb, Hooi Hooi Lean, Russell Smyth

We empirically examine the existence of an oil curse in the finance–growth nexus in Malaysia. We provide new insights into the oil curse phenomenon in Malaysia that challenges the conventional argument that Malaysia is a counter-example of an oil curse country. We do not find any significant evidence of direct effects of financial development on TFP. However, there are direct and positive effects on the level of investment due to financial development and oil dependence. While we do not find statistical evidence of a direct negative impact of oil rent on economic growth, our results reveal that the symptoms of an oil curse exist. Specifically, we find that oil rent has a weak, indirect, impact on the finance–growth nexus through the quantitative channel or investment quantity. The policy implications of our findings are that the financial sector should be more involved in productive investment activities that can strengthen its role in economic growth and that policymakers should reduce dependence on oil and promote economic diversification.

Mitigation incentives with climate finance and treaty options

- Energy Economics---2016---Jon Strand

Future greenhouse gas (GHG) mitigation action of current non-climate-policy (NP) countries is considered to take two alternative forms: 1) “climate finance” payments received in return for future reductions in its GHG emissions below a defined “baseline”; and 2) join a “climate treaty” whereby the required emissions reductions are formally binding. It is assumed that baselines defining climate finance payments, and required emissions reductions under a treaty, depend positively on current emissions. It is then shown that making such future options available reduces current GHG mitigation in NP countries, leading to higher emissions in the short run. This effect is stronger when

future climate finance payments are higher; the required relative emissions reductions under a treaty are greater; when commitments under a treaty are longer-lasting; and mitigation targets depend more on current emissions. Such short-run increases in emissions can (sometimes, more than) fully eliminate the effect of the subsequent policy. When climate finance and treaties are both future alternatives, more generous climate finance can make it harder and more expensive to induce the country to join a climate treaty.

Persistence in world energy consumption: Evidence from subsampling confidence intervals

- Energy Economics---2016---Firouz Falahehi,Mohammad Karimi,Marcel Voia

This paper analyzes the persistence properties of energy consumption in 107 countries over the 1971–2011 period. It uses subsampling confidence interval methods that are more informative than simple unit root tests to describe the underlying process of energy consumption. Because subsampling requires fewer assumptions on the nature of the data generating process, inference is less prone to a number of potential misspecification errors. By focusing on the degree of persistence in the process describing a country's energy consumption, the analysis not only provides evidence on the stationarity or nonstationarity of the energy consumption but also gives insight into the likely success of environmentally oriented government intervention. The analysis finds that the 107 countries can be grouped into three persistence classes: those whose energy consumption is explosive (highly populated countries with high growth rates); those with nonstationary energy consumption (developing and highly oil dependent economies); and those whose energy consumption is stationary (developed and energy-rich countries). In nonstationary cases, government intervention can be effective and produce permanent improvements in energy conservation and other environmental concerns. In stationary cases energy conservation and environmentally-oriented demand-management policies can have only temporary effects and thus designed to speed re-adjustment to the longer run underlying trend.

Price trends and volatility scenarios for designing forest sector transformation

- Energy Economics---2016---Kyle Lochhead,Saeed Ghafghazi,Petr Havlik,Nicklas Forsell,Michael Obersteiner,Gary Bull,Warren Mabee

Potential scenarios for the forest bioeconomy are heavily reliant on price assumptions; in particular, any abrupt changes in prices have a profound impact on the relevancy of any sector analysis. The objective of this paper was to demonstrate a new forest sector approach for incorporating price uncertainties in order to improve our assessment of investment decision making alternatives. Methodologically, we linked a multivariate generalized autoregressive conditional heteroscedasticity model (mGARCH (1,1)) with three global land use scenarios that are of strategic importance to the forest bioeconomy. The three scenarios were formulated as i) a business as usual scenario, ii) a high biomass usage scenario and iii) a no-growth scenario. Our results indicate an upward trend in prices over time for all three scenarios and for most woody biomass commodities. Under all scenarios, price volatility in the forest sector would be smaller than that for the fossil fuel energy (i.e. oil and natural gas). Price volatilities from fossil fuel markets are positively influencing woody biomass price volatility and positively influencing pulp volatility. These results are discussed in the context of a case study describing investment alternatives for a district heating facility with options for: woody biomass, natural gas, or heating oil.

Regulation and investment incentives in electricity distribution: An empirical assessment

- Energy Economics---2016---Astrid Cullmann,Maria Nieswand

We analyze the effects of incentive regulation with revenue caps on the investment behaviors of 109 German electricity distribution companies. We hypothesize that with Germany's implementation of incentive regulation in 2009 firms increase their investments in the base year when the rate base is determined for the following regulatory period. We build a model that controls for

both firm-specific heterogeneity and ownership. The results show that investments increase after 2009, especially in the base year. We find that publicly owned firms do not exhibit a different investment behavior than private firms. We conclude that a comprehensive assessment of investment decisions should include all institutional aspects of incentive regulation.

Understanding the spectrum of residential energy-saving behaviours: French evidence using disaggregated data

- Energy Economics---2016---Belaid Fateh,Thomas Garcia

Analysing household energy-saving behaviours is crucial to improve energy consumption predictions and energy policy making. How should we quantitatively measure them? What are their determinants? This study explores the main factors influencing residential energy-saving behaviours based on a bottom-up multivariate statistical approach using data from the recent French PHEBUS survey. Firstly, we assess energy-saving behaviours on a one-dimension scale using IRT. Secondly, we use linear regression with an innovative variable selection method via adaptive lasso to tease out the effects of both macro and micro factors on the behavioural score. The results highlight the impact of five main attributes incentivizing energy-saving behaviours based on cross-variable analyses: energy price, household income, education level, age of head of household and dwelling energy performance. In addition, our results suggest that the analysis of the inverted U-shape impact of age enables the expansion of the energy consumption life cycle theory to energy-saving behaviours.

An event study analysis of oil and gas firm acreage and reserve acquisitions

- Energy Economics---2016---Amir H. Sabet,Richard Heaney

We examine the impact of the announcement of acquisition of oil and gas acreage and reserves on the share price of US listed oil and gas firms. While there is

evidence of information asymmetry related differences in the share market reaction on announcement of acquisition of acreage or reserves, we also identify greater sensitivity to crude oil price volatility for acreage acquisitions, consistent with the creation of valuable real options on acquisition of acreage. This is not evident to the same extent with acquisition of reserves. For example, acreage investment announcements reveal a statistically significant 1.22% premium (3-day CAR) in periods of high crude oil volatility compared with periods of low volatility. The premium on reserve acquisitions across these periods is a statistically insignificant 0.12%. This is supported in a multiple regression setting, with share price sensitivity to crude oil price volatility being higher for acreage acquisitions than for reserve acquisitions. Our sample consists of 1391 separate acreage or reserve acquisition announcements made by oil and gas firms listed on the U.S. equity market over the period from 1992 to 2011.

On the importance of the long-term seasonal component in day-ahead electricity price forecasting

- Energy Economics---2016---Jakub Nowotarski,Rafał Weron

In day-ahead electricity price forecasting (EPF) the daily and weekly seasonalities are always taken into account, but the long-term seasonal component (LTSC) is believed to add unnecessary complexity to the already parameter-rich models and is generally ignored. Conducting an extensive empirical study involving state-of-the-art time series models we show that (i) decomposing a series of electricity prices into a LTSC and a stochastic component, (ii) modeling them independently and (iii) combining their forecasts can bring – contrary to a common belief – an accuracy gain compared to an approach in which a given time series model is calibrated to the prices themselves.

An exploration of a strategic competition model for the European Union natural gas market

- Energy Economics---2016---Zaifu Yang,Rong Zhang,Zongyi Zhang

Following Jansen et al. (2012), we examine an unconventional Cournot model of the European Union natural gas market with three major suppliers: Russian Gazprom, Norwegian Statoil, and Algerian Sonatrach. To reflect Russia's other strategic consideration besides profit, we incorporate a relative market share into Gazprom's objective function. We prove that when Gazprom pursues the control of market share along with profit, it will be good news for consumers but bad news for its pure profit maximising rivals. We further show that by seeking a proper market share, Gazprom can achieve the same profit of a Stackelberg leader in a simultaneous move model as in the standard sequential move leader-follower model. Compared with Jansen et al.'s, our approach makes both the analysis considerably simpler and more transparent, and the model more applicable.

Environmental investment and firm performance: A network approach

- Energy Economics---2016---Moriah Bostian,Rolf Färe,Shawna Grosskopf,Tommy Lundgren

This study examines the role of investment in environmental production practices for both environmental performance and energy efficiency over time. We employ a network DEA approach that links successive production technologies through intertemporal investment decisions with a period by period estimation. This allows us to estimate energy efficiency and environmental performance separately, as well as productivity change and its associated decompositions into efficiency change and technology change. Incorporating a network model also allows us to account for both short-term environmental management practices and long-term environmental investments in each of our productivity measures. We apply this framework to a panel of detailed plant-level production data for Swedish manufacturing firms covering the years 2002–2008.

Dynamic technique and scale effects of economic growth on the environment

- Energy Economics---2016---Sandeep Mohapatra,Wiktor Adamowicz,Peter Boxall

A recent literature shows that the effect of economic growth on the environment is driven by technique and scale effects. Surprisingly, there are no dynamic estimates of these components in the literature. Using data from Canada, this paper makes a novel contribution by investigating asymmetric trends in economic growth effects and by breaking the aggregate effect into time varying scale and technique components. Our results show that scale and technique effects have significant dynamic components, and, thus, accounting for such dynamics is critical for assessing whether or not economic growth is good for the environment.

How does coal price drive up inflation? Reexamining the relationship between coal price and general price level in China

- Energy Economics---2016---Jin Guo,Xinye Zheng,Zhan-Ming Chen

Due to the coal-dominated energy structure, China is currently facing significant economic uncertainties brought forward by instability of coal price. By separating the asymmetric effects that how upward and downward coal price changes pass through to the economy, this paper reexamines the relationship between coal price and general price level in China. The asymmetric effects are investigated via vector autoregression models, Granger Causality tests, and impulse response function analyses using the monthly time series data from Jun-98 to Sep-14. Results show negative coal price change presents more significant impact on inflation than positive one. The inflation responses very abruptly to coal price shock in the short run, but the impact regresses rapidly along time. Accumulatively, a 1% increase of coal price will push CPI and PPI up by 0.04% and 0.12%, while a 1% decrease of coal price will pull them down by 0.08% and 0.17%, respectively. The linkage among coal price change, PPI, and CPI is demonstrated as the main transmission channel of

price shock. The inflationary effect is strong in the initial stage, but will be weakened in the later stage since the pass through effect from PPI to CPI is tiny, which confirms PPI is more responsive than CPI to coal price change. For policy implications, how to avoid extreme volatility in general price level is a major concern of recent agendas such as reforming energy market and building green fiscal system.

Information spillover dynamics of the energy futures market sector: A novel common factor approach

- Energy Economics---2016---Duminda Kurup-puarachchi,I.M. Premachandra

We investigate sector level information spillovers from energy to other futures market sectors using a novel conditionally heteroscedastic common factor (CHCF). CHCF represents common trends of macroeconomic influences on futures markets. We find that energy sector has the highest degree of commonality compared to other sectors. Conditional correlations between energy and non-energy sectors are highly persistent. The volatility spillover from the energy sector is prominent compared with mean and extreme market risk spillovers. Extreme risk spillovers from the energy to other sectors have an asymmetric effect. Shocks to energy futures have a significant potential impact on other markets during crises.

Retraining investment for U.S. transition from coal to solar photovoltaic employment

- Energy Economics---2016---Edward P. Louie,Joshua Pearce

Although coal remains the largest source of electricity in the U.S., a combination of factors is driving a decrease in profitability and employment in the coal sector. Meanwhile, the solar photovoltaic (PV) industry is growing rapidly in the U.S. and generating many jobs that represent employment opportunities for laid off coal workers. In order to determine the viability of a smooth transition from coal to PV-related employment, this paper provides an analysis of the

cost to retrain current coal workers for solar photovoltaic industry employment in the U.S. The current coal industry positions are determined, the skill sets are evaluated and the salaries are tabulated. For each type of coal position, the closest equivalent PV position is determined and then the re-training time and investment are quantified. These values are applied on a state-by-state basis for coal producing states employing the bulk of coal workers as a function of time using a reverse seniority retirement program for the current American fleet of coal-powered plants. The results show that a relatively minor investment in re-training would allow the vast majority of coal workers to switch to PV-related positions even in the event of the elimination of the coal industry.

Price differences among crude oils: The private costs of supply disruptions

- Energy Economics---2016---Robert Kaufmann

I quantify the causes for price differences among crude oils that are set by the law of one price with a special emphasis on country risk. For crude oils that are part of the same market, I estimate cointegrating relations, which represent their long-run relation, and error correction models, which represent the rate at which the market eliminates disequilibrium in their prices. Results indicate that positive values of country risk impose a \$0.51 price penalty on a barrel of crude oil from an unreliable supplier that increases with the variance in risk and the price of crude oil. These price penalties are the first empirical estimates for how the market values the private costs of oil supply disruptions. Beyond country risk, the price effects of sulfur content, density, distance between supply ports, and OPEC membership confirm the importance of oil supply choke points, OPEC's ability to influence prices, and differences in refinery technology. Because private costs of a supply disruption attach only to nations with a non-zero country risk, previous estimates for the social costs of a supply disruption may be too large.

Technical efficiency and CO2 reduction potentials — An analysis of the German electricity and heat generating sector

- Energy Economics---2016---Stefan Seifert,Astrid Cullmann,Christian von Hirschhausen

In this paper, we analyze the technical efficiency and CO2 reduction potentials of German power and heat plants, using a non-parametric sequential Data Envelopment Analysis. We apply a metafrontier framework to evaluate plant-level efficiency in the transformation of inputs into desirable (energy) and undesirable (CO2 emissions) outputs, taking into account different fossil fuel generation technologies. We use a unique data set of coal-, lignite-, gas- and biomass-fired power plants from 2003 through 2010 that provides an unbalanced panel of 1459 observations; the results are also checked against a balanced panel with a smaller number of observations. Although we find intra-group differences within energy generation technology, natural gas fired power plants clearly have the highest efficiency. Furthermore, the analysis points to significant savings potentials for CO2 and fuel-input, and derives policy conclusions for the ongoing electricity sector reformation.

Urbanization, openness, emissions, and energy intensity: A study of increasingly urbanized emerging economies

- Energy Economics---2016---Shuddhasattwa Rafiq,Ruhul Salim,Ingrid Nielsen

This paper analyses the impact of urbanization and trade openness on emissions and energy intensity in twenty-two increasingly urbanized emerging economies. We employ three second-generation heterogeneous linear panel models as well as recently developed nonlinear panel estimation techniques allowing for cross-sectional dependence. The empirical results show that population density and affluence increase emissions and energy intensity while renewable energy seems to be dormant in these emerging economies, but non-renewable energy increases both CO2 emissions and energy intensity. In addition, openness significantly reduces both pollutant

emissions and energy intensity whereas urbanization significantly increases energy intensity, but it is insignificant in increasing emissions. This may be, in part, due to the recent increasing trend in adopting cleaner technologies in these increasingly urbanized developing economies.

The effect of foreign direct investment and stock market growth on clean energy use across a panel of emerging market economies

- Energy Economics---2016---Sudharshan Reddy Paramati,Malles Ummalla,Nicholas Apergis

This study investigates the impact of both FDI inflows and stock market developments on clean energy use across 20 emerging market economies, spanning the period 1991–2012. It accounts for cross-sectional dependence and heterogeneity in the analysis and employs robust panel econometric techniques. The empirical results on long-run elasticities display that economic output, FDI inflows and stock market developments have all a significant positive impact on clean energy consumption. Finally, the results on heterogeneous panel non-causality tests indicate the presence of unidirectional causality running from FDI to clean energy consumption in the short-run. For robustness purposes, the paper also estimates long-run elasticities for individual countries, with the findings documenting that both FDI inflows and stock market developments have a considerable positive impact on clean energy uses. The findings urge that both policy makers and governments in these emerging market economies should initiate effective public-private-partnership investments in clean energy projects by providing lucrative incentives, which, in turn, will encourage both domestic and foreign investors to invest more in clean energy projects and, eventually, moving these economies towards sustainable economic growth.

Asymmetric oil shocks and external balances of major oil exporting and importing countries

- Energy Economics---2016---Shuddhasattwa Rafiq,Pasquale Sgro,Nicholas Apergis

This study investigates the effects of oil price shocks on three measures of oil exporters' and oil importers' external balances: total trade balance, oil trade balance and non-oil trade balance. We employ three second-generation heterogeneous linear panel models and one recently developed non-linear panel estimation technique that allows for cross-sectional dependence. With respect to 28 major oil exporting countries, an increase in oil prices leads to an improved real oil trade balance, although it is detrimental to non-oil and total trade balances. This finding might be due to the expenditure effect arising from increases in proceeds from oil exports. A decrease in oil prices is found to be beneficial for both total and oil trade balances in these oil exporting countries. Forty major oil importers seem to be increasingly shielded from positive oil shocks over the 1970s and 1980s; however, they must worry about oil price declines. A decline in oil prices has a negative impact on both total and real oil trade balances resulting from increased oil imports in emerging economies. Hence, a decline in oil prices is beneficial to oil exporters due to the quantity effect outweighing the price effect, while for oil importers a stable oil price is more desirable than a price decline. These results are important to take into account if we are to gain a full understanding on the magnitude of the trade and macroeconomic effects of oil price changes and what the policy responses should be.

System-friendly wind power

- Energy Economics---2016---Lion Hirth,Simon Müller

Previous studies find that the economic value of electricity (USD/MWh) generated by wind power drops with increasing market share. Different measures can help mitigate the value drop, including electricity storage, flexible conventional plants, expansion of transmission, and demand response. This study assesses another option: a change in design of wind power plants. "Advanced" wind turbines that are higher and have a larger rotor compared to rated capacity (lower specific rating) generate electricity more constantly than "classical" turbines. Recent years have

witnessed a significant shift towards such advanced technology. Our model-based analysis for Northwestern Europe shows that such design can substantially increase the spot market value of generated electricity. At a 30% penetration rate, the value of 1MWh of electricity generated from a fleet of advanced turbines is estimated to be 15% higher than the value of 1MWh from classical turbines. The additional value is large, whether compared to wind generation costs, to the value drop, or to the effect of alternative measures such as electricity storage. Extensive sensitivity tests indicate that this finding is remarkably robust. The increase in bulk power value is not the only advantage of advanced turbines: additional benefits might accrue from reduced costs for power grids and balancing services. To fully realize this potential, power markets and support policies need to be appropriately designed and signal scarcity investors.

Asymmetric impacts of fundamentals on the natural gas futures volatility: An augmented GARCH approach

- Energy Economics---2016---Ibrahim Ergen,Islam Rizvanoglu

We investigated the determinants of daily volatility for natural gas nearby-month futures traded on the NYMEX within a GARCH framework augmented with market fundamentals. Consistent with the previous literature, we found that volatility is much higher on the natural gas and crude oil storage report announcement days, on Mondays and during winters. We also confirmed that high volatility is associated with divergence of storage levels and temperatures from seasonal norms. The asymmetric impact of storage levels on volatility across different seasons is empirically investigated and documented. The mainstream finding in the literature that lower storage levels result in higher volatility is valid only during winter. At other times, it is actually higher storage levels causing higher volatility. Also, time to maturity effect is present only in winters. Additionally, weather shocks have asymmetric impact on volatility depending on the sign of the shock. Finally, we found that augmentation with market fundamen-

tals improves the out-of-sample forecast accuracy of standard GARCH models.

Estimating and forecasting the real prices of crude oil: A data rich model using a dynamic model averaging (DMA) approach

- Energy Economics---2016---Hanan Naser

Given that oil price fluctuations have been of great interest for macroeconomics in the recent years due to its' important implications for future inflation, economic growth, and policy making, the aim of this paper is to estimate and forecast West Texas Intermediate (WTI) crude oil prices using a large monthly dataset, that covers the period from March 1983 to December 2011. To achieve this aim, forecasting with factor models offers a usual approach that utilizes large datasets, however; a forecasting model which simply includes all factors in state space equation and does not allow for time varying may be not suitable with a highly volatile market such as oil market. To overcome these limitations, an approach that accounts both for parameter and model uncertainty is employed. In particular, this study uses the Dynamic Model Averaging (DMA) approach suggested by Koop and Korobilis (2012). The key element of the DMA approach is that it allows both for model and parameter to vary at each point of time. By doing so, the DMA is robust to structural breaks. Empirical findings show that DMA approach outperforms any other alternative model used in the forecasting exercise. Results also show that there is model but not parameter variation in this oil price forecasting exercise. Finally, the findings suggest that the DMA approach provides a better proxy of expected spot prices than future prices.

An empirical analysis of the relationship between oil prices and the Chinese macro-economy

- Energy Economics---2016---Yanfeng Wei,Xiaoying Guo

Using the quarterly data from the first quarter of 1996 to the fourth quarter of 2014, this paper studies the

relationship between oil prices and the Chinese macro-economy. We find output and interest rate respond significantly to oil price shocks. Further analysis reveals that the positive response of output to oil price shocks is attributed to the influences of oil price shocks on exports. The oil price shocks have both longer and deeper effects on the exports of state-owned enterprises than on those of foreign investment enterprises. Moreover, the response of exports to oil price shocks is symmetric. Finally, oil prices are found to be useful for forecasting the China's exports in the periods shorter than about two years.

Understanding energy systems change in Canada: 1. Decomposition of total energy intensity

- Energy Economics---2016---Ralph D. Torrie,Christopher Stone,David B. Layzell

Between 1995 and 2010, the total energy intensity (E/GDP, PJ/Gross Domestic Product in 2002\$) of the Canadian economy declined by 23% or 2.64MJ/\$. To understand why, the Logarithmic Mean Divisia Index (LMD-I) method was used to decompose a large body of government statistical data supporting the observed E/GDP decline. The analysis shows that (a) 48% (1.27MJ/\$) of the decline was associated with an inter-sector structural change in the economy (i.e. an increased contribution to the total GDP of the low energy-using commercial and institutional sector compared with the high energy-using manufacturing and heavy industry sectors); (b) 24% (0.62MJ/\$) was attributed to the impact of the Canadian GDP growing faster than population; (c) 22% (0.58MJ/\$) of the decline was associated with an overall decrease in business energy intensity. A deeper analysis of business sectors shows a positive impact of 0.4MJ/\$ from increased energy intensity in the oil and gas sector, offset by a 0.98MJ/\$ decline due to energy intensity declines in the other business sectors; (d) 6.3% (0.17MJ/\$) of the decline was associated with an improvement in the energy intensity of households, mostly from residential energy use rather than personal transportation energy use. These results provide insights for policy makers

regarding those aspects of the Canadian economy that contribute to, or work against, efforts to transform energy systems toward sustainability.

The database–modeling nexus in integrated assessment modeling of electric power generation

- Energy Economics---2016---Jeffrey C. Peters, Thomas Hertel

Integrated assessment models (IAMs) are playing an increasingly important role in long-run sustainability analysis. At their core is a set of global economic and environmental accounts which capture a complete set of inter-industry and inter-regional relationships in the global economy in a consistent manner. While much attention is focused on the raw data and parameterization required to expand or add sectoral detail to IAMs, only rarely is there discussion of how different matrix balancing methods (i.e. translating disparate raw data sources into the consistent database) affect modeling results. This article offers an in-depth look into the database–modeling nexus in IAMs, focusing on the electric power sector which is both a major source of CO₂ emissions and a critical vehicle for climate change mitigation. Comparisons of the prevailing matrix balancing algorithms show how the choice of database reconciliation methodology affects modeling results using policy-relevant simulations in the context of the electric power sector. The resulting insights can be applied to the disaggregation of other, technology rich sectors in the economy. We conclude that appropriate selection of database reconciliation methodologies can reduce the deviation between bottom-up and top-down modeling.

Forecasting crude oil price volatility and value-at-risk: Evidence from historical and recent data

- Energy Economics---2016---Thomas Lux, Mawuli Segnon, Rangan Gupta

This paper adopts the Markov-switching multifractal (MSM) model and a battery of generalized autore-

gressive conditional heteroscedasticity (GARCH)-type models to model and forecast oil price volatility. Extending previous work by Wei et al., (2010) and Wang et al., (2016), we evaluate the forecasting performance of all these models via a superior predictive ability (SPA) test. We go beyond previous research by (i) considering oil price volatility in the nineteenth century along with recent data, (ii) applying different types of MSM models and (iii) considering value-at-risk predictions besides our forecasting of volatility. Confirming its successful performance in other studies, the new MSM model comes out as the model that most often across forecasting horizons and subsamples cannot be outperformed by other models. This superiority also applies to forecasting of value-at-risk.

Market conditions, trader types and price–volume relation in energy futures markets

- Energy Economics---2016---Amir H. Alizadeh, Michael Tamvakis

We investigate the asymmetric relations between trading volume and price changes, and trading volume and price volatility of energy futures contracts across maturities and under different market conditions. Using a relatively long sample of daily observations, we examine whether the impact of trading volume on returns and volatility of futures contracts can be time-varying and dependent on the market condition. We differentiate the market condition based on the slope of the forward curve into backwardation and contango. The results indicate that trading volume and returns are positively related when the market is in backwardation and negatively related when the market is in contango. In addition, the positive relation between changes in trading volume and volatility of futures contracts seem to be stronger when the market is in backwardation than when it is in contango. Finally, the results indicate that, to a certain extent, trade participation and trading activities of agents in energy futures markets can be explained by the slope of the forward curve which reflects the market condition and sentiment.

‘Nonlinear causality between crude oil price and exchange rate: A comparative study of China and India’ — A failed replication (negative Type 1 and Type 2)

- Energy Economics---2016---Glauco De Vita,Emmanouil Trachanas

Evidence published in this journal by Bal and Rath (2015) purports a bidirectional nonlinear causality between oil price and India’s exchange rate and, for China, unidirectional nonlinear causality running from exchange rate to oil price. Their entire testing protocol and ensuing results rest upon claims that all the variables contain a unit root. We raise several critical issues and revisit the order of integration of the series as well as their cointegration and Granger causality properties through a ‘pure replication’ and a ‘reanalysis’. Contrary to Bal and Rath (2015), when we repeat their estimated model with their specification of the Ng and Perron (2001) unit root test on their data, we find that their oil price series (ROL) is level stationary (negative replication Type 1), a result which makes all their subsequent results biased and misleading. Our reanalysis confirms that ROL is $I(0)$, linearly as well as nonlinearly. We also find that the basic bivariate model proposed by Bal and Rath (2015) fails to produce statistically robust and stable cointegrating patterns. Nonlinear causality tests confirm the absence of any nonlinear causality for both countries (negative replication Type 2).

Changes in the global oil market

- Energy Economics---2016---Erdenebat Bataa,Marwan Izzeldin,Denise Osborn

Changes in the parameters of a recursively identified oil market model are examined through an iterative algorithm that tests for possible breaks in coefficients and variances. The analysis detects breaks in the coefficients of the oil production and price equations, together with volatility shifts in all three equations of the model. Coefficient changes imply an enhanced response of production to aggregate demand shocks after 1980; and that the price response to supply shocks

is more persistent from the mid-1990s. All variables evidence changes in the relative contributions of individual shocks to their forecast error variances, with coefficient and volatility breaks in the first half of the 1990s being particularly important in this respect. The results show that analysts of this market should eschew constant parameter models estimated over an extended period.

Energy, human capital and economic growth in Asia Pacific countries — Evidence from a panel cointegration and causality analysis

- Energy Economics---2016---Zheng Fang,Youngho Chang

This paper examines the cointegration and causal relationship between energy consumption and economic development in 16 Asia Pacific countries over the period 1970–2011 using the augmented production function which considers not only physical capital and labor but also human capital. This is likely among the first of the energy–growth nexus literature to include human capital in the multivariate framework. Using recently developed panel unit root test and cointegration test that allow for cross-sectional dependence, this paper finds a long-run cointegrating relationship between these variables. Continuously-updated fully modified (Cup-FM) estimates are subsequently compared with panel heterogeneous fully modified ordinary least squares (FMOLS) results to confirm the importance of accounting for interdependence across countries. The bootstrap panel Granger causality test results find economic growth Granger cause energy use in the region but the relationship varies for individual countries.

A physical production function for the US economy

- Energy Economics---2016---Henry Thompson

This paper introduces and presents an estimate of a production function motivated by physics with labor and energy providing force to produce work. The separate interactions of capital with labor and energy

lead to reliable estimates for US output from 1951 to 2008 with fixed capital assets, the labor force, and total Btu energy inputs. Underpaid energy has an output elasticity twice that of labor. Overpaid labor faces elastic own substitution while there is weak substitution for capital. The policy implications of these properties are discussed.

Heterogeneous policies, heterogeneous technologies: The case of renewable energy

- Energy Economics---2016---Francesco Nicolli, Francesco Vona

This paper investigates empirically the effect of market regulation and renewable energy policies on innovation activity in different renewable energy technologies. For the EU countries and the years 1980 to 2007, we built a unique dataset containing information on patent production in eight different technologies, proxies of market regulation and technology-specific renewable energy policies. Our main finding is that, compared to privatisation and unbundling, reducing entry barriers is a more significant driver of renewable energy innovation, but that its effect varies across technologies and is stronger in technologies characterised by potential entry of small, independent power producers. In addition, the inducement effect of renewable energy policies is heterogeneous and more pronounced for wind, which is the only technology that is mature and has high technological potential. Finally, ratification of the Kyoto protocol, which determined a more stable and less uncertain policy framework, amplifies the inducement effect of both energy policy and market liberalisation.

Crude oil prices and sectoral stock returns in Jordan around the Arab uprisings of 2010

- Energy Economics---2016---Elie Bouri, Basel Awartani, Aktham Maghyreh

In this paper, we test for mean and variance causality between world oil prices and sectoral equity returns in Jordan before and after the Arab Uprisings that started in 2010. The testing methodology is based on

the sample of cross-correlation functions that are computed from the standardized residuals of a GARCH process. Our results show that the influence is not uniform across the equity sectors. The oil return shocks significantly impact the Financials and the Services sectors, while its effect is insignificant on the Industrials sector. This result is more pronounced in the period that follows the Arab Uprisings. In terms of risk transfer, we find that oil is a negligible risk factor. However, there is still a significant evidence of risk transmission to the Industrials sector particularly during the Arab Uprisings period. These results represent a unique information transmission mechanism that is useful for risk management and portfolio diversification.

Explaining credit default swap spreads by means of realized jumps and volatilities in the energy market

- Energy Economics---2016---José Da Fonseca, Katja Ignatieva, Jonathan Ziveyi

This paper studies the relationship between credit default swap (CDS) spreads for the Energy sector and oil futures dynamics. Using data on light sweet crude oil futures from 2004 to 2013, which contains a crisis period, we examine the importance of volatility and jumps extracted from the futures in explaining CDS spread changes. The analysis is performed at an index level and by rating group; as well as for the pre-crisis, crisis and post-crisis periods. Our findings are consistent with Merton's theoretical framework. At an index level, futures jumps are important when explaining CDS spread changes, with negative jumps having higher impact during the crisis. The continuous volatility part is significant and positive, indicating that futures volatility conveys relevant information for the CDS market. As for the analysis per rating group, negative jumps have an increasing importance as the credit rating deteriorates and during the crisis period, while the results for positive jumps and futures volatility are mixed. Overall, the relation between the CDS market and the futures market is stronger during volatile periods and strengthened after the Global Financial Crisis.

Integration of physical and futures prices in the US natural gas market

- Energy Economics---2016---Hamed Ghoddusi

This paper examines the integration between the prices of different types of physical (upstream/end-use) and futures contracts of natural gas in the US for the period of June 1990–Dec 2014. To examine the equilibrium relationship between physical and futures prices, several cointegration tests are applied. The study finds that (a) futures prices are cointegrated with wellhead, power, industrial, and citygate prices; (b) NG1 futures prices Granger cause all physical prices; (c) upstream physical prices Granger cause futures prices; (d) shocks to wellhead prices are the only ones among physical prices with persistent long-term effects; (e) shocks to futures prices have persistent effects on all physical prices; (f) futures contracts with a longer time-to-maturity explain a larger portion of commercial gas price variations; and (g) commercial and residential prices show different behavior compared to other physical prices in multiple tests.

Does the S&P500 index lead the crude oil dynamics? A complexity-based approach

- Energy Economics---2016---Catherine Kyrt-sou, Christina Mikropoulou, Angeliki Papan

Taking the complex property of nonlinear feedback connectivity into consideration, the goal of this paper is to apprehend the interdependences between the financial and energy sectors. Our contribution is both theoretical and methodological. We conduct a multivariate analysis employing nonlinear tools, namely the Partial Transfer Entropy and the Asymmetric Mackey-Glass causality test. In particular, we build a system comprising the petroleum complex (crude oil, gasoline and heating oil), the S&P500 index and the 1-month futures-spot spread for crude oil. By adopting a rolling-window approach, we observe a persistent lead-lag relationship between the S&P500 index and the market participants' expectations for crude oil, from 2004 to 2009. Depending on the bubble period in the stock market, it appears that the resulting coupling becomes

subject to the deterioration of global economic activity, induced by large common shocks.

Measuring demand responses to wholesale electricity prices using market power indices

- Energy Economics---2016---Talat Genc

We investigate wholesale demand response to hourly price movements in the Ontario wholesale electricity market using detailed generator and market level data. We calculate hourly market power measures such as the Lerner Index and the Residual Supplier Index, which are utilized in a Cournot competition model to structurally estimate price elasticity of demand during peak hours of days, seasons and years. We find that price elasticities are small and statistically significant, and they exhibit large variations over the times of days/seasons and show differences over the years. For instance, while the elasticity estimates fall into the range $[-0.021, -0.133]$ in 2007, they are in the interval of $[-0.013, -0.053]$ in 2008. We also extend the study period to include 2006 (during which extreme weather conditions occurred) and 2009 (when the economic crisis hit and natural gas prices plummeted) to measure the demand responses to irregular price movements and find that price elasticities during the economic crisis were higher than a year earlier. Comparing high demand winter hours to high demand summer hours indicates that consumers' price responsiveness is lower in summer than in winter during 2006–2009. Moreover, we employ these indices along with the estimated price elasticities to project the likely impact of interconnection capacity expansions on market prices. Our calibrations show that even a small amount of transmission investment (and hence trade activity) can result in substantial market price reductions. In addition, we discuss how our approach could be used to estimate price elasticities for other goods such as crude oil and gasoline.

The political drivers of renewable energies policies

- Energy Economics---2016---Isabelle Cadoret, Fabio Padovano

This paper empirically analyzes how political factors affect the deployment of renewable energy (RE) sources and compares their explanatory power to that of other economic, energy and environmental drivers that have received greater attention in the literature so far. The sample encompasses the EU countries bound to attain the target of 20% share of gross final energy consumption by 2020. The panel data analysis shows that lobbying by the manufacturing industry negatively affects RE deployment, whereas standard measures of government quality show a positive effect; furthermore, left-wing parties promote the deployment of RE more than right-wing parties.

Marginal Rate of Transformation and Rate of Substitution measured by DEA environmental assessment: Comparison among European and North American nations

- Energy Economics---2016---Toshiyuki Sueyoshi,Yan Yuan

This study discusses the new use of DEA (Data Envelopment Analysis) environmental assessment to measure MRT (Marginal Rate of Transformation) and RS (Rate of Substitution) among production factors (e.g., inputs, desirable and undesirable outputs). To measure the degree on MRT and RS, this study first examines a concept of disposability from the perspective of economic strategies to combat various environmental issues. The strategies are extendable to a policy change for pollution prevention. The underlying concept is separated into natural and managerial disposability. Under managerial disposability, it is possible for us to measure an occurrence of desirable congestion, or eco-technology innovation. Considering the disposability concept, this study discusses how to measure the type and magnitude of MRT and RS. A problem of the MRT & RS measurement is that these measures usually become unstable (e.g., very large or small in these magnitudes) because DEA does not assume any functional form for economic activities. To overcome such a difficulty, this study equips DEA environmental assessment with multiplier restriction by utilizing a unique feature on a proposed data treatment. The multiplier restriction in

DEA has been never explored in previous works on environmental assessment. In an application, this study finds three important economic concerns on Europe and North America. First, Western Europe outperforms Eastern Europe and North America in their unified efficiency measures under managerial disposability. This study statistically confirms a difference between Western and Eastern Europe, but not between Western Europe and North America. This result exhibits that Eastern Europe is not yet well developed at the level of the other two regions. Second, Eastern Europe has exhibited MRT estimates that are different from Western Europe and North America. The nations in Eastern Europe have an economic potential for industrial developments because the level of their industrial pollutions is less than that of the other two regions. The potential is also found in their MRT estimates. Finally, an interesting difference can be found in the RS estimate between Eastern Europe and Western Europe from 2008 to 2012. They have statistically exhibited a difference between the two regimes, but not with North America. This is because most nations in both Western Europe and North America have already attained a high level of economic successes so that they have a limited industrial potential under current production technology and eco-technology. The situation of the two regions will be changed along with new technology development. In contrast, Eastern Europe is different from the other two regions in terms of attaining such a level of social sustainability because of limited capital accumulation and limited opportunity for technology innovation.

Returns to damage under undesirable congestion and damages to return under desirable congestion measured by DEA environmental assessment with multiplier restriction: Economic and energy planning for social sustainability in China

- Energy Economics---2016---Toshiyuki Sueyoshi,Yan Yuan

This study discusses the concept of natural and managerial disposability from their economic and method-

ological implications on social sustainability development. Then, it explores their analytical linkages to a concept on “congestion.” The concept is classified into Undesirable Congestion (UC) under natural disposability and Desirable Congestion (DC) under managerial disposability. Considering the two disposability concepts, this study compares between Returns to Damage (RTD) under UC and Damages to Return (DTR) under DC. Conceptually, UC and DC are conceptually different from RTD and DTR although they are closely related to each other group. An occurrence of the former measures is identified by a single negative multiplier (i.e. dual variable). In contrast, the latter measures are associated with multiple negative multipliers and an intercept of a supporting hyperplane on a production and pollution possibility set. Thus, an occurrence of UC and DC is a necessary condition, but not a sufficient condition on RTD and DTR, respectively, in terms of the number of negative multipliers on production factors. To document the practicality of the proposed approach, this study applies it to Chinese economic and environmental assessment for its economic and energy planning for social sustainability development. This study identifies four important findings: First, the Chinese government has historically paid attention to the economic prosperity, but not paying serious attention on the environmental pollution (e.g., air pollution). Second, there was an increasing trend in improving the two components (i.e., economic and environmental performance measures) regarding social sustainability. Third, China’s economic and energy policy concerns have been focused upon well-developed municipalities (e.g., Beijing and Shanghai) and large provinces. Therefore, it is an important strategy for the government to allocate economic and energy resources to other provinces so that China can reduce the industrial and regional imbalances. As a result, China can enhance the level of social sustainability. Finally, the municipalities need strict regulation on traffic control in these metropolitan areas and a fuel mix shift from coal combustion to natural gas and renewable energies (e.g., solar, water, and nuclear generations). The fuel mix strategy, along with the structure change (e.g., from manufacturing to service and from public to

private energy firms), will be a major industrial policy issue for China in near future.

A robust model for the ramp-constrained economic dispatch problem with uncertain renewable energy

- Energy Economics---2016---M. Mohsen Moarefdoost, Alberto Lamadrid, Luis F. Zuluaga

The inherent uncertainty of renewable energy sources (RES) makes the solution to the electricity network’s associated economical dispatch (ED) problem with network constraints challenging. In particular, the uncertainty in the power output of RES requires conventional generation units to ramp up and down more frequently to maintain the power balance and the reliability of the system. Typically, the RES power output uncertainty is modeled in ED problems by considering its potential future scenarios. However, this leads to an optimization problem that is difficult to solve for real-sized networks. Here, we propose an alternative way of considering the uncertainty of RES and the consequent ramping of conventional generation via a robust reformulation of the problem. In particular, we show that in typical real-world instances of the ED problem, the associated deterministic formulation of the robust problem can be solved efficiently for larger scale constrained electricity networks even when the underlying uncertainty distribution is not normal. Moreover, we show that our approach results on dispatch solutions that require less ramping than scenario-based solutions, with little trade-off on the long-term expected costs of the network dispatch. These results also provide insights about how RES penetration affects cost and dispatch policies in the electricity network. To illustrate our results, we present relevant numerical experiments on IEEE test networks.

Consumer governance in electricity markets

- Energy Economics---2016---Toby Daglish

This paper examines switching decisions by households in the MainPower distribution area of New Zealand. The paper measures the extent to which customers

switch retailers following the release of information about directors' bonuses, marketing surrounding firm ownership, and work by the New Zealand Electricity Authority to promote transparency of the switching process. We document strong customer inertia, which, for some consumers, has reduced following the Electricity Authority's interventions. Customer movements following information releases and marketing campaigns are modest, suggesting that prices and inertia may be the most important drivers of customer migration.

Predicting the oil prices: Do technical indicators help?

- Energy Economics---2016---Libo Yin, Qingyuan Yang

This paper aims to investigate the predictability of technical indicators to directly forecast oil prices and compare their performances with macroeconomic variables. We find that technical indicators do exhibit statistically and economically significant in-sample and out-of-sample forecasting power under OLS regressions and forecast combinations, clearly exceeding that of well-known macroeconomic variables and state-of-the-art oil-macro forecasting variables. Moreover, the strength of the predictive evidence is substantial during recessions and expansions and can detect the typical decline in the oil returns near business-cycle peaks effectively. Furthermore, technical indicators reveal substantial economic value for investors, in terms of superior oil risk premium forecasts and sizable utility gains. The technical indicators' ability to predict the oil price stems in part from its ability to predict changes in sentiment, suggesting the financialization of oil markets.

A re-examination of maturity effect of energy futures price from the perspective of stochastic volatility

- Energy Economics---2016---Wei-han Liu

This paper selects stochastic volatility (SV) as the uncertainty or volatility measure to re-examine the Samuelson hypothesis of maturity effect (SHME) (Samuelson, 1965). Stochastic dominance is used to

examine whether the stochastic volatility level dominates with respect to maturity. The empirical analyses of energy-futures price series generally provide mild support for this hypothesis in terms of the first two degrees of stochastic dominance. Each type of futures has its own properties with respect to the maturity effect. SV levels play a role in determining the testing outcome. The hypothesis is more likely to hold at low SV levels. The higher the volatility level, the less likely the SHME will hold because SV surges to its peak level regardless of maturity.

Disentangling the determinants of real oil prices

- Energy Economics---2016---Li Liu, Yudong Wang, Chongfeng Wu, Wenfeng Wu

In this study, we quantify the impacts of economic fundamentals and derivative market speculation on the real price of crude oil. Using a structural VAR with sign restriction, we determine that oil demand from the US and China, particularly the latter one, plays a crucial role in oil price changes after the year 2000. The contribution of speculation does not exceed 10% of oil price variations in our sample period.

On the dynamic dependence between equity markets, commodity futures and economic uncertainty indexes

- Energy Economics---2016---Theo Berger, Gazi Uddin

This paper provides a thorough analysis on multiscale dependence schemes between equity markets, commodity futures and uncertainty indexes. Based on decomposed return series, we provide an exhaustive survey on time varying dependence, before and after the outbreak of financial crisis.

An alternative semiparametric approach to the modelling of asymmetric gasoline price adjustment

- Energy Economics---2016---Michael Polemis, Mike Tsionas

In this paper we revisit the wholesale and retail gasoline price adjustments to fluctuations in the input cost prices for a monthly panel dataset of 48 US states over the period 1994 to 2011. In doing so, we employ for the first time in the empirical literature nonlinear semiparametric models with local Generalized Method of Moments (GMM) estimators. Our findings indicate that wholesale and retail gasoline prices adjust more rapidly in an upward than a downward direction, confirming the “rockets and feathers” hypothesis.

The deflationary effect of oil prices in the euro area

- Energy Economics---2016---César Castro,Miguel Jerez,Andrés Barge-Gil

The inflationary effect of oil price has been widely examined by academic literature. Nowadays, the main concern in the euro area (E.A.) is its deflationary effect. In this paper we propose a method to evaluate the effect of oil price changes on inflation as well as an indicator of inflation adjusted for the short-term effect of oil prices, which is aimed to assess the risk of deflation in real time. We illustrate the practical applications of these tools by predicting the evolution of inflation in the E.A., conditional to different scenarios of oil price deflation. Our main finding is that no deflationary scenario for oil prices results in a negative inflation rate forecast for December 2016, despite oil price variation accounting for 25% of the variance of changes in inflation.

Asymmetric volatility in European day-ahead power markets: A comparative microeconomic analysis

- Energy Economics---2016---Erkan Erdoğan

This paper uses high-frequency spot price data from fourteen wholesale electricity markets in Europe to analyze asymmetric volatility in European day-ahead power markets with Exponential GARCH (E-GARCH) and TARARCH models. Our data set ranges from 1992 to 2015 and consists of approximately 926,000 observations. As such, this paper constitutes the most extensive and comprehensive work conducted so far on

European power markets, to the best of our knowledge. Unlike most of the literature that treats price as a continuous variable and attempts to model its trajectory, this paper adopts a unique approach and regards each hour in a day a separate market. The results show, in post-2008 period, the most expensive electricity is consumed in Turkey, Ireland, and UK while the cheapest power is in Russia, Nordic countries, and Czech Republic. Russia, Poland, and Czech Republic have the least volatile markets while France, Ireland, and Portugal have the most volatile ones. Volatility has decreased in many European countries in post-2008 period. Besides, we find magnitude effect is usually larger than the leverage effect, meaning that the absolute value of price change is relatively more important than the sign of the change (whether it is an increase or a decrease) to explain volatility in European day-ahead power markets. Moreover, the results imply there is not a uniform inverse leverage effect in electricity prices; that is, price increases are more destabilizing in some European markets (e.g. Poland, Slovenia, Ireland, Netherlands) than comparable price decreases but vice versa also holds true in some other countries (e.g. Portugal and France). Leverage (or inverse leverage) effect in post-2008 period is relatively stronger in Portugal, France, and Ireland, but its impact is quite limited in Turkey and Germany. Furthermore, although the impact of seasonality on prices is obvious, a specific pattern cannot be identified. Finally, large changes in the volatility will affect future volatilities for a relatively longer period of time in Nordic countries, Ireland, and the UK while changes in current volatility will have less effect on future volatilities in Czech Republic, Russia, and Turkey.

Impact of network payment schemes on transmission expansion planning with variable renewable generation

- Energy Economics---2016---Diego Bravo,Enzo Sauma,Javier Contreras,Sebastián de la Torre,José A. Aguado,David Pozo

A large number of studies have dealt with the Transmission Expansion Planning (TEP) problem. However, few

investigations have focused on analyzing the impacts of network payment schemes on network configuration and the benefits/losses distribution among the participants in electricity markets. In this paper, we propose a multi-annual transmission expansion planning model considering four different network payment schemes to finance the construction of new transmission lines, seeking to reduce the total system costs. Wind and solar power generation are included in the model taking into account their variability. The proposed models are reformulated as Mixed Integer Linear Programming (MILP) problems. We use seven performance metrics related with congestion, nodal prices and generator benefits, among others, to evaluate the effect of each payment scheme. A realistic case study based on the main power system in Chile is analyzed to illustrate the proposed models. It is shown that integrating line cost-recovering equations into the TEP model may result into a more realistic and less congested power network. Also, total system cost is highly related with transmission tariff discrimination. In that way, tariffs with high location dependence perform better in the case studied, the Chilean power system.

Energy caps: Alternative climate policy instruments for China?

- Energy Economics---2016---Valerie J. Karplus, Sebastian Rausch, Da Zhang

Decoupling fossil energy demand from economic growth is crucial for China's sustainable development, especially for addressing severe local air pollution and global climate change. An absolute cap on coal or fossil fuel consumption has been proposed as a means to support the country's energy and climate policy objectives. We evaluate potential energy cap designs that differ in terms of target fuel, point of control, and national versus regional allowance trading using a global numerical general equilibrium model that separately represents 30 provinces in China. First, we simulate a coal cap and find that relative to a cap on all fossil fuels, it is significantly more costly and results in high localized welfare losses. Second, we compare fossil energy cap designs and find that a national cap on downstream fossil

energy use with allowance trading across provinces is the most cost effective. Third, we find that a national fossil energy cap with trading is nearly as cost effective as a national CO₂ emissions trading system that penalizes energy use based on carbon content. As a fossil energy cap builds on existing institutions in China, it offers a viable intermediate step toward a full-fledged CO₂ emissions trading system.

The long-term trends on the electricity markets: Comparison of empirical mode and wavelet decompositions

- Energy Economics---2016---Dmitriy Afanasyev, Elena A. Fedorova

This paper proposes an improved approach to electricity prices trend-cyclical component filtering, which is based on the complete ensemble empirical mode decomposition with adaptive noise (CEEMDAN). A combined criterion for determining the modes to be included into the trend component is introduced. The performance of the proposed approach is compared with the ordinary empirical mode decomposition (EMD), as well as with the method of wavelet-decomposition well-known in the energy economics literature. We test it on four day-ahead electricity markets: the Europe-Ural and the Siberia price zones of the Russian ATS exchange, the PJM exchange of the USA and the APX exchange of the United Kingdom. Our results show that the proposed approach based on CEEMDAN and the combined criterion outperforms the standard EMD on all the four electricity markets, and on two of the studied markets (PJM, APX) it outperforms the wavelet-smoothing, while on the other two (ATS Europe-Ural and Siberia) it performs at least not worse than the wavelet-smoothing. At the same time, the proposed approach does not require a prior choice of the smoothing parameter, as in the case of the wavelet-decomposition, and demonstrates a certain degree of versatility on the studied markets.

Estimating the willingness to pay for reliable electricity supply: A choice experiment study

- Energy Economics---2016---Aygul Ozbafli, Glenn Jenkins

This research examines households' willingness to pay (WTP) for an improved electricity service. Households' stated WTP is estimated using the choice experiment (CE) method. The data used in the estimations come from 350 in-person interviews conducted during the period 5–22 August 2008 in North Cyprus. Compensating variation (CV) estimates for a zero-outage scenario are calculated using the parameter estimates from the mixed logit (ML) model; these are 6.65 YTL (Turkish lira) per month (3.02 USD) for summer and 25.83 YTL per month (11.74 USD) for winter. In order to avoid the cost of outages, households are willing to incur a 3.6% and a 13.9% increase in their monthly electricity bill for summer and winter, respectively. The WTP per hour unserved is 0.28 YTL (0.13 USD) for summer, and 1.08 YTL (0.49 USD) for winter. A preliminary cost–benefit analysis indicates that the annualized economic benefits are approximately 42.7 million YTL (19.4 million USD) for the residential sector. This would justify an investment in additional generation capacity of approximately 268MW, which is far more than that which is needed to eliminate the service reliability problem.

The relationships between petroleum and stock returns: An asymmetric dynamic equi-correlation approach

- Energy Economics---2016---Zhiyuan Pan, Yudong Wang, Li Liu

In this paper, we propose an asymmetric dynamic equi-correlation (ADECO) model to investigate the correlations between returns of petroleum futures and stock indices. Our ADECO reveals the in-sample significant asymmetric effect in oil–stock correlations. To evaluate out-of-sample performance, we consider a portfolio with petroleum futures and stocks in which the weights are determined by forecasts of covariance matrix. We find

that ADECO provides portfolios with better performances than existing popular DECO, DCC and ADCC models in the minimum-variance framework. Moreover, energy price risk can be better hedged by stocks in oil-exporting countries than stocks in oil-importing countries. Our findings are further demonstrated to be robust to the change of futures maturity.

Energy populism and household welfare

- Energy Economics---2016---Pedro Hancevic, Walter Cont, Fernando Navajas

Inspired on experiences observed in certain developing countries, we propose a simple model to explain the emergence of a class of subsidized energy price cycles. It exploits the use of median household's preferences for receiving transfer gains followed by future transfer losses. In our empirical application, we use data on natural gas and electricity prices, taxes, energy consumption, and household characteristics for the Buenos Aires Metropolitan Region during the 2003–2014 period. We provide detailed estimates of the actual transfers, their middle- to high-income bias and the corresponding effects on the level and stability of household welfare of a departure of energy prices from opportunity costs.

Measuring total-factor CO2 emission performance and technology gaps using a non-radial directional distance function: A modified approach

- Energy Economics---2016---Qunwei Wang, Bin Su, Peng Zhou, Ching-Ren Chiu

Implementing the “common but differentiated responsibilities” principle for CO2 mitigation requires an understanding of CO2 emission performance and technology gaps in different countries. This paper uses a meta-frontier and non-radial directional distance function to propose an alternative three stage approach to measure total-factor CO2 emission performance and technology gaps. The first stage calculates the CO2 emission performance of the group frontier. The second stage uses these results to calculate the technology gap ratio. The third stage integrates data from the first two

stages to calculate CO₂ emission performance under the meta-frontier. This approach is easier to apply than other approaches in the literature, and effectively avoids the phenomenon of the technology gap ratio being greater than unity. The proposed approach can also decompose CO₂ emission performance loss into two categories: management inefficiency and technical gaps. To demonstrate the method, an empirical analysis using data for 54 countries was conducted. The study highlighted three main findings. First, upper-middle income countries did not perform as well as high income countries and lower-middle income countries. Second, high income countries generally enjoy optimized production technology, whereas the lower-middle income countries generally had the lowest technological levels. Third, both management inefficiency and technical gaps negatively impacted CO₂ emission performance, but management inefficiency played a dominant role.

Inter-factor/inter-fuel substitution, carbon intensity, and energy-related CO₂ reduction: Empirical evidence from China

- Energy Economics---2016---Jianglong Li,Boqiang Lin

Carbon dioxide (CO₂) reduction, which is the central issue in addressing global warming, depends on the extent that clean energy can substitute for CO₂ emitting coal and non-energy factors can substitute for energy factor. The purposes of this paper are to empirically investigate inter-factor/inter-fuel substitution in China and to evaluate the determinants of China's energy-related carbon intensity as well as mitigation effects of carbon tax. Considering China's rapid increase in energy consumption and the slow adjustment in substitution, the two-stage estimation method and the dynamic error correction mechanism are employed in this study. The empirical results suggest substitutability among different types of energy sources as well as substitutability among energy, labor, and capital. The magnitude of cross-price elasticities indicates that the substitutions are inelastic, which limits the scope of the Chinese government to implement substitution strategy aiming at energy conservation and environ-

mental management. China's carbon intensity declined during 1985–2012, most of which can be attributed to labor substitution and energy price increase. However, carbon-intensive technology being embodied in China's capital investment (energy consuming equipment) has contributed to the increase in carbon intensity. A carbon tax of RMB 50/tonne could reduce 332.9 million tonnes CO₂ emissions on the basis of 2012. In addition, if ignoring the feedback between inter-factor/inter-fuel substitutions, CO₂ mitigation potential would be underestimated.

Baseline projections for Latin America: base-year assumptions, key drivers and greenhouse emissions

- Energy Economics---2016---Bas van Ruijven,Katie Daenzer,Karen Fisher-Vanden,Tom Kober,Sergey Paltsev,Robert Beach,Silvia Liliana Calderon,Kate Calvin,Maryse Labriet,Alban Kitous,André F.P. Lucena,Detlef P. van Vuuren

This paper provides an overview of the base-year assumptions and baseline projections for the set of models participating in the LAMP and CLIMACAP projects. We present the range in baseline projections for Latin America, and identify key differences between model projections including how these projections compare to historic trends. We find relatively large differences across models in base year assumptions related to population, GDP, energy and CO₂ emissions due to the use of different data sources, but also conclude that this does not influence the range of projections. We find that population and GDP projections across models span a broad range, comparable to the range represented by the set of Shared Socioeconomic Pathways (SSPs). Kaya-factor decomposition indicates that the set of baseline scenarios mirrors trends experienced over the past decades. Emissions in Latin America are projected to rise as a result of GDP and population growth and a minor shift in the energy mix toward fossil fuels. Most scenarios assume a somewhat higher GDP growth than historically observed and continued decline of population growth. Minor changes in energy intensity or energy mix are projected over the next few

decades.

Long-term abatement potential and current policy trajectories in Latin American countries

- Energy Economics---2016---Leon Clarke,James McFarland,Claudia Octaviano,Bas van Ruijven,Robert Beach,Kathryn Daenzer,Sara Her-reras Martínez,André F.P. Lucena,Alban Kitous,Maryse Labriet,Ana Maria Loboguerrero Rodríguez,Anupriya Mundra,Bob van der Zwaan

This paper provides perspectives on the role of Latin American and Latin American countries in meeting global abatement goals, based on the scenarios developed through the CLIMACAP–LAMP modeling study. Abatement potential in Latin America, among other things, is influenced by its development status, the large contributions of non-CO₂ and land use change CO₂ emissions, and energy endowments. In most scenarios in this study, the economic potential to reduce fossil fuel CO₂ as well as non-CO₂ emissions in Latin America in 2050 is lower than in the rest of the world (in total) when measured against 2010 emissions, due largely to higher emission growth in Latin America than in the rest of the world in the absence of abatement. The potential to reduce land use change CO₂ emissions is complicated by a wide range of factors and is not addressed in this paper (land use emissions are largely addressed in a companion paper). The study confirms the results of previous research that the variation in abatement costs across models may vary by an order of magnitude or more, limiting the value of these assessments and supporting continued calls for research on the degree to which models are effectively representing key local circumstances that influence costs and available abatement options. Finally, a review of policies in place in several Latin American countries at the time of this writing finds that they would be of varying success in meeting the emission levels proposed by the most recent IPCC reports to limit global temperature change to 2°C.

Energy technology roll-out for climate change mitigation: A multi-model study for Latin America

- Energy Economics---2016---Bob van der Zwaan,Tom Kober,Silvia Calderon,Leon Clarke,Katie Daenzer,Alban Kitous,Maryse Labriet,André F.P. Lucena,Claudia Octaviano,Nicolas Di Sbroiavacca

In this paper we investigate opportunities for energy technology deployment under climate change mitigation efforts in Latin America. Through several carbon tax and CO₂ abatement scenarios until 2050 we analyze what resources and technologies, notably for electricity generation, could be cost-optimal in the energy sector to significantly reduce CO₂ emissions in the region. By way of sensitivity test we perform a cross-model comparison study and inspect whether robust conclusions can be drawn across results from different models as well as different types of models (general versus partial equilibrium). Given the abundance of biomass resources in Latin America, they play a large role in energy supply in all scenarios we inspect. This is especially true for stringent climate policy scenarios, for instance because the use of biomass in power plants in combination with CCS can yield negative CO₂ emissions. We find that hydropower, which today contributes about 800 TWh to overall power production in Latin America, could be significantly expanded to meet the climate policies we investigate, typically by about 50%, but potentially by as much as 75%. According to all models, electricity generation increases exponentially with a two- to three-fold expansion between 2010 and 2050. We find that in our climate policy scenarios renewable energy overall expands typically at double-digit growth rates annually, but there is substantial spread in model results for specific options such as wind and solar power: the climate policies that we simulate raise wind power in 2050 on average to half the production level that hydropower provides today, while they raise solar power to either a substantially higher or a much lower level than hydropower supplies at present, depending on which model is used. Also for CCS we observe large diversity in model outcomes, which reflects the uncertainties with regard to

its future implementation potential as a result of the challenges this CO₂ abatement technology experiences. The extent to which different mitigation options can be used in practice varies greatly between countries within Latin America, depending on factors such as resource potentials, economic performance, environmental impacts, and availability of technical expertise. We provide concise assessments of possible deployment opportunities for some low-carbon energy options, for the region at large and with occasional country-level detail in specific cases.

A multi-model study of energy supply investments in Latin America under climate control policy

- Energy Economics---2016---Tom Kober,James Falzon,Bob van der Zwaan,Katherine Calvin,Amit Kanudia,Alban Kitous,Maryse Labriet

In this paper we investigate energy supply investment requirements in Latin America until 2050 through a multi-model approach as jointly applied in the CLIMACAP-LAMP research project. We compare a business-as-usual scenario needed to satisfy anticipated future energy demand with a set of scenarios that aim to significantly reduce CO₂ emissions in the region. We find that more than a doubling of annual investments, in absolute terms, occurs in the business-as-usual scenario between 2010 and 2050, while investments may treble over the same time horizon when climate policies are introduced. Investment costs as share of GDP, however, decline over time in the business-as-usual scenario as well as the climate policy scenarios, as a result of the fast economic growth of the region. In the business-as-usual scenario, cumulative investments of 1.4 trillion US\$ are anticipated between 2010 and 2050 in electricity supply. These investments increase when additional climate policies are introduced: under a carbon tax of 50 \$/tCO₂e in 2020 growing with a rate of 4%/yr, an additional 0.6 trillion US\$ (+45%) of cumulative investment is needed. Climate control measures lead to increased investment in low-carbon electricity technologies, primarily based on wind and solar resources, as well as CCS applied to fossil fuels

and biomass. Our analysis suggests that, in comparison to the business-as-usual case, an average additional 21 billion US\$/yr of electricity supply investment is required in Latin America until 2050 under a climate policy aiming at 2°C climate stabilisation. Conversely, there is a disinvestment in fossil fuel extraction and transformation. For oil production, a growth to 130 billion US\$ annual investment by 2050 is anticipated in a business-as-usual scenario. Ambitious climate policy reduces this to 28 billion US\$. Mobilising the necessary additional investment capital, in particular for low-carbon energy technologies, will be a challenge. Suitable frameworks and enabling environments for a scale-up of public and private investment will be critical to help reach the required low-carbon energy deployment levels.

Emissions reduction scenarios in the Argentinean Energy Sector

- Energy Economics---2016---Nicolás Di Sbroiavacca,Gustavo Nadal,Francisco Lallana,James Falzon,Katherine Calvin

In this paper the LEAP, TIAM-ECN, and GCAM models were applied to evaluate the impact of a variety of climate change control policies (including carbon pricing and emission constraints relative to a base year) on primary energy consumption, final energy consumption, electricity sector development, and CO₂ emission savings of the energy sector in Argentina over the 2010–2050 period. The LEAP model results indicate that if Argentina fully implements the most feasible mitigation measures currently under consideration by official bodies and key academic institutions on energy supply and demand, such as the ProBiomass program, a cumulative incremental economic cost of 22.8 billion US\$(2005) to 2050 is expected, resulting in a 16% reduction in GHG emissions compared to a business-as-usual scenario. These measures also bring economic co-benefits, such as a reduction of energy imports improving the balance of trade. A Low CO₂ price scenario in LEAP results in the replacement of coal by nuclear and wind energy in electricity expansion. A High CO₂ price leverages additional investments in hydropower.

By way of cross-model comparison with the TIAM-ECN and GCAM global integrated assessment models, significant variation in projected emissions reductions in the carbon price scenarios was observed, which illustrates the inherent uncertainties associated with such long-term projections. These models predict approximately 37% and 94% reductions under the High CO₂ price scenario, respectively. By comparison, the LEAP model, using an approach based on the assessment of a limited set of mitigation options, predicts an 11.3% reduction. The main reasons for this difference include varying assumptions about technology cost and availability, CO₂ storage capacity, and the ability to import bioenergy. An emission cap scenario (2050 emissions 20% lower than 2010 emissions) is feasible by including such measures as CCS and Bio CCS, but at a significant cost. In terms of technology pathways, the models agree that fossil fuels, in particular natural gas, will remain an important part of the electricity mix in the core baseline scenario. According to the models there is agreement that the introduction of a carbon price will lead to a decline in absolute and relative shares of aggregate fossil fuel generation. However, predictions vary as to the extent to which coal, nuclear and renewable energy play a role.

Climate policy scenarios in Brazil: A multi-model comparison for energy

- Energy Economics---2016---André F.P. Lucena, Leon Clarke, Roberto Schaeffer, Alexandre Szklo, Pedro R.R. Rochedo, Larissa P.P. Nogueira, Kathryn Daenzer, Angelo Gurgel, Alban Kitous, Tom Kober

This paper assesses the effects of market-based mechanisms and carbon emission restrictions on the Brazilian energy system by comparing the results of six different energy-economic or integrated assessment models under different scenarios for carbon taxes and abatement targets up to 2050. Results show an increase over time in emissions in the baseline scenarios due, largely, to higher penetration of natural gas and coal. Climate policy scenarios, however, indicate that such a pathway can be avoided. While taxes up to 32US\$/tCO₂e do

not significantly reduce emissions, higher taxes (from 50US\$/tCO₂e in 2020 to 162US\$/tCO₂e in 2050) induce average emission reductions around 60% when compared to the baseline. Emission constraint scenarios yield even lower reductions in most models. Emission reductions are mostly due to lower energy consumption, increased penetration of renewable energy (especially biomass and wind) and of carbon capture and storage technologies for fossil and/or biomass fuels. This paper also provides a discussion of specific issues related to mitigation alternatives in Brazil. The range of mitigation options resulting from the model runs generally falls within the limits found for specific energy sources in the country, although infrastructure investments and technology improvements are needed for the projected mitigation scenarios to achieve actual feasibility.

Achieving CO₂ reductions in Colombia: Effects of carbon taxes and abatement targets

- Energy Economics---2016---Silvia Calderón, Andrés Camilo Alvarez, Ana María Loboguerrero, Santiago Arango, Katherine Calvin, Tom Kober, Kathryn Daenzer, Karen Fisher-Vanden

In this paper we investigate CO₂ emission scenarios for Colombia and the effects of implementing carbon taxes and abatement targets on the energy system. By comparing baseline and policy scenario results from two integrated assessment partial equilibrium models TIAM-ECN and GCAM and two general equilibrium models Phoenix and MEG4C, we provide an indication of future developments and dynamics in the Colombian energy system. Currently, the carbon intensity of the energy system in Colombia is low compared to other countries in Latin America. However, this trend may change given the projected rapid growth of the economy and the potential increase in the use of carbon-based technologies. Climate policy in Colombia is under development and has yet to consider economic instruments such as taxes and abatement targets. This paper shows how taxes or abatement targets can achieve significant CO₂ reductions in Colombia.

Though abatement may be achieved through different pathways, taxes and targets promote the entry of cleaner energy sources into the market and reduce final energy demand through energy efficiency improvements and other demand-side responses. The electric power sector plays an important role in achieving CO₂ emission reductions in Colombia, through the increase of hydropower, the introduction of wind technologies, and the deployment of biomass, coal and natural gas with CO₂ capture and storage (CCS). Uncertainty over the prevailing mitigation pathway reinforces the importance of climate policy to guide sectors toward low-carbon technologies. This paper also assesses the economy-wide implications of mitigation policies such as potential losses in GDP and consumption. An assessment of the legal, institutional, social and environmental barriers to economy-wide mitigation policies is critical yet beyond the scope of this paper.

Pathways to Mexico' s climate change mitigation targets: A multi-model analysis

- Energy Economics---2016---Jason Veysey,Claudia Octaviano,Katherine Calvin,Sara Herreras Martinez,Alban Kitous,James McFarland,Bob van der Zwaan

Mexico' s climate policy sets ambitious national greenhouse gas (GHG) emission reduction targets—30% versus a business-as-usual baseline by 2020, 50% versus 2000 by 2050. However, these goals are at odds with recent energy and emission trends in the country. Both energy use and GHG emissions in Mexico have grown substantially over the last two decades. We investigate how Mexico might reverse current trends and reach its mitigation targets by exploring results from energy system and economic models involved in the CLIMACAP-LAMP project. To meet Mexico' s emission reduction targets, all modeling groups agree that decarbonization of electricity is needed, along with changes in the transport sector, either to more efficient vehicles or a combination of more efficient vehicles and lower carbon fuels. These measures reduce GHG emissions as well as emissions of other air pollutants. The models find different energy supply pathways, with

some solutions based on renewable energy and others relying on biomass or fossil fuels with carbon capture and storage. The economy-wide costs of deep mitigation could range from 2% to 4% of GDP in 2030, and from 7% to 15% of GDP in 2050. Our results suggest that Mexico has some flexibility in designing deep mitigation strategies, and that technological options could allow Mexico to achieve its emission reduction targets, albeit at a cost to the country.

Climate change policy in Brazil and Mexico: Results from the MIT EPPA model

- Energy Economics---2016---Claudia Octaviano,Sergey Paltsev,Angelo Gurgel

Based on an in-depth analysis of results from the MIT Economic Projection and Policy Analysis (EPPA) model of climate policies for Brazil and Mexico, we demonstrate that commitments by Mexico and Brazil for 2020—made during the UN climate meetings in Copenhagen and Cancun—are reachable, but they come at different costs for each country. We find that Brazil's commitments will be met through reduced deforestation, and at no additional cost; however, Mexico's pledges will cost 4 billion US dollars in terms of reduced GDP in 2020. We explore short- and long-term implications of several policy scenarios after 2020, considering current policy debates in both countries. The comparative analysis of these two economies underscores the need for climate policy designed for the specific characteristics of each country, accounting for variables such as natural resources and current economic structure. Our results also suggest that both Brazil and Mexico may face other environmental and economic impacts from stringent global climate policies, affecting variables such as the value of energy resources in international trade.

Agriculture, forestry, and other land-use emissions in Latin America

- Energy Economics---2016---Katherine V. Calvin,Robert Beach,Angelo Gurgel,Maryse Labriet,Ana Maria Loboguerrero Rodriguez

Nearly 40% of greenhouse gas (GHG) emissions in Latin America were from agriculture, forestry, and other land use (AFOLU) in 2008, more than double the global fraction of AFOLU emissions. In this article, we investigate the future trajectory of AFOLU GHG emissions in Latin America, with and without efforts to mitigate, using a multi-model comparison approach. We find significant uncertainty in future emissions with and without climate policy. This uncertainty is due to differences in a variety of assumptions including (1) the role of bioenergy, (2) where and how bioenergy is produced, (3) the availability of afforestation options in climate mitigation policy, and (4) N₂O and CH₄ emission intensity. With climate policy, these differences in assumptions can lead to significant variance in mitigation potential, with three models indicating reductions in AFOLU GHG emissions and one model indicating modest increases in AFOLU GHG emissions.

Macroeconomic impacts of climate change mitigation in Latin America: A cross-model comparison

- Energy Economics---2016---Tom Kober, Philip Summerton, Hector Pollitt, Unnada Chempreecha, Xiaolin Ren, William Wills, Claudia Octaviano, James McFarland, Robert Beach, Yongxia Cai, Silvia Calderon, Karen Fisher-Vanden, Ana Maria Loboguerrero Rodriguez

In this paper we analyse macroeconomic consequences of greenhouse gas emission mitigation in Latin America up to 2050 through a multi-model comparison approach undertaken in the context of the CLIMACAP-LAMP research project. We compare two carbon tax scenarios with a business-as-usual scenario of anticipated future energy demand. In the short term, with carbon prices reaching around \$15/tCO₂ by 2030, most models agree that the reduction in consumer spending, as a proxy for welfare, is limited to about 0.3%. By 2050, at carbon prices of \$165/tCO₂, there is much more divergence in the estimated impact on consumer spending as well as GDP across models and regions, which reflects uncertainties about technology costs and substitution opportunities between technologies. We observe that

the consequences of increasingly higher carbon prices, in terms of reduced consumer spending and GDP, tend to be fairly linear with the carbon price in our CGE models. However, the consequences are divergent and nonlinear in our econometric model, that is linked to an energy system model that simulates step-changes in technology substitution. The results of one model show that climate policy measures can have positive effects on consumer spending and GDP, which results from an investment stimulus and the redistribution of carbon price revenues to consumers.

Volatility and a century of energy markets dynamics

- Energy Economics---2016---Apostolos Serletis, Libo Xu

How similar is the price behavior of oil, natural gas, and coal? Are there any interactions among these three fuel prices and their volatilities? Using the Yatchew and Dimitropoulos (2016) annual data for the United States, over the period from 1870 to 2014, and state-of-the-art econometric methodology, we explore for spillovers and interactions among the three energy markets. In doing so, we use a range of univariate and multivariate volatility models. The key contribution to the literature is the estimation of a trivariate BEKK model that allows for the interdependence of oil, natural gas, and coal returns and volatilities, using the longest span prices that have ever been studied before.

Another perspective on gasoline price responses to crude oil price changes

- Energy Economics---2016---Sajjadur Rahman

The effects of oil price volatility on the responses of gasoline prices to oil price shocks have received little attention in discussions on the relationship between the prices of crude oil and gasoline. In this paper we consider such effects by using a bivariate structural vector autoregression which is modified to accommodate GARCH-in-mean errors. Our measure of oil price volatility is the conditional variance of the oil price-change forecast error. We isolate the effects of

volatility in the price of oil on the price of gasoline and employ simulation methods to calculate nonlinear impulse response functions (NIRFs) to trace any asymmetric effects of independent oil price shocks on the conditional means of gasoline prices. We test whether the relationship between the prices of crude oil and gasoline is symmetric using tests of the null hypothesis of symmetric impulse responses. Based on monthly U.S. data over the period from 1978:1 to 2014:11, our empirical results show that gasoline prices respond asymmetrically to positive and negative oil price shocks. We also find that oil price volatility has a positive effect on the price of gasoline and it contributes to the asymmetries in the transmission of oil price shocks.

Biofuel-related price transmission using Renewable Identification Number prices to signal mandate regime

- Energy Economics---2016---Jarrett Whistance, David Ripplinger, Wyatt Thompson

This paper improves on existing methods of testing price links between biofuels, petroleum, petroleum products, and agricultural commodity feedstocks by incorporating information contained in the prices of Renewable Identification Numbers (RINs) that are used for biofuel mandate compliance. Theoretical equations are developed to show the role RIN prices can play in the relationships among energy, biofuel, and agricultural commodity prices. RIN price data are used (a) to infer values of fuels where market data are unavailable and (b) to define binding and non-binding mandate regimes. A specific empirical exercise exploits the RIN price data to conduct cointegration tests on high frequency data representing spot and futures prices relating to ethanol and biodiesel from February 2009 through March 2015, finding little evidence of short-term biofuel and petroleum product substitution during this period.

The heterogeneity dependence between crude oil price changes and industry stock market returns in China: Evidence from a quantile regression approach

- Energy Economics---2016---Huiming Zhu, Yawei Guo, Wanhai You, Yaqin Xu

This paper explores the dependence between real crude oil price changes and Chinese real industry stock market returns based on the monthly data from 1994/03 to 2014/06. We address this issue using the quantile regression approach, enabling a more detailed investigation of structure and degree of dependence. Empirical results reveal that the reaction of market returns to crude oil is highly heterogeneous across conditional distribution of industry stock returns. Furthermore, there is evidence that this dependence is positive and exists only in recessions or bearish markets with low expected returns. The dependence at low quantiles is not limited to one market, but is a common feature across industries. Additionally, dependence also changes since the onset of structural breaks. We determine that Chinese industry stock and global crude oil markets have contagion in rare situations. Most cases do not demonstrate contagion.

Energy efficiency in Swedish industry

- Energy Economics---2016---Shanshan Zhang, Tommy Lundgren, Wenchao Zhou

This paper assesses energy efficiency in Swedish industry. Using unique firm-level panel data covering the years 2001–2008, the efficiency estimates are obtained for firms in 14 industrial sectors by using data envelopment analysis (DEA). The analysis accounts for multi-output technologies where undesirable outputs are produced alongside with the desirable output. The results show that there was potential to improve energy efficiency in all the sectors and relatively large energy inefficiencies existed in small energy-use industries in the sample period. Also, we assess how the EU ETS, the carbon dioxide (CO₂) tax and the energy tax affect energy efficiency by conducting a second-stage regression analysis. To obtain consistent estimates for the

regression model, we apply a modified, input-oriented version of the double bootstrap procedure of Simar and Wilson (2007). The results of the regression analysis reveal that the EU ETS and the CO₂ tax did not have significant influences on energy efficiency in the sample period. However, the energy tax had a positive relation with the energy efficiency.

The role of globalization on the recent evolution of energy demand in India: Implications for sustainable development

- Energy Economics---2016---Muhammad Shahbaz, Hrushikesh Mallick, Mantu Mahalik, Perry Sadorsky

Using annual data for the period 1971–2012, this study explores the relationship between globalization and energy consumption for India by endogenizing economic growth, financial development and urbanization. The cointegration test proposed by Bayer–Hanck (2013) is applied to estimate the long-run and short-run relationships among the variables. After confirming the existence of cointegration, the overall results from the estimation of an ARDL energy demand function reveal that in the long run, the acceleration of globalization (measured in three dimensions — economic, social and overall globalization) leads to a decline in energy demand in India. Furthermore, while financial development is negatively related to energy consumption, economic growth and urbanization are the key factors leading to increased energy demand in the long run. These results have policy implications for the sustainable development of India. In particular, globalization and financial development provide a win–win situation for India to increase its economic growth in the long run and become more environmentally sustainable.

A strategic analysis of the New Brunswick, Canada fracking controversy

- Energy Economics---2016---O'Brien, Nicole L., Keith W. Hipel

Strategic insights into the previous conflict between the Elsipogtog First Nation and the New Brunswick

(NB) Provincial Government are presented using a formal conflict resolution technique. The conflict surrounds the prospect of widespread hydraulic fracturing in NB, one of Canada's Maritime provinces on the east coast of the country. The hydraulic fracturing technique, used for mining natural gas trapped in shale rock formations, has recently received much attention. The process is strongly opposed by some groups, including the Elsipogtog First Nation, primarily due to the potential environmental impacts associated with the technique. Through the application of the Graph Model for Conflict Resolution, it is found that the status quo at the time of the conflict was the most likely outcome in this conflict. The previous Conservative New Brunswick government had a great deal of power in this conflict and it had demonstrated its intention to develop the shale gas in the province in the face of much civil unrest. It is discovered, however, that there is a potential resolution to the conflict that will appease the residents of NB, if a moratorium is issued concerning hydraulic fracturing.

The impact of wind farm visibility on property values: A spatial difference-in-differences analysis

- Energy Economics---2016---Yasin Sunak, Reinhard Madlener

Today's investment decisions in large-scale onshore wind projects in Germany are no longer determined only by the investment's economic benefit, but also by concerns associated to social acceptance. Despite a mostly positive attitude towards the expansion of wind power, local public concerns often stem from the belief that the proximity to large-scale wind farms may lead to a decrease in property prices. In particular, the change in landscape caused by the construction of a wind farm may have an adverse impact on the view from some properties, and thus may negatively affect their price. To investigate the potential devaluation of properties in Germany due to wind farms, we use a quasi-experimental technique and apply a spatial difference-in-differences approach to various wind farm sites in the federal state of North Rhine-Westphalia.

We adopt a quantitative visual impact assessment approach to account for the adverse environmental effects caused by the wind turbines. To properly account for spatial dependence and unobserved variables biases, we apply augmented spatial econometric models. The estimates indicate that the asking price for properties whose view was strongly affected by the construction of wind turbines decreased by about 9–14%. In contrast, properties with a minor or marginal view on the wind turbines experienced no devaluation.

Uncertainty and crude oil returns

- Energy Economics---2016---Riadh Aloui,Rangan Gupta,Stephen Miller

We use a copula approach to investigate the effect of uncertainty on crude-oil returns. Using copulas to construct multivariate distributions of time-series data permit the calculation of the dependence structure between the series independently of the marginal distributions. Further, we implement the copula estimation using a rolling window method to allow for a time-varying effect of equity and economic policy uncertainty on oil returns. The results show that higher uncertainty, as measured by equity and economic policy uncertainty indices, significantly increase crude-oil returns only during certain periods of time. That is, we find a positive dependence prior to the financial crisis and Great Recession. Interestingly, estimation of the copula over the entire sample period leads to a negative dependence between the equity and economic policy indices and the crude-oil return.

Effects of construction activities on residential electricity consumption: Evidence from Singapore's public housing estates

- Energy Economics---2016---Sumit Agarwal,Rengarajan Satyanarain,Tien Foo Sing,Derek Vollmer

This study aims to empirically test the effects of negative environmental externalities (i.e. noise pollution) due to construction activities within half to one kilometer (km) radius and how households react to such

externalities by increasing the use of air-conditioners to mitigate noise from the construction work. We use a unique dataset of electricity consumption by public housing residents in Singapore measured at the building level and merge it with the dataset of construction sites for the periods from 2009 to 2011. Using a difference-in-differences approach, we find that electricity consumption by the households living close to the construction sites increases by 6% compared to the households who are not affected by noises from construction sites during the construction periods, after controlling for building and month of the year fixed effects. The results remain robust after controlling for spatial autocorrelated lag and error terms. The economic cost of the construction externalities for each household amounts to approximately S\$98 per annum. We also find that the increases in electricity consumption of the affected households were persistent, and the electricity consumption of the affected households did not revert to the pre-construction levels, after the removal of the negative externality.

A consistent two-factor model for pricing temperature derivatives

- Energy Economics---2016---Andreas Groll,Brenda López-Cabrera,Thilo Meyer-Brandis,Brenda López-Cabrera

In the past decade, the Chicago Mercantile Exchange began to trade weather derivatives to hedge weather risk. The pricing of weather derivatives is challenging since the underlying is not tradable and thus classical arbitrage approaches have to be used with caution. In typical pricing approaches all information available to the market is assumed to be incorporated in the underlying and thus forward-looking information about non-tradable assets such as meteorological forecasts is often ignored. In this article, we analyze a new pricing methodology for temperature derivatives that accounts for forward-looking information. More precisely, we provide an empirical back-up for the theoretical framework of so-called consistent factor models for temperature forecast curves introduced previously in the literature and put this pricing approach into prac-

tice. First, we perform a thorough statistical analysis of meteorological forecast curve data. Second, based on this analysis we propose a specific consistent two-factor model, derive explicit temperature derivative prices, and calibrate the market price of risk (MPR). The power of the model is demonstrated against alternative pricing models. This confirms that at least parts of the irregularity of the MPR observed in earlier studies are not due to irregular risk perception but rather due to information misspecification.

Marine trade-offs: Comparing the benefits of off-shore wind farms and marine protected areas

- Energy Economics---2016---Aljona Kar-lõševa,Sulev Nõmmann,Tea Nõmmann,Evelin Urbel-Piirsalu,Wiktor Budziński,Mikolaj Czajkowski,Nick Hanley

The drive to increase renewable electricity production in many parts of Europe has led to an increasing concentration of new wind energy sites at sea. This results in a range of environmental impacts which should be taken into account in a benefit–cost analysis of such proposals. In this paper, we use choice modeling to investigate the relative gains and losses from siting new windfarms off the coast of Estonia, relative to the option of creating a new marine protected area. We find that, while respondents are generally opposed to converting marine shoals to conventional wind farms and prefer the establishment of marine protected areas instead, benefits from constructing ‘environmentally-friendly’ wind farms – an alternative program which is also considered by the government – are not statistically different with respect to consumers’ welfare to those associated with creating a new marine protected area. Methodologically, the paper makes a contribution by showing the ability of the latent class mixed logit model to represent both within- and between-class preference heterogeneity, and thus its power to provide a more sophisticated representation of preference heterogeneity than stand-alone latent class or mixed logit approaches. The paper also presents the first use of the latent class mixed logit model in willingness-to-pay space for environmental goods.

Market efficiency and the U.S. market for sulfur dioxide allowances

- Energy Economics---2016---Claudia Hitaj,Andrew Stocking

Focusing on the U.S. sulfur dioxide (SO₂) allowance market from its inception in 1994 to 2009, we model allowance prices to determine the influence of market fundamentals on allowance price level and volatility. We find evidence that the SO₂ market operates in ways that are not inconsistent with an efficient market – prices that reflect marginal abatement costs – after the first few years of the program but before a court decision that introduced significant uncertainty into the market in mid-2008. Our empirical analysis finds that the SO₂ market, similar to other emission markets studied in the literature, can remain relatively inefficient for several years after launch. We also find that market volatility increases in response to all types of communications from the administrator, suggesting that the development of a formal communication strategy, possibly similar to that used by central banks, would reduce price volatility and increase the efficiency of the market.

The role of question format for the support for national climate change mitigation policies in Germany and the determinants of WTP

- Energy Economics---2016---Reinhard Uehleke

This contingent valuation survey examines the willingness to pay (WTP) for climate change mitigation in Germany. Willingness to pay is assessed by using a classic dichotomous choice referendum format and a two-way payment ladder in a split-sample design. We find that mean WTP under the referendum format is more than twice the WTP in the payment ladder format, but median WTP does not differ. Moreover, we test the possible effect of different determinants on WTP. Determinants that considerably influence WTP are personal norm, climate change scepticism, agreement with the German Renewable Energy Law and individualistic cognition. Income and gender are also important predictors.

Price regimes in an energy island: Tacit collusion vs. cost and network explanations

- Energy Economics---2016---Sandro Sapio,Nicola Spagnolo

In this paper, we explore the determinants of wholesale electricity prices in an energy island such as Sicily, by estimating regime switching models with fixed and time-varying transition probabilities on daily data in the 2012–2014 period. Explanatory variables used alternatively in the price equation and in the switching equation include power demand, the supply of intermittent renewables, the residual supply index, and a congestion indicator. Four competing hypotheses on the determinants of price regimes are tested (arbitrary market power, cost profile, tacit collusion, congestion) in order to understand why, despite the general trend of declining prices induced by renewables in southern Italy, Sicilian prices stood high. The pattern of estimated coefficients is consistent with a tacit collusion story.

Undesirable congestion under natural disposability and desirable congestion under managerial disposability in U.S. electric power industry measured by DEA environmental assessment

- Energy Economics---2016---Toshiyuki Sueyoshi,Mika Goto

This study discusses a new use of DEA environmental assessment to measure a possible occurrence of desirable congestion, or eco-technology innovation, in electric power plants. The phenomenon is compared with an occurrence of undesirable congestion in this study. The identification of undesirable congestion is important to avoid a cost increase and a shortage of generation. However, the identification of desirable congestion is much more important than that of undesirable congestion from the perspective of environmental assessment. This study looks for a sustainable economic growth by identifying eco-technology innovation that can be effectively used to reduce the amount

of air pollution so that electric power companies satisfy a governmental standard on environmental protection. The proposed approach is applied to evaluate the performance of coal-fired power plants in the United States. This study finds two policy implications. First, power plants operated by bituminous coal (i.e., black coal) outperform those with sub-bituminous coal (i.e., brown coal). The result implies that power plants with sub-bituminous coal should be replaced by bituminous coal. Second, the undesirable congestion, due to a line limit between points of power generation and consumption, may occur on most of coal-fired power plants. In contrast, desirable congestion, due to eco-technology innovation, may occur on a limited number of power plants. Thus, the identification of desirable congestion assists us in selecting which technology, or the type of power plant, should be invested to facilitate eco-technology innovation and its related engineering management for a future sustainable economic growth.

The effect of ethanol policies on the vertical price transmission in corn and food markets

- Energy Economics---2016---Dusan Drabik,Pavel Ciaian,Jan Pokrivcak

This paper analyzes the impact of ethanol policies on price transmission along the food supply chain. We consider the US corn sector and its vertical links with food and ethanol (energy) markets. We find that ethanol is a source of imperfect price transmission in the food supply chain. Ethanol, however, alters price transmission only under a binding blender's tax credit and only from food to corn (not vice versa). Our results indicate that ethanol weakens the response of corn and food prices in terms of their level changes to shocks occurring in agricultural (corn and food) markets. The results are robust to different assumptions on the model parameters. Although market power has previously been identified as a source of imperfect price transmission in the food supply chain, our findings show that in the presence of ethanol, the imperfect price transmission may occur even if markets are perfectly competitive. This warrants careful evaluation of markets before any policy intervention.

The relationship between U.S. retail gasoline and crude oil prices during the Great Recession: “Rockets and feathers” or “balloons and rocks” behavior?

- Energy Economics---2016---Dale S. Bremmer,Randall G. Kesselring

Previous studies of the relationship between crude oil and gasoline prices have often found “rockets and feathers” behavior: a scenario where gasoline prices increase more rapidly when crude oil prices rise than they fall when crude oil prices drop. While we find this behavior in times of generally rising crude oil prices, we find the opposite to be true during times of generally falling crude oil prices, a phenomenon we call “balloons and rocks” behavior. This result was obtained by testing for parameter stability in error-correction models which were estimated for periods of significant variability in both crude oil and gasoline prices. The data used to estimate these results is unique in the literature as it is comprised of daily U.S. retail gasoline prices and daily crude oil prices. The sample was taken during the Great Recession, an exceptional period of time that saw both sharp increases and decreases in gasoline and crude oil prices.

Long term climate change mitigation goals under the nuclear phase out policy: The Swiss energy system transition

- Energy Economics---2016---Ramachandran Kanan,Hal Turton

The Swiss electricity system is dominated by low-carbon hydro and nuclear generation. The Government’s decision to phase-out nuclear energy exacerbates Switzerland’s climate change mitigation goals. Response to this challenge requires systemic changes to the energy system, which is generally a long-term, uncertain and systemic process, affected by technology choices across the entire energy system. A comprehensive Swiss TIMES Energy system Model (STEM) with high temporal detail has been developed for the analysis of plausible low-carbon energy pathways focusing

on uncertainties related to policy (climate change mitigation and acceptability of new centralised electricity generation) and international fuel prices. Increasing electrification of end-uses is seen across the scenarios, resulting in continuous growth in electricity demands. The electrification of heating and e-mobility substitute direct use of fossil fuels in end-use sectors and contribute to a significant carbon dioxide emission (CO₂) reduction. Centralised gas power plants and renewables become key source of electricity supply. Given the phaseout of nuclear generation, clear policy signals are required to ensure capacity is built to achieve a low-carbon energy system. At the same time, it is also essential to ensure consistency between the electricity sector and end-use energy policies. For the long-term carbon reduction target, some non-cost-effective conservation measures are important early in the period because they are available only at the time of building renovation.

Effects of nuclear power plant shutdowns on electricity consumption and greenhouse gas emissions after the Tohoku Earthquake

- Energy Economics---2016---Seong-Hoon Cho,Katsuya Tanaka,Junjie Wu,Roland K. Robert,Taeyoung Kim

This study analyzes how the substitution of fossil fuels for nuclear power due to the shutdown of nuclear power plants after the Tohoku Earthquake affects electricity consumption and greenhouse gas emissions in Japan. Results indicate that Japan generated 4.3 million metric tons (or 0.3%, with a 95% confidence interval) of additional CO₂ emissions in 2011 following the earthquake. The increase in CO₂ emissions stemmed from the combined effects of decreased electricity consumption due to energy conservation efforts and the substitution of fossil fuels for nuclear power following the Tohoku Earthquake. Results also show considerable spatial variation in the impacts of the earthquake on net CO₂ emissions. A majority of the prefectures (40 of 47 prefectures, or 85%) were predicted to experience higher CO₂ emissions after the Tohoku Earthquake while the remaining (7 prefectures) were predicted to

experience lower CO₂ emissions. Our findings suggest that Japan and countries under similar risks may want to reformulate energy policy by emphasizing utilization of diverse power and energy sources, including more renewable energy production and electricity conservation. The policy reform should also consider spatial variation in the combined effects of reduced reliance on nuclear power and increased CO₂ conversion factors.

Efficiency and environmental factors in the US electricity transmission industry

- Energy Economics---2016---Manuel Llorca,Luis Orea,Michael Pollitt

The electricity industry in most developed countries has been restructured over recent decades with the aim of improving both service quality and firm performance. Regulated segments (e.g. transmission) still provide the infrastructure for the competitive segments and represent a significant share of the total price paid by final customers. However there is a lack of empirical studies that analyse firms' performance in the electricity transmission sector. In this paper an empirical analysis of US electricity transmission companies is conducted for the period 2001–2009. We use alternative stochastic frontier models that allow us to identify the determinants of firms' inefficiency. These models also permit us to control for weather conditions, potentially one of the most decisive uncontrollable factors in electricity transmission. Our results suggest that weather conditions clearly have an influence on transmission costs and that there is room for improvement in the management of US electricity transmission systems. Regulators should also be aware that more adverse conditions generate higher levels of inefficiency, and that achieving long-term efficiency improvements tends to worsen firms' short-term relative performance.

Do gasoline prices asymmetrically affect US consumers' economic outlook?

- Energy Economics---2016---Hamid Baghestani

Changes in gasoline prices can affect consumer sentiment which may then influence consumption. We

utilize the Michigan Surveys of Consumers data on the Index of Current Economic Conditions (ICC) and the Index of Consumer Expectations (ICE) in order to explore the dynamic relationship between US consumers' economic outlook (ICE) and real gasoline prices (P_g) for 1993–2015. We find that ICE and ICC as well as ICE and P_g are cointegrated: ICE is positively related to ICC and negatively related to P_g in the long-run. In the short-run, ICE responds symmetrically to ICC movements but asymmetrically to P_g movements. That is, ICE remains unchanged when P_g declines but deteriorates when P_g rises.

Made in Mexico: Energy reform and manufacturing growth

- Energy Economics---2016---Jorge Alvarez,Fabian Valencia

We assess the real effects of a recent opening of the energy sector in Mexico to private investment. We look at one particular channel, which operates through the change in the structure of electricity generation in favor of cheaper sources of energy, such as natural gas. We look at the potential impact of this structural change on electricity prices and ultimately on manufacturing output using subsector and state-level manufacturing output data. We first document that electricity prices—relative to oil and gas—are more important to the manufacturing sector, with a one-standard deviation reduction in those prices leading to a 2.8% increase in manufacturing output. This elasticity, together with estimated decreases in electricity prices on the back of the reform, could increase manufacturing output by up to 3.6%, and overall real GDP by 0.6%. Larger effects are possible in the long run if increased efficiency in the electricity sector leads to further decreases in electricity prices. There can also be larger effects stemming from output in the services sector which we find to also respond statistically significantly to electricity prices; and from the endogenous response of unit labor costs, which decrease with lower electricity prices.

Oil reserve life and the influence of crude oil prices: An analysis of Texas reserves

- Energy Economics---2016---Nicholas Apergis,Bradley Ewing,James Payne

Oil producing exploration and production companies generate revenue from reserves which, from any given well, are depleting over time. The reserve life index measures how long reserves would last at the current production rate if there were no additions to reserves. In this study, we examine the time series behavior of the reserve life index for each of the twelve onshore oil producing districts in Texas. Specifically, we model the relationship between reserve life and the real price of oil within a nonlinear ARDL framework. Among the results, we find evidence of both long-run and short-run asymmetries in the response of reserve life to increases/decreases in real oil prices. Further, the magnitude of the effect is greater for positive changes in real oil prices than for negative changes in real oil prices. The findings are important to operators, investors and policymakers interested in sustainability.

Cost efficiency of electric grid utilities in China: A comparison of estimates from SFA–MLE, SFA–Bayes and StoNED–CNLS

- Energy Economics---2016---Hong-Zhou Li,Maria Kopsakangas-Savolainen,Xing-Zhi Xiao,Zhen-Zhen Tian,Xiao-Yuan Yang,Jian-Lin Wang

With the purpose of estimating the range of cost efficiency levels of the power grid sector in China, we assembled a data set including 23 provincial power grid companies spanning from 2005 to 2009 and conducted an empirical study based on the SFA–MLE, SFA–Bayes and StoNED–CNLS methodologies. Empirical results show that the average values of efficiency from different models vary from 0.85 to 0.92, depending especially on the assumptions underlying inefficiency content. Further, results demonstrate that there is exogenous technical progress during the sample period, and per capita GDP of the province is negatively related to the costs of the electric grid company located in the corresponding province. We hope this empirical study

will contribute to the debate on an efficiency-based regulation scheme which was introduced to the Chinese electric grid sector on a pilot base in 2014.

Estimating dynamics of US demand for major fossil fuels

- Energy Economics---2016---Dragan Miljkovic,Nathan Dalbec,Lei Zhang

Long-run demand relationships among fossil fuels in the United States were investigated using annual data covering 1918 through 2013. Due to the endogeneity problem among the variables of interest, as indicated by the findings from the Granger Causality test, weak exogeneity test, and Directed Acyclic Graphs, the use of the seemingly unrelated regression (SUR) method was deemed appropriate. The SUR model demonstrated that there was low level of substitutability among fossil fuels, but the small magnitude of the estimated coefficient indicates that natural gas, oil, and coal are more properly classified as independent goods than as substitutes of each other within the US market. Income elasticities for all three fossil fuels indicate that they are normal goods. Several external shocks have significant impact on demand for each of the fossil fuels. Slightly lower explanatory power of oil demand equation may be explained with the fact that the model did not include US oil imports although the US economy has been dependent, to some degree, on imported oil.

Farmers' willingness to contract switchgrass as a cellulosic bioenergy crop in Kansas

- Energy Economics---2016---Jason E. Fewell,Jason Bergtold,Jeffery Williams

Farmers' adoption of cellulosic biofuel feedstock enterprises plays an important role in the future of agriculture and the renewable fuels industry. However, no set markets currently exist for bioenergy feedstocks outside of very localized geographic locations and farmers may be reluctant to produce the feedstocks without contracts that help mitigate uncertainty and risk. This study examines farmers' willingness to grow switchgrass under contract using a stated choice approach.

Data were collected using an enumerated survey of Kansas farmers and analyzed using latent class logistic regression models. Farmers whose primary enterprise is livestock are less inclined to grow switchgrass. Shorter contracts, greater harvest flexibility, crop insurance, and cost-share assistance increase the likelihood that farmers will grow switchgrass for bioenergy production.

Dynamically estimating the distributional impacts of U.S. climate policy with NEMS: A case study of the Climate Protection Act of 2013

- Energy Economics---2016---Danny Cullenward, Jordan T. Wilkerson, Michael Wara, John P. Weyant

We present a new method that enables users of the federal government's flagship energy policy model (NEMS) to dynamically estimate the direct energy expenditure impacts of climate policy across U.S. household incomes and census regions. Our approach combines NEMS output with detailed household expenditure data from the Consumer Expenditure Survey, improving on static methods that assess policy impacts by assuming household energy demand remains unchanged under emissions pricing scenarios. To illustrate our method, we evaluate a recent carbon fee-and-dividend proposal introduced in the U.S. Senate, the Climate Protection Act of 2013 (S. 332). Our analysis indicates this bill, if enacted, would have cut CO₂ emissions from energy by 17% below 2005 levels by 2020 at a gross cost of less than 0.5% of GDP, while offering rebates sufficient to offset increased direct energy expenditures for typical households making less than \$120,000 per year and average households in all regions of the United States.

An economic analysis of transportation fuel policies in Brazil: Fuel choice, land use, and environmental impacts

- Energy Economics---2016---Hector Nuñez, Hayri Önal

Brazil uses taxes, subsidies, and blending mandates as policy instruments to manage and stabilize its trans-

portation fuel markets. The fuel sector has been very dynamic in recent years due to frequent policy adjustments and variable market conditions. In this paper, we use a price endogenous economic simulation model to analyze the impacts of such policy adjustments under various challenging conditions in the global ethanol and sugar markets. Our analysis specifically focuses on Brazilian producers' supply responses, consumers' driving demand and fuel choice, ethanol trade, land use, greenhouse gas emissions, and social welfare. The model results show that (i) under a low ethanol blending rate, conventional vehicles would be driven significantly less while flex-fuel and ethanol-dedicated vehicles would not be affected significantly; (ii) lowering the fuel taxes adversely affects the competitiveness of sugarcane ethanol against gasoline blends, thus lowering producers' surplus; and (iii) while a reduction in fuel taxes is advantageous in terms of overall social welfare, it has serious environmental impacts by increasing the GHG emissions from transportation fuels consumed in Brazil.

Value and granularity of ICT and smart meter data in demand response systems

- Energy Economics---2016---Stefan Feuerriegel, Philipp Bodenbenner, Dirk Neumann

The large-scale integration of intermittent resources of power generation leads to unprecedented fluctuations on the supply side. An electricity retailer can tackle these challenges by pursuing strategies of flexible load shifting — so-called demand response mechanisms. This work addresses the associated trade-off between ICT deployment and economic benefits. The ICT design of a demand response system serves as the basis of a cost-value model, which incorporates all relevant cost components and compares them to the expected savings of an electricity retailer. Our analysis is based on a typical German electricity retailer to determine the optimal read-out frequency of smart meters. For our set of parameters, a positive information value of smart meter read-outs is achieved within an interval of 21 to 57min regarding variable costs. Electricity retailers can achieve a profitable setting by restricting

smart meter roll-out to large customers.

The impact of oil shocks on exchange rates: A Markov-switching approach

- Energy Economics---2016---Syed Basher, Alfred Haug, Perry Sadorsky

This paper uses Markov-switching models to investigate the impact of oil shocks on real exchange rates for a sample of oil exporting and oil importing countries. This is an important topic to study because an oil shock can affect a country's terms of trade which can affect its competitiveness. We detect significant exchange rate appreciation pressures in oil exporting economies after oil demand shocks. We find limited evidence that oil supply shocks affect exchange rates. Global economic demand shocks affect exchange rates in both oil exporting and importing countries, though there is no systematic pattern of appreciating and depreciating real exchange rates. The results lend support to the presence of regime switching for the effects of oil shocks on real exchange rates.

Is our everyday comfort for sale? Preferences for demand management on the electricity market

- Energy Economics---2016---Thomas Broberg, Lars Persson

In a European perspective, the electricity markets have been experiencing major changes via deregulation, new technologies and changes in the production mix. Together with the daily and seasonal peak hours on the demand side, the changing markets put pressure on increased flexibility to handle and sustain balance in the grid systems. This paper focuses on the demand side and analyzes preferences related to demand management of Swedish households' energy use. In a web-based choice experiment respondents were faced with three hypothetical electricity contracts. The choices of preferred contracts revealed preferences for attributes related to external control of heating, household electricity and information dissemination (integrity). The results show that people put a substantial value on not being controlled, illustrated by compensations up

to thousands of SEK for accepting a contract characterized by external control of energy use in various dimensions. In addition, the results show that household composition, age, gender and income play a role for the perceived discomfort from the external control and information dissemination.

Quantile dependence of oil price movements and stock returns

- Energy Economics---2016---Juan Re-boredo, Andrea Ugolini

We examine the impact of quantile and interquantile oil price movements on different stock return quantiles by testing the hypothesis of equality in conditional and unconditional quantile distribution functions of stock returns. We capture quantile dependence under different stock market conditions, while taking into account different kinds of oil price movements, by computing unconditional and conditional stock return quantiles through marginal models for stock returns and copula functions for oil-stock dependence. Analyzing stock return data for three developed economies (the US, the UK and the European Monetary Union) and the five BRICS countries (Brazil, Russia, India, China and South Africa) for 2000 to 2014, our results indicate that: (1) the impact of extreme upward and downward oil price changes on upper and lower stock price quantiles was much smaller before compared to after crisis onset; (2) the downside spillover effects were larger than the upside spillover effects for most countries before crisis onset and for all countries after crisis onset; and (3) small positive and negative oil price movements had no impact on any stock return quantiles neither before nor after crisis onset.

Sources of energy productivity change in China during 1997–2012: A decomposition analysis based on the Luenberger productivity indicator

- Energy Economics---2016---Ke Wang, Yi-Ming Wei

Given that different energy inputs play different roles in production and that energy policy decision making

requires an evaluation of productivity change in individual energy input to provide insight into the scope for improvement of the utilization of specific energy input, this study develops, based on the Luenberger productivity indicator and data envelopment analysis models, an aggregated specific energy productivity indicator combining the individual energy input productivity indicators that account for the contributions of each specific energy input toward energy productivity change. In addition, these indicators can be further decomposed into four factors: pure efficiency change, scale efficiency change, pure technology change, and scale of technology change. These decompositions enable a determination of which specific energy input is the driving force of energy productivity change and which of the four factors is the primary contributor of energy productivity change. An empirical analysis of China's energy productivity change over the period 1997–2012 indicates that (i) China's energy productivity growth may be overestimated if energy consumption structure is omitted; (ii) in regard to the contribution of specific energy input toward energy productivity growth, oil and electricity show positive contributions, but coal and natural gas show negative contributions; (iii) energy-specific productivity changes are mainly caused by technical changes rather than efficiency changes; and (iv) the Porter Hypothesis is partially supported in China that carbon emissions control regulations may lead to energy productivity growth.

Forecasting the adoption of residential ductless heat pumps

- Energy Economics---2016---Alexander N. Hlavinka, James W. Mjelde, Senarath Dhar-masena, Christine Holland

Energy-efficient technologies have the potential to provide savings to households and utilities, but consumers do not always adopt these innovations over traditional technologies. The ductless heat pump (DHP) is one such technology designed to increase energy efficiency and comfort in space conditioning. DHP adoption by single-family residences in the Pacific Northwest of the

United States is investigated by quantifying the effects of utility-provided rebates and expenditures on activities such as advertising and installer training on the number of installations and forecasting installations through 2018. The number of installations is elastic with respect to net installation costs and inelastic with respect to expenditures. Given the proposed rebate budgets, doubling the current rebate is necessary to maximize installations through 2018.

Forecasting realized volatility in electricity markets using logistic smooth transition heterogeneous autoregressive models

- Energy Economics---2016---Hui Qu, Wei Chen, Mengyi Niu, Xindan Li

We apply the non-parametric realized volatility technique and the associated jump detection test to measure volatility and jumps in electricity prices. Then, we propose a group of logistic smooth transition heterogeneous autoregressive (LSTHAR) models of realized volatility. The models can simultaneously approximate long memory behavior and describe sign and size asymmetries. They differ in the underlying heterogeneous autoregressive structure and the transition variable specification. The out-of-sample forecast accuracy of the LSTHAR models is evaluated through the Diebold–Mariano test and the superior predictive ability test, in terms of the mean square error and the mean absolute error. Using high-frequency prices from the Australian New South Wales (NSW) electricity market as empirical data, we draw the following conclusions. 1) Introducing the logistic smooth transition structure with appropriate transition variable specification to the heterogeneous autoregressive models improves volatility forecasts. 2) Overall, the LSTHAR model that uses the sum of Beta function weighted past returns as the transition variable and includes past daily jumps as a predictor is the superior model for predicting volatility in the NSW market. This model significantly outperforms the others.

Bidding structure, market efficiency and persistence in a multi-time tariff setting

- Energy Economics---2016---Ezgi Avci-Surucu,A. Kursat Aydogan,Doganbey Akgul

The purpose of this study is to examine the fractal dynamics of day ahead electricity prices by using parametric and semi parametric approaches for each time zone in a multi-time tariff setting in the framework of bidding strategies, market efficiency and persistence of exogenous shocks. We find that that electricity prices have long term correlation structure for the first and third time zones indicating that market participants bid hyperbolically and not at their marginal costs, market is not weak form efficient at these hours and exogenous shocks to change the mean level of prices will have permanent effect and be effective. On the other hand, for the second time zone we find that price series does not exhibit long term memory. This finding suggests the weak form efficiency of the market in these hours and that market participants bid at their marginal costs. Furthermore this indicates that exogenous shocks will have temporary effect on electricity prices in these hours. These findings constitute an important foundation for policy makers and market participants to develop appropriate electricity price forecasting tools, market monitoring indexes and to conduct ex-ante impact assessment.

Energy production in Brazil: Empirical facts based on persistence, seasonality and breaks

- Energy Economics---2016---Carlos Barros,Luis Gil-Alana,Peter Wanke

This paper investigates the statistical properties of the production of energy in Brazil using long range dependence techniques in monthly data from January 2000 to February 2013. Two important features of the data are analyzed, in particular, its degree of persistence and seasonality. The results indicate first that seasonality is an essential issue in modeling the persistence in energy production. Also, the persistence itself, measured in terms of the differencing parameter is relevant, with orders of integration in the series found to be positive

though smaller than 1 and thus implying mean reversion. A single structural break is also found in two of the series. Policy implications of the results obtained are also derived.

Investors' reaction to the government credibility problem: A real option analysis of emission permit policy risk

- Energy Economics---2016---Sang Baum Kang,Pascal Létourneau

In relation to creating a CO2 emission permit market, there are two types of climate change policy risks: (1) It is uncertain whether and when a cap-and-trade system will be implemented; and (2) once a policy is in place, there may be government credibility issues. This paper examines the effect of these policy risks on real option decisions of electric power plant investment. To model both an investment decision and generation flexibility, this study evaluates an exotic compound American option on multiple strips of European spread options through the implementation of least squares Monte Carlo simulation. Government credibility risk leads to more investment in “less green” resources and induces additional cash flow variation, which increases the average time to investment (value of waiting). However, in an extreme case, government credibility can actually hasten investment because the risk may be more favorable to electric power companies. Furthermore, if emission trading is planned to be implemented in the future (e.g., 2020), and the market believes that the probability of successful implementation is low, firms will build a “less green” plant early to benefit from the period before the green rule is applied.

Distribution network prices and solar PV: Resolving rate instability and wealth transfers through demand tariffs

- Energy Economics---2016---Paul Simshauser

1-in-4 detached households in Southeast Queensland have installed rooftop solar PV—amongst the highest take-up rates in the world. Electricity distribution

network capacity is primarily driven by periodic demand, and household load generally peaks in the early evening, whereas solar PV production peaks during the middle of the day and thus a mismatch exists. Compounding matters is the fact that the structure of the regulated two-part network tariff is dominated by a flat-rate variable charge. In this article, interval meter data at the customer switchboard circuit level confirms that solar households use only slightly less peak capacity than non-solar households and, that non-trivial cross-subsidies are rapidly emerging. A tariff model demonstrates that a peak capacity-based ‘demand tariff’ is a more efficient, cost-reflective and equitable pricing structure that improves the stability of tariffs given a rate-of-return regulatory constraint.

Substitution elasticities between GHG-polluting and nonpolluting inputs in agricultural production: A meta-regression

- Energy Economics---2016---Boying Liu,C. Richard Shumway

This paper reports meta-regressions of substitution elasticities between greenhouse gas (GHG) polluting and nonpolluting inputs in agricultural production, which is the main feedstock source for biofuel in the U.S. We treat energy, fertilizer, and manure collectively as the “polluting input” and labor, land, and capital as nonpolluting inputs. We estimate meta-regressions for samples of Morishima substitution elasticities for labor, land, and capital vs. the polluting input. Much of the heterogeneity of Morishima elasticities can be explained by type of primal or dual function, functional form, type and observational level of data, input categories, number of outputs, type of output, time period, and country categories. Each estimated long-run elasticity for the reference case, which is most relevant for assessing GHG emissions through life-cycle analysis, is greater than 1.0 and significantly different from zero. Most predicted long-run elasticities remain significantly different from zero at the data means. These findings imply that life-cycle analysis based on fixed proportion production functions could provide grossly inaccurate measures of GHG of biofuel.

Who pays and who gains from fuel policies in Brazil?

- Energy Economics---2016---Madhu Khanna,Hector Nuñez,David Zilberman

Brazil has pursued a mix of policy interventions in the fuel sector to achieve multiple objectives of economic and social development, promoting biofuels and reducing dependence on oil. We develop an economic framework to provide insight on the fuel policy choices in Brazil and to analyze the trade-offs they have engendered in the fuel and sugar sectors. We also examine their distributional impacts on producers and consumers in the sugar, oil and biofuel sectors and on government revenues. Additionally, we undertake a normative analysis for the purpose of comparing the welfare and environmental impacts of existing policies with those justified by the goal of maximizing social welfare and addressing market failure. The ex-post analysis of the outcomes for different stakeholders in the fuel and sugar sectors provides insights on the likely political-economic factors guiding policy choices. We find that the status quo policies are likely to have been motivated by the objectives of increasing oil exports, raising government revenue and promoting rural development through the sugarcane sector and have had a significant adverse effect on fuel and sugar consumers, aggregate social welfare and greenhouse gas emissions in Brazil.

The dynamics of fuel demand and illegal fuel activity in Turkey

- Energy Economics---2016---A. Talha Yalta,A. Yasemin Yalta,Ayşe Yasemin Yalta

We expose the dynamics of road fuel demand by employing maximum entropy resampling based interval estimates in a fixed width rolling window framework. Our approach facilitates using a uniform specification in a sequential procedure while also providing robust and efficient estimates that can evolve over time. Ours is also the first study to develop a method for estimating illegal fuel activity. To demonstrate our methodology, we use monthly data between 2003–2012 and focus

on the demand for diesel and gasoline in Turkey. The results show estimated monthly illegal activity ranging between 5–23 million liters over the last six years.

Risk spillovers across the energy and carbon markets and hedging strategies for carbon risk

- Energy Economics---2016---Mehmet Balcilar,Riza Demirer,Shawkat Hammoudeh,Duc Khuong Nguyen

This study examines the risk spillovers between energy futures prices and Europe-based carbon futures contracts. We use a Markov regime-switching dynamic correlation, generalized autoregressive conditional heteroscedasticity (MS-DCC-GARCH) model in order to capture the time variations and structural breaks in the spillovers. We further evaluate the optimal weights, hedging effectiveness, and dynamic hedging strategies for the MS-DCC-GARCH model based on both the regime-dependent and regime-independent optimal hedge ratios. We finally complement our analysis by examining the in- and out-of sample hedging performances for alternative strategies. Our results mainly show significant volatility and time-varying risk transmission from energy markets to carbon market. We also find that spot and futures segments of the emission markets exhibit time-varying correlations and volatile hedging effectiveness. The subsample estimates show significant changes in the hedge effectiveness over the different phases of the European carbon market. These results have important investment and policy implications.

Why does real-time information reduce energy consumption?

- Energy Economics---2016---John Lynham,Kohei Nitta,Tatsuyoshi Saijo,Nori Tarui

A number of studies have estimated how much energy conservation is achieved by providing households with real-time information on energy use via in-home displays. However, none of these studies tell us why real-time information changes energy-use behavior. We explore the causal mechanisms through which real-time

information affects energy consumption by conducting a randomized-control trial with residential households. The experiment attempts to disentangle two competing mechanisms: (i) learning about the energy consumption of various activities, the “learning effect”, versus (ii) having a constant reminder of energy use, the “saliency effect”. We have two main results. First, we find a statistically significant treatment effect from receiving real-time information. Second, we find that learning plays a more prominent role than saliency in driving energy conservation. Our findings support the use of energy conservation programs that target consumer knowledge regarding the energy use of different devices and activities.

Modeling energy price dynamics: GARCH versus stochastic volatility

- Energy Economics---2016---Joshua Chan,Angelia Grant

We compare a number of GARCH and stochastic volatility (SV) models using nine series of oil, petroleum product and natural gas prices in a formal Bayesian model comparison exercise. The competing models include the standard models of GARCH(1,1) and SV with an AR(1) log-volatility process, as well as more flexible models with jumps, volatility in mean, leverage effects, and t distributed and moving average innovations. We find that: (1) SV models generally compare favorably to their GARCH counterparts; (2) the jump component and t distributed innovations substantially improve the performance of the standard GARCH, but are unimportant for the SV model; (3) the volatility feedback channel seems to be superfluous; (4) the moving average component markedly improves the fit of both GARCH and SV models; and (5) the leverage effect is important for modeling crude oil prices—West Texas Intermediate and Brent—but not for other energy prices. Overall, the SV model with moving average innovations is the best model for all nine series.

Volatility linkages between energy and agricultural commodity prices

- Energy Economics---2016---Brenda López Cabrera, Franziska Schulz

We investigate price and volatility risk originating in linkages between energy and agricultural commodity prices in Germany and study their dynamics over time. We propose an econometric approach to quantify the volatility and correlation risk structure, which has a large impact for investment and hedging strategies of market participants as well as for policy makers. Volatilities and their short and long run linkages are analyzed using an asymmetric dynamic conditional correlation GARCH model as well as a multivariate multiplicative volatility model. Our approach provides a flexible and accurate fitting procedure for volatility and correlation risk. We find that in the long run prices move together and preserve an equilibrium, while correlations are mostly positive with persistent market shocks. Our results reveal that concerns about biodiesel being the cause of high and volatile agricultural commodity prices are rather unjustified.

Role of carbon swap trading and energy prices in price correlations and volatilities between carbon markets

- Energy Economics---2016---Takashi Kanamura

The present paper theoretically and empirically examines the role of carbon swap trading and energy prices in volatilities and price correlations between the EU and Kyoto Protocol emissions trading schemes. A supply and demand based correlation model between EUA and sCER price returns is proposed in detail using inverse Box-Cox type marginal abatement cost (MAC) curves and simple emission reduction volume processes. The model includes financial players' EUA-sCER swap transaction in boom periods of carbon prices using the logit model for EUA and EUA-sCER swap volume correlations, and stronger energy price impacts on EUA prices than sCER prices using a mean-reverting lognormal process for energy prices. The empirical studies

using EUA and sCER prices estimate the model parameters, resulting in a positive EUA volume impact on EUA-sCER swap transactions and a positive energy price impact on EUA prices. It is shown that high EUA-sCER price correlations during high EUA price periods stemmed from EUA-sCER swap transactions, whereas high EUA-sCER price correlations during the period of financial turmoil with low EUA prices came from the drop in energy prices. We also show that the leverage effects often observed in security markets exist in both the EUA and sCER markets according to the price-volatility relation.

An examination of the flow characteristics of crude oil: Evidence from risk-neutral moments

- Energy Economics---2016---Arjun Chatrath, Hong Miao, Sanjay Ramchander, Tianyang Wang

This paper examines the information content of risk-neutral moments to explain crude oil futures returns. Implied volatility and higher moments are extracted from observed crude oil option prices using a model-free implied volatility framework and the Black-Scholes model. We find a tenuous and time-varying association between returns and implied volatility and its innovations. Specifically, changes in implied volatility are found to be meaningfully associated with crude returns only over the period spanning the recent financial crisis. The results lead us to conclude that crude oil prices are determined primarily in a flow demand/supply environment. Finally, we document that oil risk is priced into the cross-section of stock returns in the oil and transportation sectors.

Exogenous shocks and the spillover effects between uncertainty and oil price

- Energy Economics---2016---Lei Li, Libo Yin, Yimin Zhou

This paper evaluates the information spillover between equity-related uncertainty and the oil price before and after the 2008 global financial crisis, and the effects of exogenous shocks on the pattern of information

spillover. In particular, we investigate mean and volatility spillovers between uncertainty and the oil price with and without exogenous shocks by using a bivariate EGARCH model. There are two main findings in our paper. First, the evidence ensures significant information transmission between equity-related uncertainty and the oil price, and shows remarkable differences in transmission patterns before and after the crisis. Second, the results show that exogenous shocks can intensify information transmission between oil prices and uncertainty in terms of both the mean and volatility spillover effects. Moreover, exogenous shocks exhibit direct spillover effects on oil prices.

Hedging emerging market stock prices with oil, gold, VIX, and bonds: A comparison between DCC, ADCC and GO-GARCH

- Energy Economics---2016---Syed Basher,Perry Sadorsky

While much research uses multivariate GARCH to model volatility dynamics and risk measures, one particular type of multivariate GARCH model, GO-GARCH, has been underutilized. This paper uses DCC, ADCC and GO-GARCH to model volatilities and conditional correlations between emerging market stock prices, oil prices, VIX, gold prices and bond prices. A rolling window analysis is used to construct out-of-sample one-step-ahead forecasts of dynamic conditional correlations and optimal hedge ratios. In most of the situations we study, oil is the best asset to hedge emerging market stock prices. Hedge ratios from the ADCC model are preferred (most effective) for hedging emerging market stock prices with oil, VIX, or bonds. Hedge ratios estimated from the GO-GARCH are most effective for hedging emerging market stock prices with gold in some instances. These results are reasonably robust to choice of model refits, forecast length and distributional assumptions.

The transition between energy efficient and energy inefficient states in Cameroon

- Energy Economics---2016---Philip Adom

I use a two-state (energy efficient/inefficient) Markov-switching dynamic model to study energy efficiency in Cameroon in a novel manner, employing yearly data covering 1971 to 2012. I find that the duration of an energy inefficient state is about twice as long as an energy efficient state, mainly due to fuel subsidies, low income, high corruption, regulatory inefficiencies, poorly developed infrastructure and undeveloped markets. To escape from an energy inefficient state a broad policy overhaul is needed. Trade liberalization and related growth policies together with the removal of fuel subsidies are useful, but insufficient policy measures; the results suggest that they should be combined with structural policies, aiming at institutional structure and investment in infrastructure.

Environmental Kuznets curves: New evidence on both panel and country-level CO2 emissions

- Energy Economics---2016---Nicholas Apergis

Using data on per capita CO2 emissions and per capita real GDP from fifteen countries, spanning the period 1960–2013, this paper tests the validity of the Environmental Kuznets Curve (EKC) using both panel-based and time-series-based methodological approaches of cointegration. Given that the EKC hypothesis postulates an inverted U-shaped relationship between emissions and output, the study tests for cointegration between per capita CO2 emissions, per capita real GDP and the squared values of per capita real GDP. The evidence from panel cointegration methodologies is mixed. This result might arise due to time dependence of cointegrating coefficients. The time-varying cointegration approaches provide strong evidence in favor of time-varying cointegration parameters. Furthermore, based on the quantile cointegration approach, the results indicate that the EKC hypothesis holds in 12 out of the 15 countries. However, even for these three countries, the EKC hypothesis seems to hold at certain quantiles.

Renewable energy policy performance in reducing CO2 emissions

- Energy Economics---2016---Miguel Pérez de Arce, Enzo Sauma, Javier Contreras

The growth of fossil fuel power production and the consequent increase in the level of carbon dioxide (CO₂) emissions have set off an alarm signal worldwide. Different policies have been implemented to incentivize the development of renewable energy sources with the goal of reducing CO₂ emissions. Notwithstanding the different policies contribute to reduce greenhouse gas emissions through the incentives provided for renewable energy, a relevant question is which of these is the most efficient. However, within the context of oligopolistic competition, the answer is very sensitive to the operation of the system. In particular, significant changes in the results can be observed when considering or ignoring reserve constraints.

Asymmetric fuel price responses under heterogeneity

- Energy Economics---2016---Jacint Balaguer, Jordi Ripollés

We explore the effect of cross-sectional aggregation of data on estimation and test of asymmetric retail fuel price responses to wholesale price shocks. The analysis is performed on data collected daily from individual fuel stations in the Spanish metropolitan areas of Madrid and Barcelona. While the standard OLS estimator is applied to an error correction model in the case of the aggregated time series, we use the mean group approaches developed by Pesaran and Smith (1995) and Pesaran (2006) to estimate the short- and long-run micro-relations under heterogeneity. We found remarkable differences between the results of estimations using aggregated and disaggregated data, which are highly robust to both datasets considered. Our findings could help to explain many of the results in the literature on this research topic. On the one hand, they suggest that the typical estimation with aggregated data clearly tends to overestimate the persistence of shocks. On the other hand, we show that aggregation may

generate a loss of efficiency in econometric estimates that is sufficiently large to hide the existence of the “rockets and feathers” phenomenon.

Does FDI influence renewable energy consumption? An analysis of sectoral FDI impact on renewable and non-renewable industrial energy consumption

- Energy Economics---2016---Nadia Doytch, Seema Narayan

This study examines the link between foreign direct investment (FDI) and energy demand. FDI is a source of financing that allows businesses to grow. At the same time, FDI can be a source of innovation that promotes energy efficiency. Existing evidence on the impact of aggregate FDI inflows on energy consumption is scarce and inconclusive. In the current study, we disaggregate FDI inflows into mining, manufacturing, total services, and financial services components and examine the impact of these FDI flows on renewable – and non-renewable industrial energy – sources for 74 countries for the period 1985–2012. We employ a Blundell–Bond dynamic panel estimator to control for endogeneity and omitted variable biases in our panels. The results point broadly to an energy consumption-reducing effect with respect to non-renewable sources of energy and an energy consumption-augmenting effects with respect to renewable energy. We find that these effects vary in magnitude and significance by sectoral FDI.

On the predictability of energy commodity markets by an entropy-based computational method

- Energy Economics---2016---F. Benedetto, G. Giunta, L. Mastroeni

This paper proposes a novel computational method for assessing the predictability of commodity market time series, by predicting the entropy of the series under investigation. Assessing the predictability of a time series is the first mandatory step in order to further apply low-risk and efficient price forecasting methods. According to conventional entropy-based analysis (where

the entropy is always ex-post estimated), high entropy values characterize unpredictable series, while more stable series exhibits lesser entropy values. Here, we predict (i.e. ex-ante) the entropy regarding the future behavior of a series, based on the observation of historical data. Our prediction is performed according to the optimum least squares minimization algorithm, usually used in many computational aspects of management science. Preliminary results, applied to energy commodity futures, show the effectiveness of the proposed method for application to energy market time series.

Estimating direct rebound effects for personal automotive travel in Great Britain

- Energy Economics---2016---Lee Stapleton, Steve Sorrell, Tim Schwanen

Direct rebound effects result from increased consumption of cheaper energy services. For example, more fuel-efficient cars encourage more car travel. This study is the first to quantify this effect for personal automotive travel in Great Britain. We use aggregate time series data on transport activity, fuel consumption and other relevant variables over the period 1970–2011 and estimate the direct rebound effect from the elasticity of both vehicle and passenger kilometres with respect to: a) vehicle fuel efficiency (km/MJ); b) the fuel cost of driving (£/km); and c) road fuel prices (£/MJ). We estimate a total of 108 models, paying careful attention to methodological issues and model diagnostics. Taking changes in fuel efficiency as the explanatory variable, we find little evidence of a long-run direct rebound effect in Great Britain over this period. However, taking changes in either the fuel cost of driving or fuel prices as the explanatory variable we estimate a direct rebound effect in the range 9% to 36% with a mean of ~19%. This estimate is consistent with the results of US studies and suggests that around one fifth of the potential fuel savings from improved car fuel efficiency may have been eroded through increased driving. We also show how the normalisation of distance travelled (per capita, per adult or per driver) affects the results obtained.

Market-specific news and its impact on forward premia on electricity markets

- Energy Economics---2016---Ewa Lazarczyk

This paper studies the impact of market-specific news on the short-term forward premia on the Nordic electricity market. I show that the short-term premia between the day-ahead and intra-day electricity prices on the Nordic market can be partly explained by the arrival of news specific to the power market. By exploring the types of news, I show that production failures are most important in shaping premia. Production disruptions in coal-powered units are most frequent and have the greatest effect on the differences between the day-ahead and intra-day prices.

Regulatory interventions in the US oil and gas sector: How do the stock markets perceive the CFTC's announcements during the 2008 financial crisis?

- Energy Economics---2016---Istemi Berk, Jannes Rauch

This paper analyzes the effects of the Commodity Futures Trading Commission's (CFTC) announcements on the stock returns of oil and gas companies around the financial crisis of 2008. Using event study methodology and regression analyses, we examine a set of 122 oil and gas related stocks listed in the New York Stock Exchange (NYSE) for 35 announcements. Our results indicate that CFTC announcements, depending on their content, can affect the stock returns of oil and gas companies. In particular, this is found to hold true during the period of high-volatility in oil prices, i.e., the period following Lehman Brothers failure. During this period, oil and gas related stock returns respond positively to most regulatory announcements, showing that the CFTC's regulatory interventions are perceived positively by the stock market.

Border carbon adjustment and trade retaliation: What would be the cost for the European Union?

- Energy Economics---2016---Jean Fouré, Houssein Guimbard, Stéphanie Monjon

Unilateral climate policy, such as carbon pricing, represents an additional cost to the economy, especially to energy-intensive industrial sectors, as well as those exposed to international competition. A border carbon adjustment (BCA) is often presented as an attractive policy option for countries that wish to go ahead without waiting for a global climate agreement. We used the computable general equilibrium model MIRAGE to simulate the impact of the introduction of a BCA on imports of energy-intensive products in EU and EFTA countries and to evaluate the exports their main trade partners would lose. Given that a BCA is a trade measure, it might cause disputes at the World Trade Organization (WTO). If the BCA is considered illegal, the losses suffered by some partners may justify trade retaliations. At that point, it would be likely that prohibitive retaliatory tariffs target sensitive products in the EU, which are often related to the European agricultural sector. These trade measures would limit the drop in production in the energy-intensive and trade-exposed (EITE) sectors, but at the expense of the other sectors. Nevertheless, neither the BCA nor retaliation would have sizeable impacts on real income or GDP in the EU or on the retaliators, while leading to a small decrease in global emissions.

A multiplicative environmental DEA approach to measure efficiency changes in the world's major polluters

- Energy Economics---2016---Abbas Valadkhani,Israfil Roshdi,Russell Smyth

We propose a multiplicative environmental data envelopment analysis (ME-DEA) approach to measure the performance of 46 countries that generate most of the world's carbon dioxide (CO₂) emissions. In the model, we combine economic (labour and capital), environmental (freshwater) and energy inputs with a desirable output (GDP) and three undesirable outputs (CO₂, methane and nitrous oxide emissions). We rank each country according to the optimum use of its resources employing a multiplicative extension of environmental DEA models. By computing partial efficiency scores for each input and output separately, we thus identify

major sources of inefficiency for all sample countries. Based on the partial efficiency scores obtained from the model, we define aggregate economic, energy and environmental efficiency indexes for 2002, 2007 and 2011, reflecting points in time before and after the official enactment of the Kyoto Protocol. We find that for most countries efficiency scores increase over this period. In addition, there exists a positive relationship between economic and environmental efficiency, although, at the same time, our results suggest that environmental efficiency cannot be realized without first reaching a certain threshold of economic efficiency. We also find support for the Paradox of Plenty, whereby an abundance of natural and energy resources results in their inefficient use.

Are fundamentals enough? Explaining price variations in the German day-ahead and intraday power market

- Energy Economics---2016---Christian Pape,Simon Hagemann,Christoph Weber

European electricity market participants are encouraged to balance intraday deviations from their day-ahead schedules via trades in the intraday market. Together with the increasing production of variable renewable energy sources (RES), the intraday market is gaining importance. We investigate the explanatory power of a fundamental modeling approach explicitly accounting for must-run operations of combined heat and power plants (CHP) and intraday peculiarities such as a shortened intraday supply stack. The fundamental equilibria between every hour's supply stack and aggregated demand in 2012 and 2013 are modeled to yield hourly price estimates. The major benefits of a fundamental modeling approach are the ability to account for non-linearities in the supply stack and the ability to combine time-varying information consistently. The empirical results show that fundamental modeling explains a considerable share of spot price variance. However, differences between the fundamental and actual prices persist and are explored using regression models. The main differences can be attributed to (avoided) start up-costs, market states and

trading behavior.

Carbon emissions in China: How far can new efforts bend the curve?

- Energy Economics---2016---Xiliang Zhang,Valerie J. Karplus,Tianyu Qi,Da Zhang,Jiankun He

While China is on track to meet its global climate commitments through 2020, China's post-2020 CO₂ emissions trajectory is highly uncertain, with projections varying widely across studies. Over the past year, the Chinese government has announced new policy directives to deepen economic reform, to protect the environment, and to limit fossil energy use in China. To evaluate how new policy directives could affect energy and climate change outcomes, we simulate two levels of policy effort—a continued effort scenario that extends current policies beyond 2020 and an accelerated effort scenario that reflects newly announced policies—on the evolution of China's energy and economic system over the next several decades. We perform simulations using the China-in-Global Energy Model, C-GEM, a bespoke recursive-dynamic computable general equilibrium model with global coverage and detailed calibration of China's economy and future trends. Importantly, we find that both levels of policy effort would bend down the CO₂ emissions trajectory before 2050 without undermining economic development. Specifically, in the accelerated effort scenario, we find that coal use peaks around 2020, and CO₂ emissions level off around 2030 at 10 bmt, without undermining continued economic growth consistent with China reaching the status of a “well-off society” by 2050.

Decomposing energy demand across BRIC countries

- Energy Economics---2016---Morakinyo O. Ade-tutu,Anthony J. Glass,Thomas G. Weyman-Jones

Energy plays an important role within the production technology of fast emerging economies, such that firms' reaction to changes in energy prices provides useful information on factor productivity and factor intensity, as well as the likely outcome of energy policy initiatives,

among other things. Drawing on duality theory, this paper decomposes changes in energy demand into substitution and output effects using annual sector-level production data for Brazil, Russia, India, Indonesia and China (BRIC) for the period 1995–2009. Unlike previous studies, this study analyzed the economic properties of the underlying production technology. Results indicate that changes in energy demand are strongly dominated by substitution effects. More importantly, an intriguing finding that emerges from our analysis is the role of economies of scale and factor accumulation, as opposed to technical progress, in giving rise to the growth performance of sampled economies.

Climate normals and weather normalization for utility regulation

- Energy Economics---2016---Seoung Joun Won,X. Wang,Henry E. Warren

In the regulation of natural gas and electric utilities, the determination of rate revenues commonly involves a sales adjustment to reflect the difference between actual weather and normal weather. This adjustment process, commonly known as weather normalization, is required to properly determine a set of rates which yields the revenue requirement under the assumption of normal weather. Normal weather values that characterize long-term weather patterns are critical component of weather normalization. Conventionally, normal weather values are calculated using the Standard Climate Normal (SCN). The SCN for any given calendar day is the 30-year average of the associated weather observations for that calendar day. In the regulatory process the SCN can inadvertently introduce biases in the weather normalization adjustment. This study investigates the sources and mitigation of these biases.

Oil price volatility and stock returns in the G7 economies

- Energy Economics---2016---Elena Maria Diaz,Juan Carlos Molero,Fernando Pérez de Gracia

This study examines the relationship between oil

price volatility and stock returns in the G7 economies (Canada, France, Germany, Italy, Japan, the UK and the US) using monthly data for the period 1970 to 2014. In order to measure oil volatility we consider alternative specifications for oil prices (world, nominal and real prices). We estimate a vector autoregressive model with the following variables: interest rates, economic activity, stock returns and oil price volatility taking into account the structural break in the year 1986. We find a negative response of G7 stock markets to an increase in oil price volatility. Results also indicate that world oil price volatility is generally more significant for stock markets than the national oil price volatility.

Energy price shocks and economic activity: Which energy price series should we be using?

- Energy Economics---2016---Mark Melichar

There is not one primary energy market and the price of oil is not a good proxy for many alternative energy prices. Therefore, this paper explores the effects of alternative energy price shocks on economic activity, and examines the relative performance of these alternative measures in predicting state level economic activity using the Davidson and MacKinnon J-test. The alternative energy price series considered are as follows: gasoline, diesel, natural gas, heating oil, and electricity. Alternative measures of energy price shocks produce different patterns of impulse responses than oil price shocks. Additionally, overwhelming evidence indicates that alternative energy price models, excluding models containing the price of gasoline, outperform the baseline model containing the price of oil for many states, particularly at short-to-mid forecast horizons. Using alternative energy prices should lead to a more accurate modeling of the energy price-macroeconomy relationship.

International spillover and rebound effects from increased energy efficiency in Germany

- Energy Economics---2016---Simon Koesler, John Swales, Karen Turner

The pollution/energy leakage literature raises the concern that policies implemented in one country, such as a carbon tax or tight energy restrictions, might simply result in the reallocation of energy use to other countries. This paper addresses these concerns in the context of policies to increase energy efficiency, rather than direct action to reduce energy use. Using a global CGE simulation model, we extend the analyses of ‘economy-wide’ rebound from the national focus of previous studies to incorporate international spill-over effects from trade in goods and services. Our focus is to investigate whether these effects have the potential to increase or reduce the overall (global) rebound of local energy efficiency improvements. In the case we consider, increased energy efficiency in German production generates changes in comparative advantage that produce negative leakage effects, thereby actually rendering global rebound less than national rebound.

Linking the gas and oil markets with the stock market: Investigating the U.S. relationship

- Energy Economics---2016---Hayette Gatfaoui

Energy markets can represent a strategic advantage when they are supporting each other, and specifically when energy segments are complementary enough to support economic development and growth. In this light, a high and strategic interest relies on the possible interactions between energy market segments as well as their impact on a given country’s financial market. The proposed research focuses on the interaction between the U.S. natural gas and U.S. crude oil markets on one side and their dependencies with the U.S. stock market on the other side. After controlling for structural changes or breaks, we characterize previous dependencies with the multivariate copula methodology. First, we assess the joint link prevailing between the natural gas and crude oil markets. Then, we characterize the joint risk structure prevailing between previous energy markets and the U.S. stock market. Finally, we assess the joint dependence structure between the natural gas, crude oil and stock markets.

Demand shifting bids in energy auction with non-convexities and transmission constraints

- Energy Economics---2016---Izabela Zoltowska

The major objective of this paper was to propose clearing and pricing models suitable for demand shifting bids in the efficient, but non-convex pool-based auction. Complex generators' offers bring non-convexities into the efficient auctions due to e.g. start-up costs and times. This paper focused on the responsive demands, introducing simple, yet adequate linear constraints into a multi-period bid/offer-based optimal power flow (OPF DC) model. As the standard locational marginal prices (LMPs) may not support the auction outcomes due to non-convexities, uplifts are needed to reduce generators' loss. Previous work has developed a minimum-uplift pricing model that directly optimizes prices, so that uplifts arising from generators' profit-suboptimality and simple, elastic demands' benefit-suboptimality are minimized. This work extended the mixed integer linear programming (MILP) formulation of the previous model to incorporate new linear constraints defining benefit-suboptimality of demand shifting bids. Furthermore, the transmission constrained market was attempted. As a result, the buyers were protected against over-curtailment; moreover, prices complemented with minimum uplifts were fair for both generators and demands. The models were validated on the literature-based cases, including IEEE RTS 24-node 24-hour system.

Capacity, investment and market power in the economic value of energy firms

- Energy Economics---2016---Vicente Salas-Fumás,Jorge Rosell-Martinez,José Manuel Delgado-Gómez

Regulation of energy firms faces the complex problem of balancing private (earning a fair rate of return on investment) and public (assure safe and reliable supply of energy at the lowest possible costs) goals. Tobin's q is a forward looking indicator on investment opportunities and on market power of firms that energy regulators can use for more effective regulation. This

paper presents the empirical evidence on the determinants of differences in observed values of Tobin's q for a sample of large listed energy firms from 10 different countries in the period 2000–2006. We find that adjustment costs represent around sixty percent of the difference between economic and book value of the assets for the representative firm, while rents from market power represent the other forty percent. Therefore, across countries there is room for regulatory actions aiming at reducing energy prices, but less than what may be inferred from the observed average q values.

Impact of the financial crisis on Indian commodity markets: Structural breaks and volatility dynamics

- Energy Economics---2016---Velappan Shalini,Krishna Prasanna

The shocks transmitted across the financial markets during the financial crisis resulted in structural changes in commodity volatility. Hence, understanding volatility dynamics in changing scenario is vital for derivative pricing, risk management and monetary policy stabilization. This paper studies the impact of the financial crisis by analyzing the following aspects: 1.) Presence of structural break/regime shift in volatility by deploying Markov and Wavelet model during financial crisis; and 2.) Crisis impact on volatility dynamic behavior such as persistence, leverage and long memory by deploying hybrid Wavelet-EGARCH and fractional integration. Spot prices of 18 commodities were examined, including all sub-sectors of energy, metals and agriculture; Indian commodity indices & sub-indices, global benchmark indices, and also stock indices such as S&P 500, S&P and VIX, Nifty 50. The results show that there was a shift from low to high volatility regime in commodity market returns during the global financial crisis. The duration of stay in each regime, and the convergence and divergence from long run equilibrium were different across commodities; agricultural commodities showed faster convergence to long run equilibrium while metal and energy experienced higher persistence and attracted more financial speculation. The impact of the crisis on agricultural commodities

was limited to internationally traded commodities such as sugar and rubber. The common breaks and different volatility dynamics have been attributed to systematic risk and to idiosyncratic components respectively. It was also found that during and after the crisis, more than idiosyncratic risk, it was systematic risk that contributed significantly to the volatility patterns of Indian commodity markets.

The impact of renewable energy consumption to economic growth: A panel data application

- Energy Economics---2016---Roula Inglesi-Lotz

Internationally, the importance of renewable energy in the energy mix has been increasingly appreciated. The advantages of the renewable energy usage for the world's energy security and the environment are indisputable and much discussed in the literature. However, its effects on the economic welfare of the countries are yet to be examined fully and described quantitatively. The purpose of this paper is to estimate the impact of the renewable energy consumption to economic welfare by employing panel data techniques. The results show that the influence of renewable energy consumption or its share to the total energy mix to economic growth is positive and statistically significant. From a policy point of view, promoting renewable energies bears benefits not only for the environment but also for the economic conditions of the countries.

Taxing fossil fuels under speculative storage

- Energy Economics---2016---Semih Tumen, Deren Unalmis, Ibrahim Unalmis, Filiz Unsal

Long-term environmental consequences of taxing fossil fuel usage have been extensively studied in the literature. However, these taxes may also impose several short-run macroeconomic policy challenges, the nature of which remains underexplored. This paper investigates the mechanisms through which environmental taxes on fossil fuel usage can affect the main macroeconomic variables in the short-run. We concentrate on a particular mechanism: speculative storage. Formulating and using a dynamic stochastic general

equilibrium (DSGE) model, calibrated for the United States, with an explicit storage facility and nominal rigidities, we show that in designing environmental tax policies it is crucial to account for the fact that fossil fuel prices are subject to speculation. The existence of forward-looking speculators in the model improves the effectiveness of tax policies in reducing fossil fuel usage. Improved policy effectiveness, however, is costly: it drives inflation and interest rates up, while impeding output. Based on this tradeoff, we seek an answer to the question how monetary policy should interact with environmental tax policies in our DSGE model of fossil fuel storage. We show that, in an environment with no speculative storers, monetary policy should respond to output along with CPI inflation in order to minimize the welfare losses brought by taxes. However, when the storage facility is activated, responding to output in the monetary policy rule becomes less desirable.

Optimal design of feed-in-tariffs to stimulate renewable energy investments under regulatory uncertainty — A real options analysis

- Energy Economics---2016---Ingmar Ritzenhofen, Stefan Spinler

Feed-in-tariffs (FITs) are widely used as policy instruments to promote investments in renewable energy sources (RES). While FITs are often regarded as the most effective RES support scheme, regulators around the world continuously review their FIT schemes in the light of budget constraints and evolving policy goals. We assess the impact of adjustments to FIT schemes by quantifying the relationship between FIT levels, i.e., the guaranteed amount paid per quantity of electricity produced and the propensity to invest in RES. Through a regime switching model, we quantify the impact of regulatory uncertainty induced by regulators considering moves from a FIT scheme to a more market-oriented regulatory regime. Our focus is on market-independent, fixed FITs, the dominant scheme in Europe receiving increasing attention globally. We find that RES investment projects under market-independent, fixed FIT schemes become now-or-never decisions and derive FIT thresholds required to induce investment. We show

that uncertainty regarding future regulatory regimes delays or even reduces investment activity for FIT levels near electricity market prices and high probabilities of an imminent regime switch.

Evolution of the world crude oil market integration: A graph theory analysis

- Energy Economics---2016---Qiang Ji,Ying Fan

This paper investigates the evolution of the world crude oil market and the pricing power for major oil-producing and oil-consuming countries using graph theory. A minimal spanning tree for the world crude oil market is constructed and some empirical results are given. The integration of the world crude oil market is verified. Furthermore, the world crude oil market is characterised as a geographical and organisational structure. The crude oil markets of adjacent countries or regions tend to link together, while OPEC is well-integrated. We also found that the links in the South and North American region and the African region are relatively stable. The crude oil markets in the U.S., Angola and Saudi Arabia take up the core, with a higher ‘betweenness centrality’ and lower ‘farness’, whereas the markets in the East and Southeast Asian countries are on the fringe. Finally, the degree of globalisation for the world crude oil market is becoming further entrenched, verified by a decreasing normalised tree length; hence, its systemic risk may increase due to the future uncertainty of world politics.

The effects of oil price shocks on output and inflation in China

- Energy Economics---2016---Lin Zhao,Xun Zhang,Shouyang Wang,Shanying Xu

Crude oil price shocks derive from many sources, each of which may bring about different effects on macro-economy variables and require completely different designs in macro-economic policy; thus, distinguishing the sources of oil price fluctuations is crucial when evaluating these effects. This paper establishes an open-economy dynamic stochastic general equilibrium (DSGE) model with two economies: China and the rest

of the world. To assess the effects of oil price shocks, the CES production function is extended by adding oil as an input. Based on the model, the effects of four types of oil price fluctuations are evaluated. The four types of oil price shocks are supply shocks driven by political events in OPEC countries, other oil supply shocks, aggregate shocks to the demand for industrial commodities, and demand shocks that are specific to the crude oil market. Simulation results indicate the following: Oil supply shocks driven by political events mainly produce short-term effects on China’s output and inflation, while the other three shocks produce relatively long-term effects; in addition, demand shocks that are specific to the crude oil market contribute the most to the fluctuations in China’s output and inflation.

Co-movement of international crude oil price and Indian stock market: Evidences from nonlinear cointegration tests

- Energy Economics---2016---Sajal Ghosh,Kakali Kanjilal

This article explores nonlinear cointegration between international crude oil price and Indian stock market in a multivariate framework for the period January 2, 2003 to July 29, 2011 by threshold cointegration tests which determine the structural breaks endogenously. The tests reject any long-run equilibrium relationship among the variables for the entire data span. In order to get better insight, threshold cointegration tests have been applied on three sub-phases; prior (phase I) and post (phase III) to most volatile phase (phase II) spanning from July 2, 2007 to Dec 29, 2008. The tests suggest existence of cointegration in phase III only. Toda–Yamamoto version of Granger causality tests reveals that movements of international crude oil price have impact on Indian stock market in phases II and III with no feedback effect. The findings also suggest that global crude oil price is exogenously determined.

Flexibility in Europe's power sector — An additional requirement or an automatic complement?

- Energy Economics---2016---Joachim Bertsch,Christian Growitsch,Stefan Lorenczik,Stephan Nagl

By 2050, the European Union aims to reduce greenhouse gases by more than 80%. The EU member states have therefore declared to strongly increase the share of renewable energy sources (RES-E) in the next decades. Given a large deployment of wind and solar capacities, there are two major impacts on electricity systems: First, the electricity system must be flexible enough to cope with the volatile RES-E generation, i.e., ramp up supply or ramp down demand on short notice. Second, sufficient back-up capacities are needed during times with low feed-in from wind and solar capacities. This paper analyzes whether there is a need for additional incentive mechanisms for flexibility in electricity markets with a high share of renewables. For this purpose, we simulate the development of the European electricity markets up to the year 2050 using a linear investment and dispatch optimization model. Flexibility requirements are implemented in the model via ramping constraints and provision of balancing power. We found that an increase in fluctuating renewables has a tremendous impact on the volatility of the residual load and consequently on the flexibility requirements. However, any market design that incentivizes investments in least (total system) cost generation investment does not need additional incentives for flexibility. The main trigger for investing in flexible resources is the achievable full load hours and the need for backup capacity. In a competitive market, the cost-efficient technologies that are most likely to be installed, i.e., gas-fired power plants or flexible CCS plants, provide flexibility as a by-product. Under the condition of system adequacy, flexibility never poses a challenge in a cost-minimal capacity mix. Therefore, any market design incentivizing investments in efficient generation thus provides flexibility as an inevitable complement.

Reassessing the integration of European electricity markets: A fractional cointegration analysis

- Energy Economics---2016---Lilian M. de Menezes,Melanie A. Houllier

This study extends existing literature on the assessment of electricity market integration in Europe, by developing and testing hypotheses on the convergence of electricity wholesale prices, and adopting a time-varying fractional cointegration analysis. In addition, the potential impacts of some special events that may affect system capacity (new interconnection, market coupling, increase in share of intermittent generation) on spot and forward markets are considered and evaluated. Daily spot prices from February 2000 to March 2013 of nine European electricity spot markets (APX-UK, APX-NL, Belpex, EPEX-FR, EPEX-DE, IPEX, Nordpool, Omel and OTE) and month-ahead prices in four markets (French, British, German and Dutch) from November 2007 to December 2012 are investigated. Results show that unit root tests, which are generally used in the literature to test market integration, are inadequate for assessing electricity spot market convergence, because spot prices are found to be fractionally integrated and mean-reverting time series. Furthermore, spot price behaviour and their association with different markets change over time, reflecting changes in the EU electrical system. One-month-ahead prices, by contrast, were found to have become more resilient to shocks and to follow more stable trends.

Is efficiency of crude oil market affected by multifractality? Evidence from the WTI crude oil market

- Energy Economics---2016---Rongbao Gu,Bing Zhang

In this paper, we investigate the dynamics of relationship between efficiency and multifractality of WTI crude oil market. Based on the cross-correlation analysis and the nonlinear Granger causality analysis, we find that the inefficiency and multifractality of the

WTI crude oil returns interact positively in a nonlinear mechanism. This suggests that the increase of multifractality degree will lead to the lower degree of market efficiency and vice versa. Our findings have some important implications for oil price forecasting and portfolio management.

Futures trading with information asymmetry and OTC predominance: Another look at the volume/volatility relations in the European carbon markets

- Energy Economics---2016---Yves Rannou,Pascal Barneto

This paper constitutes the first exercise of analysing the European carbon market efficiency from a double perspective combining both nature of execution venues (screen vs. OTC trading) and their volatility/liquidity relations. Using a bivariate asymmetric GJR-GARCH model, we first document that OTC (exchange traded) trading volume shows consistent bi-(uni) directional Granger causality to our volatility estimates, consistent with greater responsiveness of the OTC (exchange traded) market to changes in market-wide (idiosyncratic) risks. Second, we report significant contemporaneous and lagged positive causality of OTC derivatives volume on spot/futures volatility confirming that the Sequential Information Arrival Hypothesis (SIAH) applies. Third, we find that the one-way causality from OTC to futures volumes is mainly driven by heterogeneous investor beliefs: trading volume provides an indication on how (private) information is dispersed and held at different levels rather than proxying information signal itself. After rejecting execution venues' substitutability, we advocate for systematic clearing and netting of OTC positions through a unique clearing house and reporting rules to identify speculation in line with Mifid (Art. 59) proposals.

Jumps and stochastic volatility in crude oil futures prices using conditional moments of integrated volatility

- Energy Economics---2016---Christopher Baum,Paola Zerilli

We evaluate alternative models of the volatility of commodity futures prices based on high-frequency intraday data from the crude oil futures markets for the October 2001–December 2012 period. These models are implemented with a simple GMM estimator that matches sample moments of the realized volatility to the corresponding population moments of the integrated volatility. Models incorporating both stochastic volatility and jumps in the returns series are compared on the basis of the overall fit of the data over the full sample period and subsamples. We also find that jumps in the returns series add to the accuracy of volatility forecasts.

Cross-border constraints, institutional changes and integration of the Dutch–German gas market

- Energy Economics---2016---Gerard Kuper,Machiel Mulder

We evaluate the contribution of nine institutional changes to the integration of the Dutch and German gas markets. We analyse this contribution through the impact of bottlenecks in the cross-border infrastructure on the absolute value of cross-border price differences. In the period 2007–2013, the absolute value of the differences in price levels between the Dutch and the German NCG market decreased, indicating more integration. We find evidence that the improved connections within the German networks as well as between the Dutch and the German network contributed to this. The strengthening of the connections with the UK market and the Russian supply, however, had a negative effect on market integration between the Dutch and the German NCG market. The liquidity-enhancing changes within the Dutch market had a negligible effect.

Determinants of investment under incentive regulation: The case of the Norwegian electricity distribution networks

- Energy Economics---2016---Rahmatallah Poudineh,Tooraj Jamasb

Investment in electricity networks, as regulated natural monopolies, is among the highest regulatory and en-

ergy policy priorities. The electricity sector regulators adopt different incentive mechanisms to ensure that the firms undertake sufficient investment to maintain and modernise the grid. Thus, an effective regulatory treatment of investment requires understanding the response of companies to the regulatory incentives. This study analyses the determinants of investment in electricity distribution networks using a panel dataset of 129 Norwegian companies observed from 2004 to 2010. A Bayesian Model Averaging approach is used to provide a robust statistical inference by taking into account the uncertainties around model selection and estimation. The results show that three factors drive nearly all network investments: investment rate in previous period, socio-economic costs of energy not supplied and finally useful life of assets. The results indicate that Norwegian companies have, to some degree, responded to the investment incentives provided by the regulatory framework. However, some of the incentives do not appear to be effective in driving the investments.

A time consistent risk averse three-stage stochastic mixed integer optimization model for power generation capacity expansion

- Energy Economics---2016---P. Pisciella,M.T. Vespucci,M. Bertocchi,S. Zigrino

We propose a multi-stage stochastic optimization model for the generation capacity expansion problem of a price-taker power producer. Uncertainties regarding the evolution of electricity prices and fuel costs play a major role in long term investment decisions, therefore the objective function represents a trade-off between expected profit and risk. The Conditional Value at Risk is the risk measure used and is defined by a nested formulation that guarantees time consistency in the multi-stage model. The proposed model allows one to determine a long term expansion plan which takes into account uncertainty, while the LCoE approach, currently used by decision makers, only allows one to determine which technology should be chosen for the next power plant to be built.

Pollution control under emission constraints: Switching between regimes

- Energy Economics---2016---Enrico Saltari,Giuseppe Travaglini

In this paper we develop a model of pollution control. The aim of the society is to maximize the net social benefits which are negatively affected by the emission of pollutants. We show that the presence of an upper constraint on pollution growth rate affects the actual trajectory of emissions even when emissions are far below the level where the constraint binds. We get three main results. First, we find that for a society it is optimal to take into account the impact of the latent constraint at the outset of the planning horizon and to modify the emission flows even when the constraint is still slack. Second, we analyze how the constraint works effectively in the intermediate phases before the constraint binds. One crucial result is that the constraint on pollution growth may generate the unexpected result of increasing, instead of reducing, the emissions at the beginning and in the intermediate phases before the constraint binds. Finally, we state the boundary conditions to compute the optimal trajectory of emissions switching between regimes.

Modelling futures price volatility in energy markets: Is there a role for financial speculation?

- Energy Economics---2016---Matteo Manera,Marcella Nicolini,Ilaria Vignati

This paper models volatility in four energy futures markets, adopting GARCH models. The variance equation is enriched with alternative measures of speculation, based on CFTC data: the market share of non-commercial traders, the Working's T index, and the percentage of net long positions of non-commercials over total open interest in future markets. It also includes a control for market liquidity. We consider four energy commodities (light sweet crude oil, heating oil, gasoline and natural gas) over the period 2000–2014, analysed at weekly frequency. We find that speculation presents a negative and significant sign. The robustness exercise

shows that: i) results remain unchanged through different model specifications (GARCH-in-mean, EGARCH, and TARCH); ii) results are robust to different specifications of the mean and variance equation.

Club membership and transboundary pollution: Evidence from the European Union enlargement

- Energy Economics---2016---Xudong Chen,Bihong Huang

We set up a theoretical model in which a less developed country (the LDC) undertakes an activity that imposes negative transboundary pollution effects on a more developed country (the MDC). The MDC can effectively make a Coasian payment in the form of direct environmental assistance, but can also encourage good “environmental citizenship” through its influence over the prospect that the LDC will gain the benefits of membership into a particular international club. We examine the strategic interactions between the LDC and the MDC in this regional environmental game, and our comparative statics analysis explores how a change in the membership “payoff” will affect the environmental efforts and outcome of both countries. Our theoretical model also addresses the issue of the economic growth in the LDC as well as its environmental impacts in the region. We also conduct empirical study and examine the evidence in the thirteen Central and Eastern European (CEE) countries that joined the European Union (EU) in the 21st century and investigate the impacts of EU membership on their environmental performance. We find that there is a robust correlation between the degree of EU integration and pollution abatement from the LDC, and we also observe that emissions of selected pollutants seem to follow a concave pattern relative to the national income, both of which coincide with our theoretical discussions.

Convenience yield in commodity price modeling: A regime switching approach

- Energy Economics---2016---Abdullah Almansour

This paper attempts to model the futures term structures of crude oil and natural gas using the notion of convenience yield in a regime switching framework. Unlike the existing studies, which assume the convenience yield to have either a constant value or to have a stochastic behavior with mean reversion to one equilibrium level, the model of this paper extends the Gibson and Schwartz (1990) model to allow for regime switching in the convenience yield along with the other parameters. A closed form solution for the futures price is derived and the model parameters are estimated using the maximum likelihood method. The results show that the estimated regimes are very close to the contango and backwardation regimes commonly seen in futures markets. The results also show that the transitional probabilities play an important role in shaping the futures term structure implied by the model.

Carbon emission permit price volatility reduction through financial options

- Energy Economics---2016---Li Xu,Shi-Jie Deng,Valerie M. Thomas

We develop a stylized model to investigate the impact of financial options on reducing carbon permit price volatility under a cap-and-trade system. The existence of an option market provides a mechanism to hedge the uncertainty of future spot prices and is a stimulus for investment in carbon emission abatement technologies. We show that both the spot price level and the price volatility of carbon permits can be reduced via the trading of financial options, while achieving the emission reduction target. We also show that introducing financial options in a banking environment offers more flexibility to risk management in carbon permit trading.

Asymmetric impacts of European transmission network development towards 2050: Stakeholder assessment based on IRENE-40 scenarios

- Energy Economics---2016---D. Pudjianto,M. Castro,G. Strbac,Zheng Liu,L. van der Sluis,G. Paefthymiou

This paper presents the assessment of stakeholder impacts of European electricity transmission network investments for a set of future system development scenarios. A techno-economic analysis is adopted, which quantifies the economic impacts on different stakeholders including electricity producers, consumers, and network investors, under the future de-carbonisation pathways described in the IRENE-40 scenarios, ranging from 2010 to 2050. To quantify the impact of transmission infrastructure development, for each pathway, two distinct scenarios of future European transmission development are assessed: “low” (no new transmission between 2010 and 2050) and “high” (optimal transmission development between 2010 and 2050 to accommodate the generation pathway).

Capacity payment impact on gas-fired generation investments under rising renewable feed-in — A real options analysis

- Energy Economics---2016---Daniel Hach,Stefan Spinler

We assess the effect of capacity payments on investments in gas-fired power plants in the presence of different degrees of renewable energy technology (RET) penetration. Low variable cost renewables increasingly make investments in gas-fired generation unprofitable. At the same time, growing feed-in from intermittent RETs amplifies fluctuations in power generation, thus entailing the need for flexible buffer capacity—currently mostly gas-fired power plants. A real options approach is applied to evaluate investment decisions and timing of a single investor in gas-fired power generation. We investigate the necessity and effectiveness of capacity payments. Our model incorporates multiple uncertainties and assesses the effect of capacity payments under different degrees of RET penetration. In a numerical study, we implement stochastic processes for peak-load electricity prices and natural gas prices. We find that capacity payments are an effective measure to promote new gas-fired generation projects. Especially in times of high renewable feed-in, capacity payments are required to incentivize peak-load investments.

Quality frontier of electricity distribution: Supply security, best practices, and underground cabling in Finland

- Energy Economics---2016---Antti Saastamoinen,Timo Kuosmanen

Electricity distribution is a prime example of local monopoly. In most countries, the costs of electricity distribution operators are regulated by the government. However, the cost regulation may create adverse incentives to compromise the quality of service. To avoid this, cost regulation is often amended with quality incentives. This study applies theory and methods of productivity analysis to model the frontier of service quality. A semi-nonparametric estimation method is developed, which does not assume any particular functional form for the quality frontier, but can accommodate stochastic noise and heteroscedasticity. The empirical part of our paper examines how underground cabling and location affect the interruption costs. As expected, higher proportion of underground cabling decreases the level of interruption costs. The effects of cabling and location on the variance of performance are also considered. Especially the location is found to be a significant source of heteroscedasticity in the interruption costs. Finally, the proposed quality frontier benchmark is compared to the current practice of Finnish regulation system. The proposed quality frontier is found to provide more meaningful and stable basis for setting quality targets than the average practice benchmarks currently in use.

Psychological barriers in oil futures markets

- Energy Economics---2016---Michael Dowling,Mark Cummins,Brian M. Lucey

WTI and Brent futures are tested for the presence of psychological barriers around \$10 price levels, applying a multiple hypothesis testing approach for statistical robustness. Psychological barriers are found to be present in Brent prices but not in WTI prices, which is argued to be due to the more prominent role that Brent plays as a global benchmark and, based on recent behavioural finance research, the greater complexity

inherent in Brent fundamental value determination. Brent particularly displays evidence that when breaching a \$10 barrier level from below with rising prices, the trend is for prices to fall on average subsequently. Similar behavioural-based patterns are evidenced at the \$1 barrier level for the WTI–Brent spread. We show that psychological barriers only appear to influence prices in the pre-credit crisis period of 1990–2006, with such effects dissipating during the crisis and as markets reverted back to wider economy focused fundamentals. A range of reaction windows are applied with the main finding being that the trading potential around such psychological barrier levels is primarily in the immediate 1–5 days following a breach. The research contributes to the scant existing research on psychological influences on energy market traders, and suggests strong potential for further application of behavioural finance theories to improving understanding of energy markets price dynamics.

Recent hikes in oil-equity market correlations: Transitory or permanent?

- Energy Economics---2016---Bing Zhang,Xiao-Ming Li

This paper empirically examines the long-run behavior of eight oil-equity correlations based on the ADCC (asymmetric dynamic conditional correlation) model and a novel decomposing approach. We select equity price indexes from three developed countries (the US, the UK and Germany) and five BRICS member countries (Brazil, Russia, India, China and South Africa) and consider ten economic/financial events for investigation. Seven correlations exhibit a positively sloped trend, and one exhibits a horizontal trend. All of these trends have undergone one or two structural breaks, which moved the corresponding correlations to their highest-ever evolutionary paths. These structural breaks are associated with one or more of the ten episodes considered, and a common event impacting all eight of the correlation trends is detected to be the 2008 adverse oil shock. The broken trends explain why the correlations were low in the early years and high in the recent years. Our findings indicate that

recent hikes in the oil-equity correlations are a long-run phenomenon.

Frontiers in the economics of energy efficiency

- Energy Economics---2015---Carlos de Miguel,Xavier Labandeira,Andreas Löschel

Energy efficiency has become an essential instrument to obtain effective greenhouse gas mitigation and reduced energy dependence. This introductory article contextualizes the contributions of the supplemental issue by showing the new setting for energy efficiency economics and policy; discussing the role of price instruments to promote energy savings; presenting new approaches for energy efficiency policies; and placing energy efficiency within a wider energy and environmental framework.

Measurement of energy efficiency based on economic foundations

- Energy Economics---2015---Massimo Filippini,Lester Hunt

Energy efficiency policy is seen as a very important activity by almost all policy makers. In practical energy policy analysis, the typical indicator used as a proxy for energy efficiency is energy intensity. However, this simple indicator is not necessarily an accurate measure given changes in energy intensity are a function of changes in several factors as well as ‘true’ energy efficiency; hence, it is difficult to make conclusions for energy policy based upon simple energy intensity measures. Related to this, some published academic papers over the last few years have attempted to use empirical methods to measure the efficient use of energy based on the economic theory of production. However, these studies do not generally provide a systematic discussion of the theoretical basis nor the possible parametric empirical approaches that are available for estimating the level of energy efficiency. The objective of this paper, therefore, is to sketch out and explain from an economic perspective the theoretical framework as well as the empirical methods for measuring the level of energy efficiency. Additionally, in the second part of the paper, some of the empirical studies that have

attempted to measure energy efficiency using such an economics approach are summarized and discussed.

The role of information for energy efficiency in the residential sector

- Energy Economics---2015---A. Ramos,A. Gago,X. Labandeira,Pedro Linares

In spite of the large potential and existing efforts to foster energy efficiency in the residential sector, much remains to be achieved. This may be partially due to the many barriers and market failures faced by energy efficiency, which are even greater in this sector. In particular, informational failures seem to be pervasive and relevant in this area. Addressing these issues requires specific policy instruments and strategies. This paper reviews the empirical evidence on the effectiveness of such instruments, focusing on energy certificates, feedback programs, and energy audits. Results show that energy certificates and feedback programs can be effective, but only if they are carefully designed, whereas the evidence about the effectiveness of energy audits is mixed. In addition, the paper points out the large potential for new instruments as well as combinations of existing ones.

Information v. energy efficiency incentives: Evidence from residential electricity consumption in Maryland

- Energy Economics---2015---Anna Alberini,Charles Towe

We focus on two utility programs intended to reduce energy usage and the associated CO₂ emissions—a home energy audit and rebates on the purchase of high-efficiency air-source heat pumps. We use a unique panel dataset from participating and non-participating households to estimate the average treatment effect of participating in either program on electricity usage. We fit models with household-by-season, season-by-year, and household-by-year fixed effects to account for all possible confounders that might influence energy usage. Since the programs are voluntary, we seek to restore near-exogeneity of the program “treatment” by

matching participating households with control households. We deploy coarsened exact matching (CEM; Iacus et al., 2011) as our main matching method. We ask whether it is sufficient to match households based on past electricity usage, or if we gain by adding structural characteristics of the home, including heating system type. We find that the two programs reduce electricity usage by 5% on average. The effects are strong in both winter and summer for the energy audit groups but appear to be stronger in the winter for the heat pump rebate group. Adding house characteristics to the matching variables does seem to affect results, suggesting that using past usage alone, or house characteristics alone, may not be sufficient to identify the effects of program participation.

Heterogeneity in the response to gasoline prices: Evidence from Pennsylvania and implications for the rebound effect

- Energy Economics---2015---Kenneth Gillingham,Alan Jenn,Inês M.L. Azevedo

The consumer response to changing gasoline prices has long interested economists and policymakers, for it has important implications for the effects of gasoline taxation and vehicle energy efficiency policies. This study examines both the elasticity of driving with respect to changing gasoline prices and heterogeneity in this elasticity by geography, the fuel economy of the vehicle, and the age of the vehicle. We use detailed annual vehicle-level emissions inspection test data from Pennsylvania that include odometer readings, inspection zip codes, and extensive vehicle characteristics. We estimate a short-run gasoline price elasticity of driving demand of -0.10 , and find substantial heterogeneity in this responsiveness. The elasticity is largely driven by low fuel economy vehicles, as well as vehicles between 3 and 7 years old. Our findings help reconcile some of the recent literature and provide guidance on the magnitude of the direct rebound effect from light duty vehicle energy efficiency policies.

Energy efficiency subsidies with price-quality discrimination

- Energy Economics---2015---Marie-Laure Nauleau,Louis-Gaëtan Giraudet,Philippe Quirion

We compare various designs of energy efficiency subsidies in a market subject to both energy-use externalities and price-quality discrimination by a monopolist. We find that differentiated subsidies can establish the social optimum. Unlike per-quality regimes, ad valorem regimes generate downstream interferences: Subsidising of the high-end good leads the monopolist to reduce the quality of the low-end good. For this reason, ad valorem differentiated rates should always decrease with energy efficiency, a result seemingly at odds with actual practice. In contrast, with per-quality differentiated subsidies, the rates can increase if the externality is large enough relative to the market share of “low” type consumers. Contrary to differentiated subsidies, what we shall call single-instrument subsidies only achieve second-best outcomes. A uniform ad valorem subsidy should have a rate higher than that needed to specifically internalise energy-use externalities. Lastly, if, as is often observed in practice, only the high-end good is to be incentivised, a per-quality regime should be preferred to an ad valorem one. An ad valorem tax on the high-end good may even be preferred to an ad valorem subsidy if the externality is small enough and low-end consumers dominate the market.

Peeling the onion: Analyzing aggregate, national and sectoral energy intensity in the European Union

- Energy Economics---2015---Andreas Löschel, Frank Pöthen, Michael Schymura

One of the most promising ways of meeting climate policy targets is improving energy efficiency, i.e., reducing the amount of scarce and polluting resources needed to produce a given quantity of output. Relying upon the World Input-Output Database (WIOD), we investigate the decline in energy intensity in the EU27 countries

between 1995 and 2009. Changes in energy intensity can be attributed to two different drivers: changes in the industrial composition of an economy and changes in its sectoral energy intensities. We conduct a series of index decomposition analyses (IDA) to isolate the effects exerted by these drivers. We then take the findings from the index decomposition analysis and subject them to panel estimations. The objective is to control for factors that may have shaped the evolution of energy intensity in the European Union. We estimate the changes in energy intensity as well as the changes in (energy-relevant) structural change and in the sectoral energy intensities. Therefore, we are able to reveal the channels through which factors such as economic growth, capital intensity, and energy prices affect energy intensity.

How effective are energy-efficiency incentive programs? Evidence from Italian homeowners

- Energy Economics---2015---Anna Alberini, Andrea Bigano

We evaluate incentives for residential energy upgrades in Italy using data from an original survey of Italian homeowners. In this paper, attention is restricted to heating system replacements, and to the effect of monetary and non-monetary incentives on the propensity to replace the heating equipment with a more efficient one. To get around adverse selection and free riding issues, we ask stated preference questions to those who weren't planning energy efficiency upgrades any time soon. We argue that these persons are not affected by these behaviors. We use their responses to fit an energy-efficiency renovations curve that predicts the share of the population that will undertake these improvements for any given incentive level. This curve is used to estimate the CO₂ emissions saved and their cost-effectiveness. Respondents are more likely to agree to a replacement when the savings on the energy bills are larger and experienced over a longer horizon, and when rebates are offered to them. Reminding the respondents about possible CO₂ emissions reductions (our non-monetary incentive) had little effect. Even under optimistic assumptions, monetary

incentives similar to those in the Italian tax credit program are generally not cost-effective.

Bending the learning curve

- Energy Economics---2015---Jan Witajewski-Baltvilks,Elena Verdolini,Massimo Tavoni

The aim of this paper is to improve the application of the learning curve, a popular tool used for forecasting future costs of renewable technologies in integrated assessment models (IAMs). First, we formally discuss under what assumptions the traditional (OLS) estimates of the learning curve can deliver meaningful predictions in IAMs. We argue that the most problematic of them are the absence of any effect of technology cost on its demand (reverse causality) and the ability of IAMs to predict all determinants of cumulative capacity. Next, we show that these assumptions can be relaxed by modifying the traditional econometric method used to estimate the learning curve. The new estimation approach presented in this paper is robust to the two problems identified but preserves the reduced form character of the learning curve. Finally, we provide new estimates of learning curves for wind turbines and PV technologies which are tailored for use in IAMs. Our results suggest that the learning rate should be revised upward for solar PV. Our estimate of learning rate for wind technology is almost the same as the traditional OLS estimates.

Living up to expectations: Estimating direct and indirect rebound effects for UK households

- Energy Economics---2015---Mona Chitnis,Steve Sorrell

This study estimates the combined direct and indirect rebound effects from various types of energy efficiency improvement by UK households. In contrast to most studies of this topic, we base our estimates on cross-price elasticities and therefore capture both the income and substitution effects of energy efficiency improvements. Our approach involves estimating a household demand model to obtain price and expenditure elasticities of different goods and services, utilising a mul-

ti-regional input-output model to estimate the GHG emission intensities of those goods and services, combining the two to estimate direct and indirect rebound effects, and decomposing those effects to reveal the relative contribution of different mechanisms and commodities. We estimate that the total rebound effects are 41% for measures that improve the efficiency of domestic gas use, 48% for electricity use and 78% for vehicle fuel use. The primary source of this rebound is increased consumption of the cheaper energy service (i.e. direct rebound) and this is primarily driven by substitution effects. Our results suggest that the neglect of substitution effects may have led prior research to underestimate the total rebound effect. However, we provide a number of caveats to this conclusion, as well as indicating priorities for future research.

Intergenerational effects of a green tax reform for a more sustainable social security system

- Energy Economics---2015---Carlos de Miguel,María Montero,Claustre Bajona

Green tax reforms are popular in some circles not only because of their direct effect on reducing pollution but also because their revenue capacity may allow to reduce other more distortionary taxes. Despite their potential benefits, the political implementation of green tax reforms is not straightforward. Changes in environmental taxes have different intergenerational effects which need to be taken into account when considering their political support among a country's population. In this paper, we analyze the economic and intergenerational welfare effects of introducing a green tax reform to ameliorate the Spanish social security system. We consider two types of energy taxes: an energy-consumption tax and an energy input tax. We find that both types of reforms are favored by young individuals, but rejected by older generations. The number of generations supporting the reform depends crucially on the disutility that individuals derive from pollution, suggesting that an increase in environmental awareness may be needed for green tax reforms to be politically viable.

Asymmetric industrial energy prices and international trade

- Energy Economics---2015---Misato Sato,Antoine Dechezleprêtre

This paper measures the response of bilateral trade flows to differences in industrial energy prices across countries. Using a rich panel dataset with 42 countries, 62 manufacturing sectors over 16 years (1996–2011) and covering 60% of global merchandise trade, we estimate the short-run effects of sector-level energy price asymmetry on trade. We find that changes in relative energy prices have a statistically significant but very small impact on imports. On average, a 10% increase in the energy price difference between two country-sectors increases imports by 0.2%. The impact is larger for energy-intensive sectors. Even in these sectors, however, the magnitude of the effect is such that changes in energy price differences across time explain less than 0.01% of the variation in trade flows. Simulations based on our model predict that a €40–65/tCO₂ price of carbon in the EU ETS would increase Europe's imports from the rest of the world by less than 0.05% and decrease exports by 0.2%.

The future of solar energy: A personal assessment

- Energy Economics---2015---Richard Schmalensee

To reduce global carbon dioxide emissions substantially by mid-century, electricity generation from solar energy will likely have to be increased dramatically. While the intermittency of the solar resource and the use of rare elements in some current solar technologies are concerns, the most important barrier to a massive scale-up is the current high cost of solar electricity, which will make a dramatic increase in solar deployment politically difficult in many countries. Ambitious publicly-funded research and development efforts aimed at fundamental advances constitute the most plausible approach to substantial cost reductions. Current deployment support programs are generally inefficient, particularly those that favor residential-scale systems, and are less likely to reduce costs substantially.

Delaying the introduction of emissions trading systems—Implications for power plant investment and operation from a multi-stage decision model

- Energy Economics---2015---Jian-Lei Mo,Joachim Schleich,Lei Zhu,Ying Fan

Relying on real options theory, we employ a multistage decision model to analyze the effect of delaying the introduction of emission trading systems (ETS) on power plant investments in carbon capture and storage (CCS) retrofits, on plant operation, and on carbon dioxide (CO₂) abatement. Unlike previous studies, we assume that the investment decision is made before the ETS is in place, and we allow CCS operating flexibility for new power plant investments. Thus, the plant may be run in CCS-off mode if carbon prices are low. We employ Monte Carlo simulation methods to account for uncertainties in the prices of CO₂ certificates, other inputs, and output prices, relying on a realistic parameterization for a supercritical pulverized coal plant in China. We find that CCS operating flexibility lowers the critical carbon price needed to support CCS investment because it renders CCS investment less irreversible. For a low carbon price path, operating flexibility also implies that delaying the introduction of an ETS hardly affects plant CO₂ abatement since the plant operator is better off purchasing emission certificates rather than operating the plant in CCS mode. Interestingly, for low carbon prices we find a U-shaped relation between the length of the delay and the economic value of the plant. Thus, delaying the introduction of an ETS may make investors worse off.

Economies of scale and scope in expansion of the U.S. natural gas pipeline network

- Energy Economics---2015---Matthew E. Oliver

I analyze cost, capacity, mileage, and technical data for 254 U.S. natural gas pipeline projects over the period 1997–2012. Although project costs exhibit economies of scale over the capacity margin and economies of scope over the spatial margin, network expansion costs

may not exhibit cost economies overall. That is, proportional increases in both transmission capacity and length (in miles) may result in a proportional (or even greater-than-proportional) increase in expansion costs. Moreover, large projects (high-capacity pipelines spanning long distances) likely require installation of compression horsepower, which has direct cost effects. My results suggest such projects exhibit significant diseconomies in cost structure. As a result, pipeline tariffs based on cost-of-service pricing likely present a disincentive for prospective pipeline customers to commit to long-term contracts—which are necessary for the pipeline to acquire regulatory permission to build—particularly for large, long-distance expansion projects. The implication is that cost-of-service pricing may inhibit network expansion, exacerbating congestion issues.

A firm-level analysis of outage loss differentials and self-generation: Evidence from African business enterprises

- Energy Economics---2015---Musiliu Oseni, Michael Pollitt

This study examines the outage loss differential between firms that engage in backup generation and those that do not. Unmitigated outage losses were estimated to be US\$2.01–23.92 per kWh for firms engaging in self-generation, and range from US\$1.54 to 32.46 per kWh for firms without self-generation. We also find that firms engaging in self-generation would have suffered additional 1–183% outage losses had they not invested in self-generation. On the other hand, firms without self-generation would have reduced their outage losses by around 6–46% if they had engaged in self-generation. Further analyses, however, reveal that, although engagement in self-generation reduced outage losses, a firm engaging in self-generation may still suffer a greater unmitigated outage loss relative to a firm without a backup generator. The relative outage losses depend on the relative vulnerability of the operations of the two sets of firms to power interruption, and the relative generating capacity of a self-generating firm to its own required electricity loads. Policy reforms that

allow firms, whose operations are highly vulnerable to outages, to make a binding contract with utilities in order to get preferential supply are recommended.

Preferences for improved cook stoves: Evidence from rural villages in north India

- Energy Economics---2015---M.A. Jeuland, V. Bhojvaid, A. Kar, J.J. Lewis, O. Patange, S.K. Patanayak, N. Ramanathan, I.H. Rehman, J.S. Tan Soo, V. Ramanathan

Because emissions from solid fuel burning in traditional stoves impact global climate change, the regional environment, and household health, there is today real interest in improved cook stoves (ICS). Nonetheless, surprisingly little is known about what households like about these energy products. We report on preferences for biomass-burning ICS attributes in a large sample of 2120 rural households in north India, a global hotspot for biomass fuel use and the damages that such use entails. Households have a strong baseline reliance and preference for traditional stoves, a preference that outweighs the \$10 and \$5 willingness to pay (WTP) for realistic (33%) reductions in smoke emissions and fuel needs on average, respectively. Preferences for stove attributes are also highly varied, and correlated with a number of household characteristics (e.g. expenditures, gender of household head, patience and risk preferences). These results suggest that households exhibit cautious interest in some aspects of ICS, but that widespread adoption is unlikely because many households appear to prefer traditional stoves over ICS with similar characteristics. The policy community must therefore support a reinvigorated supply chain with complementary infrastructure investments, foster experimentation with products, encourage continued applied research and knowledge generation, and provide appropriate incentives to consumers, if ICS distribution is to be scaled up.

Comprehensive measurement of energy market integration in East Asia: An application of dynamic principal component analysis

- Energy Economics---2015---Dandan Zhang,Xunpeng Shi,Yu Sheng

The energy market integration (EMI) in East Asia has been carried out for over a decade. Despite the efforts exerted by countries in the region, little has been known about the EMI progress. This paper innovatively applies the dynamic principal component analysis to measure the EMI and its evolution in East Asia between 1995 and 2011. The EMI is measured by using information from all the five dimensions that have been identified in the literature: (1) energy trade liberalisation; (2) investment liberalisation; (3) development of energy infrastructure and its associated institutional arrangements; (4) domestic market openness; and (5) energy pricing reform. Results show that although significant progress has been made for EMI in East Asia, there are significant cross-country disparities in different aspects. Moreover, we show that further efforts towards EMI in general should focus on liberalising national markets first, then phasing out fossil fuel subsidies and finally, liberalising investment regime since national market liberalisation is the least developed dimensions. Certain countries that lag behind in EMI need to learn from either their past experiences or from other nations and focus their efforts on their relatively weak dimensions.

Hidden regimes and the demand for carbon dioxide from motor-gasoline

- Energy Economics---2015---Travis Roach

Perhaps the most tactile source of anthropogenic carbon dioxide (CO₂) emissions stem from vehicle-use. Because consumers are well aware of their price and quantity decisions it is likely that consumer demand for CO₂ emissions from motor-gasoline are quite responsive to the overall state of the economy. Using a structurally identified Markov-switching demand model I find that CO₂ emissions respond asymmetrically to

changes in income and the price of gasoline in expansionary and contracting states of the economy. The findings of this paper indicate that flexible policy instruments have the potential to mitigate undue burden on consumers and producers compared to their static counterparts.

Science and the stock market: Investors' recognition of unburnable carbon

- Energy Economics---2015---Paul A. Griffin,Amy Myers Jaffe,David H. Lont,Rosa Dominguez-Faus

This paper documents the stock market's reaction to a 2009 paper in the Nature journal of science, which concluded that only a fraction of the world's existing oil, gas, and coal reserves could be emitted if global warming by 2050 were not to exceed 2°C above pre-industrial levels. This Nature article is now one of the most cited environmental science studies in recent years. Our analysis indicates that this publication prompted an average stock price drop of 1.5% to 2% for our sample of the 63 largest U.S. oil and gas firms. Later, in 2012–2013, the press “discovered” this article, writing hundreds of stories on the grim consequences of unburnable carbon for fossil fuel companies. We show only a small negative reaction to these later stories, mostly in the two weeks following their publication. This limited market response contrasts with the predictions of some analysts and commentators of a substantial decline in the shareholder value of fossil fuel companies from a carbon bubble. Our paper discusses possible reasons for this discrepancy.

Growth and competition in renewable energy industries: Insights from an integrated assessment model with strategic firms

- Energy Economics---2015---Benjamin D. Leibowicz

This article describes the development, implementation, and application of an integrated assessment modeling framework featuring renewable technology markets with producers engaged in Cournot competition. Scenario results reveal how climate policy and inter-firm

learning spillovers interact with market structure to affect wind and solar PV prices, adoption, producer profits, and carbon emissions. Competitive markets yield consistently lower markups than concentrated markets, leading to significantly more adoption and lower emissions. Widespread solar PV adoption is a key component of the largest emissions reductions, but this requires substantial price reductions that only occur if the solar PV market is competitive and learning spills over across producers. Whether a leading firm has a profit incentive to facilitate or obstruct learning spillovers depends on the availability of cost-competitive substitute technologies. If such a substitute exists, the firm prefers strong spillovers that help its industry compete against the substitute; if not, the firm prefers weak spillovers that prevent competitors in its industry from seizing market share. The relationship between price and cumulative capacity is endogenous in the modeling framework. Regression analysis of scenario results yields price learning rates which are similar to unit production cost learning rates in competitive markets, but substantially lower – even negative – in concentrated markets.

The global markets for coking coal and iron ore — Complementary goods, integrated mining companies and strategic behavior

- Energy Economics---2015---Harald Hecking,Timo Panke
- The global market for coking coal is linked to the global market for iron ore since both goods are complementary inputs in pig iron production. Moreover, international trade of both commodities is highly concentrated, with only a few large companies active on both input markets. Given this setting, the paper presented investigates the strategy of quantity-setting (Cournot) mining companies that own both a coking coal and an iron ore division. Do these firms optimize the divisions' output on a firm level or by each division separately (division-by-division)? First, using a theoretical model of two Cournot duopolies of complementary goods, we find that there exists a critical capacity constraint below/above at which firm-level

optimization results in identical/superior profits compared with division-level optimization. Second, by applying a spatial multi-input equilibrium simulation model of the coking coal and iron ore markets, we find that due to the limited capacity firms gain no (substantial) additional benefit from optimizing output on a firm level.

Impact measurement of tariff changes when experimentation is not an option—A case study of Ontario, Canada

- Energy Economics---2015---Ahmad Faruqui,Sanem Sergici,Neil Lessem,Dean Mountain

This paper presents the first year results of a three-year study that was designed to measure the impact of time-of-use rates in the Canadian province of Ontario. Unlike prior studies, which have analyzed such impacts in an experimental setting featuring the randomized allocation of customers to treatment and control groups, this study deals with a situation where the deployment of time-of-use rates was not experimental in nature. It was part of a full-scale program. By carefully drawing samples across four local distribution companies, we were able to interpret the study as a natural experiment and construct control groups and treatment groups. We used the Addilog model of consumer demand to estimate elasticities of substitution between peak, mid-peak and off-peak periods. The Addilog model includes as a special case the constant elasticity of substitution model that has been widely used in the literature on customer response to time-of-use rates. The estimated elasticities are well behaved and consistent with those found in the literature.

Retail and wholesale gasoline price adjustments in response to oil price changes

- Energy Economics---2015---Donald Bumpass,Vance Ginn,M.H. Tuttle

This research examines the long-run relationship between the spot oil price and retail and wholesale gasoline prices. Recent research suggests that the response

of the retail gasoline price is faster and the size of the change is larger, in magnitude, following a crude oil price increase compared with periods when the crude oil price is falling; however, some recent papers examining potential asymmetries present mixed results. Our results from a common threshold model estimating the adjustment of gasoline prices and the spot oil price suggest a long-run relationship between retail and wholesale gasoline prices and the crude oil price. Further, results here suggest that both retail and wholesale gasoline prices respond symmetrically to an oil price shock in the long run, indicating little market power by gas stations and wholesalers.

The world trade network and the environment

- Energy Economics---2015---Carlos Aller,Lorenzo Ductor,Maria Jesus Herrerias

This paper analyses the role of the world trade network on the environment. We rely on methods developed for social network analysis to identify the most important countries in connecting trade between all the other countries in the world trade network. We then estimate how the network or indirect effects from trade affect the environmental quality of a country. As the trade networks are endogenously determined by trade and environmental conditions, we use as instrumental variables the growth in the population of trade partners and the growth in the population of trade partners' partners to exploit exogenous variation in the world trade network. Once we simultaneously estimate the environmental, trade, income, and network equations using a three-stage least square procedure, we find that network effects harm the environmental quality of developed countries but improve the environment of developing countries.

Comparison among U.S. industrial sectors by DEA environmental assessment: Equipped with analytical capability to handle zero or negative in production factors

- Energy Economics---2015---Toshiyuki Sueyoshi,Yan Yuan

A green image is recently an important component of corporate sustainability in modern business. By extending the two previous works (i.e., Wang et al., 2014; Sueyoshi and Wang, 2014a), this study discusses a new use of Data Envelopment Analysis (DEA) for environmental assessment by incorporating an analytical capability to handle zero and/or negative in a data set. The proposed approach provides us with not only new quantitative assessment on unified (operational and environmental) performance of firms but also information regarding how to invest for eco-technology innovation for abating an amount of their industrial pollutions. According to the previous studies, the energy industry is an attractive investment target if desirable outputs are measured by Return on Assets (ROA) as a short-term concern and an amount of CO₂ emission reduction. The selection on a desirable output combination is important in understanding the corporate sustainability of the energy industry because it is the largest emitter among seven industry sectors examined in the previous studies. However, if the ROA is replaced by a corporate value, measured by Tobin's q ratio as a long-term concern, the energy industry is not so attractive because it uses a very large production process so that green investment does not immediately increase the corporate value. An empirical problem of these previous studies is that they have investigated only successful companies with positive ROA or Tobin's q ratios. The analytical feature clearly indicates a methodological drawback of their studies. In contrast, this study pays attention to both successful companies with positive net incomes and unsuccessful companies with negative net incomes, so being able to measure all aspects of their performance in a short-term concern. This study finds that the energy industry exhibits a high level of potential on green investment. However, the energy industry may be not attractive even in the short-term concern (i.e., net income), partly because governmental regulations on their operation and pollution prevention efforts are stricter than the other industrial sectors. This result may be seemingly inconsistent with Wang et al. (2014). Rather, the result indicates that successful energy firms can attain the corporate sustainability by investing eco-technology

innovation, but unsuccessful ones cannot attain the sustainability, even in the short-term concern, because they do not have large capital accumulation for eco-technology investment whose importance has been first discussed by Sueyoshi and Goto (2010a). In other words, the eco-technology investment for enhancing a high level of corporate sustainability depends upon an amount of net income generated by each energy firm.

Japanese fuel mix strategy after disaster of Fukushima Daiichi nuclear power plant: Lessons from international comparison among industrial nations measured by DEA environmental assessment in time horizon

- Energy Economics---2015---Toshiyuki Sueyoshi,Mika Goto

On June 1, 2015, the Japanese government has announced that the fuel mix will consist of nuclear generation with a range between 20% and 22% and renewable generation with a range between 22% and 24% of the total electricity generation by 2030. A difficulty in understanding the governmental future energy plan is that it does not contain any scientific evidence concerning why Japan needs to maintain the amount of nuclear generation and that of renewable at the level between 20% and 22% and between 22% and 24%, respectively. To investigate the future energy plan, this study uses Data Envelopment Analysis (DEA) as a methodology. The proposed DEA approach incorporates the property of “translation invariance”. The property indicates that an efficiency measure should not be influenced even if inputs and/or outputs are shifted toward a same direction by adding or subtracting a specific real number. The property makes it possible that we can evaluate the performance of organizations, whose production factors (i.e., inputs, desirable and undesirable outputs) contain many zeros and negative values in a data set. Such an occurrence of zero and negative in production factors is widely observed in many DEA performance evaluations. This study first uses the desirable property for DEA environmental assessment in a time horizon. The proposed DEA environmental assessment identifies that the reasonable ranges for

Japanese future fuel mix are (a) combustible fuel generation within the range between 34.5% and 56.1%, (b) hydro generation within the range between 22.4% and 40.5%, (c) nuclear generation within the range between 10.4% and 13.7%, (d) pumped hydro generation within the range between 3.9% and 6.9% and (e) renewable generation within the range between 3.7% and 8.4%, all of which are measured by these generation capacities. It is clearly identified that the future fuel mix proposed by the Japanese government is inconsistent with the estimated one, which we determine by relatively comparing it with the energy structures of 33 industrial nations. The comparison indicates that the Japanese future energy plan will be too ambitious to implement the future goal. It is easily envisioned that the energy plan will have a considerable difficulty in future. It is hoped that the electric power industry can access drastic technological advancements, including eco-technology innovation, and then Japan will be able to change the future direction on fuel mix as the government expects.

Pricing of forwards and other derivatives in cointegrated commodity markets

- Energy Economics---2015---Fred Espen Benth,Steen Koekebakker

We analyze cointegration in commodity markets, and propose a parametric class of pricing measures which preserves cointegration for forward prices with fixed time to maturity. We present explicit expressions for the term structure of volatility and correlation in the context of our spot price models based on continuous-time autoregressive moving average dynamics for the stationary components. The term structures have many interesting shapes, and we provide some empirical evidence from refined oil future prices at NYMEX defending our modeling idea. Motivated from these results, we present a cointegrated forward price dynamics using the Heath–Jarrow–Morton approach. In this setting, the concept of cointegration is extended to what we call cointegration in the limit, which is an asymptotic form of the notion. The Margrabe formula for spread option prices is shown to hold, with

an explicit plug-in volatility. We present several numerical examples showing that cointegration leads to significantly cheaper spread options compared to the complete market case, where cointegration disappears with respect to the pricing measure.

Long-run relation and short-run dynamics in energy consumption–output relationship: International evidence from country panels with different growth rates

- Energy Economics---2015---Hassan Moham-madi,Modhurima Dey Amin

The long-run relation and short-run dynamics between output and consumption of energy (electricity) are examined in panels of countries with different growth rates. Seventy nine countries over 1971–2011 are grouped into high-, low- and negative-growth categories based on exponential growth rate of their per capita output. Tests of cointegration suggest the existence of long-run relation between energy (electricity) consumption and output in high- and low-growth panels but its absence in the panel with negative growth. Accounting for cross-country dependency strengthens the findings. Estimates of long-run elasticity of output with respect to energy (electricity) are significant in panels with positive growth rates. The common correlated effect mean-group estimators of the error-correction model suggest (1) long-run bidirectional causality between output and energy (electricity) in all three groups of countries, (2) short-run bidirectional causality in output-energy relation for the full sample as well as in the low-growth category; and (3) unidirectional causality from output to energy in the negative-growth category. The finding of long-run bidirectional causality is robust to inclusion of carbon emission, urbanization, exports, and foreign direct investment as control variables.

Energy efficiency and exporting: Evidence from firm-level data

- Energy Economics---2015---Jayjit Roy,Mahmut Yasar

While exporting firms and non-exporters have been

compared across several dimensions, empirical comparisons on the basis of environmental performance are relatively few. Moreover, analyzing the environmental implications of firm-level exports is not trivial due to non-random selection into exporting. In this light, we examine the impact of exporting on firms' energy efficiency by resorting to an instrumental variables strategy based on a differencing approach (Pitt and Rosenzweig, 1990). Utilizing data from Indonesia, we find (i) exporting to reduce the use of fuels (relative to electricity) and (ii) concerns over endogeneity of exporting status to be relevant.

Is there an Environmental Kuznets Curve for South Africa? A co-summability approach using a century of data

- Energy Economics---2015---Adnen Ben Nasr,Rangan Gupta,João Ricardo Sato

There exists a huge international literature on the, so-called, Environmental Kuznets Curve (EKC) hypothesis, which in turn, postulates an inverted u-shaped relationship between environmental pollutants and output. The empirical literature on EKC has mainly used test for cointegration, based on polynomial relationships between pollution and income. Motivated by the fact that, measured in per capita CO2 equivalent emissions, South Africa is the world's most carbon-intensive non-oil-producing developing country, this paper aims to test the validity of the EKC for South Africa. For this purpose, we use a century of data (1911–2010), to capture the process of development better compared to short sample-based research; and the concept of co-summability, which is designed to analyze non-linear long-run relations among persistent processes. Our results, however, provide no support of the EKC for South Africa, both for the full-sample and sub-samples (determined by tests of structural breaks), implying that to reduce emissions without sacrificing growth, policies should be aimed at promoting energy efficiency.

Dynamic changes in CO2 emission performance of different types of Iranian fossil-fuel power plants

- Energy Economics---2015---Alireza Nabavieh,Davoud Gholamiangonabadi,Ali Asghar Ahangaran

In this paper, the MNMCPI (metafrontier non-radial Malmquist CO2 emission performance index) is applied to study the CO2 emission performance of different types of Iranian fossil-fuel power plants during the period of 2007–2012. The MNMCPI has several advantages, including the ability to apply group heterogeneity as well as its decomposability to different components, which facilitates identifying the effective factors on performance. The results indicate that the gas-fired and combined cycle power plants have a constant trend and show little progression, while the steam power plants have the worst performance. This is due to the factors such as lack of specified regulations about the type of consumed fuels. Moreover, there does not exist any technological leadership among the fossil-fuel power plants. It was also found that even by considering these conditions, proper resource management and utilizing suitable benchmarks can reduce the current level of CO2 emissions in the power plants up to 25%.

Governance strategies and transaction costs in a renovated electricity market

- Energy Economics---2015---Guilherme Signorini,R. Brent Ross,H. Christopher Peterson

This study applies a transaction cost economics (TCE) framework to examine how economic agents adopt governance strategies in Brazil's recently renovated electricity market. In light of a well-established TCE model, four attributes of transactions (i.e., asset-specificity, uncertainty, complexity, and frequency) are examined for three unregulated transactions between generating firms and final consumers. The qualitative analysis of attributes unfolds into a comparative analysis of theory-predicted governance strategies versus strategies observed in the marketplace. It is argued that Williamson's model continues to effectively predict

the most efficient governance strategy in the sense of minimizing transaction costs and safeguarding idiosyncratic assets. Misalignment between theory predictions and observations, however, suggests that two additional concepts – implementability and reputation – must be examined alongside with Williamson's four attributes of transactions in order to better explain strategic decisions in Brazil's electricity market. Capital availability, existence of compatible partners, and reputation play crucial roles in explaining those decisions.

Interactions between oil and financial markets — Do conditions of financial stress matter?

- Energy Economics---2015---Jer-Yuh Wan,Chung-Wei Kao

This study uses a structural threshold VAR model to study the nonlinear relationships between oil and financial variables. The threshold effect is robust across models having different structural orderings of shocks. Evidence shows that shocks associated with different financial stress regimes explain the asymmetric responses of the system. Shocks in the stressed regime usually have larger and longer effects than shocks in the normal regime. The inverse relationship between real interest rate and real oil price is conditioned on a number of factors, and is not robust across all manner of circumstances. The relationship between oil price and the US dollar is shock-dependent. A negative shock that depreciates the dollar may trigger an increase in oil price, yet a positive oil shock may lead to appreciation of the dollar. Finally, oil's ability to hedge against rising risk is limited to a market with normal stress conditions. It is the US dollar that generally serves as a safe haven when financial markets are enmeshed in considerable tension.

Structural breaks and electricity prices: Further evidence on the role of climate policy uncertainties in the Australian electricity market

- Energy Economics---2015---Nicholas Apergis,Marco Chi Keung Lau

The primary objectives and the strategies of a national electricity market are the efficient delivery of network services and the electricity infrastructure to meet the long-term consumer's interests. Therefore, the objective of this study is to explore whether electricity prices across the six Australian States display instability. Such instability is closely associated with the presence of structural breaks in relevance to policy events on Australian carbon policies. The study makes use of weekly Australian wholesale electricity prices spanning the period from June 8th, 2008 to March 30th, 2014 along with linear and non-linear unit root testing methodologies. The results provide supportive evidence that the Australian electricity market can be described as a less stable electricity market, which implies that a high degree of market power is exercised by generators across regional markets. These findings are expected to have substantial consequences for the effectiveness of carbon dioxide mitigating policies, especially, when there is uncertainty as to whether the planned environmental policy is put in place for the lifespan of undertaken investments.

Asymmetric pricing of diesel at its source

- Energy Economics---2015---Abbas Valadkhani,Russell Smyth,Farshid Vahid

Competitive diesel pricing can yield tangible benefits to truck drivers, fleet operators and farmers. The ability, and willingness, of wholesale distributors to asymmetrically pass on changes in diesel costs to consumers can adversely distort the market. Existing studies for Australia have focused on petrol (gasoil) prices, while there has been no testing for asymmetry in diesel prices. We test for rocket and feather effects in Australian wholesale diesel prices at their source. We find that in all seven seaport cities, when the price of oil goes up, diesel prices shoot up like a rocket and when the price of oil decreases, diesel prices fall like a feather. The asymmetric responses are more noticeable when oil prices are rising than falling. Results support the view that suppliers adopt or coordinate almost the same asymmetric pricing behaviour before distributing diesel among retailers.

An analytical approach to activating demand elasticity with a demand response mechanism

- Energy Economics---2015---Cédric Clastres,Haikel Khalfallah

The aim of this work is to demonstrate analytically the conditions under which activating the elasticity of consumer demand could benefit social welfare. We have developed an analytical equilibrium model to quantify the effect of deploying demand response on social welfare and energy trade. The novelty of this research is that it demonstrates the existence of an optimal area for the price signal in which demand response enhances social welfare. This optimal area is negatively correlated to the degree of competitiveness of generation technologies and the market size of the system. In particular, it should be noted that the value of unserved energy or energy reduction which the producers could lose from such a demand response scheme would limit its effectiveness. This constraint is even greater if energy trade between countries is limited. Finally, we have demonstrated scope for more aggressive demand response, when only considering the impact in terms of consumer surplus.

Variable selection in the analysis of energy consumption–growth nexus

- Energy Economics---2015---Mariam Camarero,Anabel Forte,Gonzalo Garcia-Donato,Yurena Mendoza,Javier Ordoñez

There is abundant empirical literature that focuses on whether energy consumption is a critical driver of economic growth. The evolution of this literature has largely consisted of attempts to solve the problems and answer the criticisms arising from earlier studies. One of the most common criticisms is that previous work concentrates on the bivariate relationship, energy consumption–economic growth. Many authors try to overcome this critique using control variables. However, the choice of these variables has been ad hoc, made according to the subjective economic rationale of the authors. Our contribution to this literature is to apply a robust probabilistic model to select the explanatory

variables from a large set of potential candidates in the case of the US from 1949 to 2010, not only for an aggregate analysis but also for a sector analysis. The results highlight the critical role of public spending and energy intensity in the explanation of growth. Furthermore, since the study reveals different explanatory variables for each sector, it indicates the importance of policy decisions specifically aimed at different sectors.

Policy induced price volatility transmission: Linking the U.S. crude oil, corn and plastics markets

- Energy Economics---2015---Jingze Jiang,Thomas Marsh,Peter Tozer

Policy changes and the evolution of green technology have induced new linkages in commodity markets. In this research, we study a representative market system, the U.S. crude oil, corn and plastics markets affected by policies promoting corn-based energy and corn-based bioplastics production. A vector error correction model (VECM) is estimated to study price transmission among markets in the United States, especially price volatility spillover effects. We find that plastics prices and corn futures prices move together in the long run, but that the crude oil futures prices are weakly exogenous to this system. We identify significant bidirectional volatility transmission between the corn futures and plastics markets, which brings new challenges to stakeholders in both markets. Moreover, we demonstrate that EISA 2007 has strengthened linkages between the corn futures and crude oil futures markets. In addition, changes in the linkages across the three markets are associated with the fuel ethanol-gasoline consumption ratio. The potential application of these findings for policy makers and risk managers is discussed.

The increase in Brazilian household income and its impact on CO2 emissions: Evidence for 2003 and 2009 from input-output tables

- Energy Economics---2015---Fernando Perobelli,Weslem Rodrigues Faria,Vinicius de Almeida Vale

In recent years, Brazil has experienced economic growth and a recovery of income that has had a positive impact on the consumption of goods. In this paper, we evaluate the impact of Brazilian household consumption on the CO2 emissions for 2003 and 2009 using input-output tables from the World Input-Output Database. We used a semi-closed model with eight household groups in order to apply the hypothetical extraction method in the consumption structure of each group. Further, we use the result from the hypothetical extraction to evaluate the impacts of the structure consumption of each household group in terms of CO2 emissions. We find that there is a trade-off between the households' greater satisfaction from consumption and the increasing setback in emissions from the restructuring and modification of the consumption basket. Thus, this study contributes to the research on emissions by mapping the recent behavior of the Brazilian economy in terms of increased income, changes in the consumption structure, and their impacts on emissions. The paper's aggregated results by income and consumption structure based on the intensity of the emissions and their systemic effects add to the discussions on less-polluting production processes, more conscious consumption of goods, and more rational uses of energy and transportation.

Testing fractional persistence and non-linearities in the natural gas market: An application of non-linear deterministic terms based on Chebyshev polynomials in time

- Energy Economics---2015---Olaoluwa Yaya,Luis Gil-Alana,Hector Carcel

Studying variations of natural gas prices in relation to consumer prices may give us better indicators for the analysis of economic activity. This paper deals with the analysis of natural gas spot prices using fractional integration techniques in the context of non-linear deterministic trends. We find nonstationarity with mean reverting coefficients (i.e., orders of integration in the range (0.5, 1)) in the daily and monthly series, as well as in their logarithmic transformations. Evidences of non-linearities are only obtained in the monthly series

which may be a consequence of the higher degree of volatility associated with this frequency.

Convergence and persistence in per capita energy use among OECD countries: Revisited using confidence intervals

- Energy Economics---2015---Firouz Fallahi, Marcel Voia

This paper investigates the convergence in per capita energy use of a group of 25 OECD countries over the period 1960–2012. Unlike the previous studies, which mainly used unit root tests, in this study, we construct subsampling confidence intervals to assess the convergence in the per capita energy use. These confidence intervals are more informative than the unit root tests, as they provide us with further information on the degree of persistence of the energy use. Our findings suggest that the per capita energy use in Australia, Austria, Belgium, Denmark, Finland, Greece, Italy, Japan, Luxembourg, Netherlands, Norway, Spain, and Switzerland has a convergent pattern. However, the per capita energy use in Greece, Luxemburg, and Spain appear to be very persistent. For the rest of the countries, i.e. 12 countries, we see a divergent pattern.

Consumers' willingness to pay for green electricity: A meta-analysis of the literature

- Energy Economics---2015---Swantje Sundt, Katrin Rehdanz

At present, electricity generated from power plants using renewable sources costs more than electricity generated from power plants using conventional fuels. Consumers bear these expenses directly or indirectly through higher prices for renewable energy or taxes. The number of studies published over the last few years focusing on people's preferences for renewables has increased steadily, making it more and more difficult to identify key explanatory factors that determine people's willingness-to-pay (WTP) for renewables. We present results of a meta-regression on valuation of consumer preferences for a larger share of renewable

energy in their electricity mix. Our meta-regression results reveal a number of important factors that explain the differences in WTP values for renewable energy. Different valuation methods show widely different values, with choice experiments producing the highest estimates. Our results further indicate that consumers' WTP for green electricity differs by source, with hydropower being the least valued. Variables that are often omitted from primary valuation studies are important in explaining differences in values. These variables describe individual and household characteristics as well as information on the type of power plant that will be replaced by renewables. Further, the marginal effect of a survey conducted in the US is pronounced. We also assess the potential for using the results for out-of-sample value transfer and find a median error of 21%.

Cross-border effects of capacity mechanisms: Do uncoordinated market design changes contradict the goals of the European market integration?

- Energy Economics---2015---Roland Meyer, Olga Gore

This paper analyses cross-border effects of a strategic reserve (SR) and reliability options (ROs) based on a two-country simulation model. Using a game-theoretic approach, the countries' policy options for capacity remuneration mechanisms (CRMs) are analysed with respect to welfare and distribution effects. An SR tends to narrow down the market, while ROs intensify price competition. However, cross-border effects are most likely negative for consumers and producers in total in the case of a unilateral implementation of a CRM, and market design changes should be coordinated.

Energy efficiency in the transport sector in the EU-27: A dynamic dematerialization analysis

- Energy Economics---2015---Jadwiga R. Ziolkowska, Bozydar Ziolkowski

Energy use in the European Union's (EU) transport sector amounted to 340Mtoe11Mtoe=megatoe (one

million toe). Toe — ton of oil equivalent. in 1999 with the following increasing trend up to 379Mtoe in 2007 and a decrease from 2008 on, down to 365Mtoe in 2010. This changing pattern posed several fundamental questions and uncertainties regarding the broader picture of energy efficiency and environmental protection. One of them refers to absolute changes in energy use efficiency in the transport sector over time and the ways of measuring efficiency. Traditional scientific approaches conceptualized to measure efficiency of energy use do not address annual dynamics of changes in the energy use in a given sector per capita. Thus, they are not precise enough for political and methodological purposes as they do not reflect the exact amount of energy consumed in the respective countries and societies.

Are benefits from oil–stocks diversification gone? New evidence from a dynamic copula and high frequency data

- Energy Economics---2015---Krenar Avdulaj,Jozef Baruník

Oil is perceived as a good diversification tool for stock markets. To fully understand this potential, we propose a new empirical methodology that combines generalized autoregressive score copula functions with high frequency data and allows us to capture and forecast the conditional time-varying joint distribution of the oil–stocks pair accurately. Our realized GARCH with time-varying copula yields statistically better forecasts of the dependence and quantiles of the distribution relative to competing models. Employing a recently proposed conditional diversification benefits measure that considers higher-order moments and nonlinear dependence from tail events, we document decreasing benefits from diversification over the past ten years. The diversification benefits implied by our empirical model are, moreover, strongly varied over time. These findings have important implications for asset allocation, as the benefits of including oil in stock portfolios may not be as large as perceived.

Energy efficiency of selected OECD countries: A slacks based model with undesirable outputs

- Energy Economics---2015---Nicholas Apergis,Goodness C. Aye,Carlos Barros,Rangan Gupta,Peter Wanke

This paper presents an efficiency assessment of selected OECD countries using a Slacks Based Model with undesirable or bad outputs (SBM-Undesirable). In this research, SBM-Undesirable is used first in a two-stage approach to assess the relative efficiency of OECD countries using the most frequent indicators adopted by the literature on energy efficiency. Besides, in the second stage, GLMM–MCMC methods are combined with SBM-Undesirable results as part of an attempt to produce a model for energy performance with effective predictive ability. The results reveal different impacts of contextual variables, such as economic blocks and capital–labor ratio, on energy efficiency levels.

The nexus between oil price and Russia's real exchange rate: Better paths via unconditional vs conditional analysis

- Energy Economics---2015---Jamal Bouoiyour,Refk Selmi,Aviral Tiwari,Muhammad Shahbaz

Instead of analyzing the causality between two time series (unconditional analysis), as it is usually done, the present study deals with the nexus between oil price and Russia's real exchange rate conditioning upon potential control variables at well-specified horizons and on a frequency by frequency basis. This research accounts also for the possible transient linkages and signal discontinuities. A major finding of this paper is deeply suggestive of a sharp causality running from oil price to real exchange rate in lower frequencies. This implies that Russia should better tackle with turbulence triggered by oil price and continue to reduce its energy dependency via drastic and proactive measures. The economic and fiscal initiatives of Putin administration may help to cope with sudden shocks, to lessen the great oil dependence and to build confidence needed for economic recovery. While our research does not say much about the routes through which oil price may

affect differently real exchange rate, it clearly indicates the presence of short-term relationship conditional to GDP, government expenditures, terms of trade and productivity differential. The conditional analysis and signal detection appear as meaningful exercises to find new insights into the focal issue.

Index decomposition analysis with multidimensional and multilevel energy data

- Energy Economics---2015---B.W. Ang,H. Wang

Index decomposition analysis (IDA) is a popular tool for analyzing changes in energy consumption over time. Traditionally, a typical IDA study uses a single dimensional energy dataset, such as industrial energy consumption by industrial sector or transportation energy consumption by transport mode. More recently, there have been a growing number of studies using more sophisticated datasets, e.g. energy consumption by geographical region and by economic sector in a single dataset. For IDA studies using energy data with multiple attributes, intermediate decomposition results can be generated using subsets of the entire dataset, and these results provide further insight into the energy system and problem studied. To ensure that these intermediate results are consistent and meaningful, the IDA method used should ideally satisfy two properties: perfect in decomposition at the subcategory level and consistency in aggregation. It is shown that the logarithmic mean Divisia index method I (LMDI-I) satisfies these two properties in both additive and multiplicative decomposition analysis. It is therefore the recommended IDA method when dealing with energy data with multiple attributes.

Impact of energy prices and cellulosic biomass supply on agriculture, energy, and the environment: An integrated modeling approach

- Energy Economics---2015---Rebecca S. Dodder,P. Ozge Kaplan,Amani Elobeid,Simla Tokgoz,Silvia Secchi,Lyubov Kurkalova

The accelerated growth in biofuel markets has both created and reinforced linkages between agriculture and

energy. The evolution of biofuel markets over the next 10–20years and the implications for energy, agriculture, and the environment are uncertain. Building on an integrated agriculture–energy modeling framework, this study analyzes a baseline and three alternative scenarios: two scenarios based on energy prices (crude oil and natural gas) and one based on assumptions regarding cellulosic biomass availability. By examining the impact of scenarios driven by (a) changes in the energy sector and (b) changes in the agricultural sector, we can compare the differential effects on biofuels markets, commodity prices and quantities in each sector, and CO₂ emissions. Scenario comparisons show biofuel markets affected more by crude oil prices than natural gas prices. However, higher natural gas prices shift the biofuel production mix away from corn-grain based to more cellulosic ethanol via multiple mechanisms. Alternatively, the scenario with no cellulosic feedstock lowers total ethanol production and raises ethanol and corn prices. In terms of environmental impacts, higher ethanol levels driven by higher oil prices lead to lower CO₂ emissions. In comparison, the no cellulosic scenario results in the highest CO₂ trajectory relative to the baseline.

A deterministic parametric metafrontier Luenberger indicator for measuring environmentally-sensitive productivity growth: A Korean fossil-fuel power case

- Energy Economics---2015---Ning Zhang,Bing Wang

This paper contributes to the current literature by proposing an alternative parametric metafrontier productivity approach called the deterministic parametric metafrontier Luenberger Productivity Indicator (DPMLPI) for measuring environmentally sensitive productivity growth incorporating technological heterogeneities. The Luenberger productivity indicator is constructed based on a quadratic output directional distance function with undesirable outputs, and then combined with the deterministic metafrontier to develop DPMLPI. The DPMLPI can be decomposed into efficiency change, technological change and pro-

ductivity growth gap. The productivity growth gap can be further divided into efficiency change gap and technological change gap. The parametric linear programming technique is used to estimate parameters and construct the metafrontier. An empirical study for the Korean fossil fuel power industry at the plant-level is conducted for the 2003–2011 period. The results show a 0.15% increase in environmentally-sensitive productivity growth, which is mainly driven by environmental technological change. The oil-fired power plants show higher levels than the coal-fired ones of environmentally sensitive productivity growth and technological change performance. Some related policy implications are also proposed for the Korean fossil-fuel power sector.

Value-at-Risk estimation of energy commodities: A long-memory GARCH–EVT approach

- Energy Economics---2015---Manel Youssef, Lotfi Belkacem, Khaled Mokni

In this paper, we evaluate Value-at-Risk (VaR) and expected shortfall (ES) for crude oil and gasoline market. We adopt three long-memory-models including, FI-GARCH, HYGARCH and FIAPARCH to forecast energy commodity volatility by capturing some volatility stylized fact such as long-range memory, heteroscedasticity, asymmetry and fat-tails. Then we consider extreme value theory which concentrates on the tail distribution rather than the entire distribution. EVT is considered as a potential framework for the separate treatment of tails of distributions which allows for asymmetry. Our results show that the FIAPARCH model with extreme value theory performs better in predicting the one-day-ahead VaR. Using the fitted long-memory GARCH-model and a simulation approach to estimate VaR for horizons over than one day, back-testing results show that our approach still performs for lower estimation frequencies. Overall, our findings confirm that taking into account long-range memory, asymmetry and fat tails in the behavior of energy commodity prices returns combined with filtering process such as EVT are important in improving risk management assessments and hedging strategies in the high volatile energy market.

Drivers of regional decarbonization through 2100: A multi-model decomposition analysis

- Energy Economics---2015---Adriana Mar-
cucci, Panagiotis Fragkos

This study explores short and long-term drivers of alternative decarbonization pathways in four major economies (China, India, Europe and USA), using a multi-model decomposition analysis. The paper focuses on determining the energy system transformations that drive the changes in carbon emissions and identifying the model characteristics that lead to differences in the decarbonization strategies. First, we compare the decomposition over time of near-past carbon emissions and near-future model projections as a methodology to validate baseline scenarios. We show that a no-policy baseline scenario is in line with historical trends for all regions except China, where all models project higher improvements in energy and carbon intensity than the near-past historical development. Second, we compare regional decarbonization drivers across models in a scenario with moderate policy targets that represent the current fragmented international climate policy landscape. The results from the different models show that energy efficiency improvements represent the main strategy in achieving the moderate climate targets. Finally, we develop an LMDI decomposition analysis to determine the additional energy system changes needed to achieve a global GHG concentration target of 450ppm compared to the moderate policy case. In all models, reducing regional carbon intensity of energy is the major decarbonization strategy after 2030. In the long-term (after 2050), most of the models find that negative carbon emissions are critical in such scenario, emphasizing the key role of biomass with CCS. However, the level of contribution of the decarbonization factor varies significantly across models, due to the large uncertainty in the availability of renewables and the development of CCS technologies. Overall, we find that the main differences in the decomposition results across models are due to assumptions concerning availability of natural resources and variety of backstop technologies.

The demand for transport fuels in Turkey

- Energy Economics---2015---Mübariz Hasanov

In this paper, we estimate the demand for transport fuels in Turkey. Specifically, using four different models, namely a partial adjustment model, a distributed lag model, an autoregressive distributed lag model, and an error correction model, we estimate gasoline and diesel demand functions with quarterly data covering the period 2003:Q1–2014:Q3. We find a stable long-run relationship only for diesel demand, income and price. Our results imply that gasoline demand does not respond to income and price in the long run, reflecting a shift from gasoline towards diesel induced by differential tax policies. Furthermore, we find that transport fuel demand is price inelastic, making tax on fuel a perfect tool for raising budget revenues. In addition, our results suggest that fuel demand responds to negative and positive price changes symmetrically.

A harmonized calculation model for transforming EU bottom-up energy efficiency indicators into empirical estimates of policy impacts

- Energy Economics---2015---Marvin J. Horowitz, Paolo Bertoldi

This study is an impact analysis of European Union (EU) energy efficiency policy that employs both top-down energy consumption data and bottom-up energy efficiency statistics or indicators. As such, it may be considered a contribution to the effort called for in the EU's 2006 Energy Services Directive (ESD) to develop a harmonized calculation model. Although this study does not estimate the realized savings from individual policy measures, it does provide estimates of realized energy savings for energy efficiency policy measures in aggregate. Using fixed effects panel models, the annual cumulative savings in 2011 of combined household and manufacturing sector electricity and natural gas usage attributed to EU energy efficiency policies since 2000 is estimated to be 1136PJ; the savings attributed to energy efficiency policies since 2006 is estimated to be 807PJ, or the equivalent of 5.6% of 2011 EU energy consumption. As well as its contribution to energy

efficiency policy analysis, this study adds to the development of methods that can improve the quality of information provided by standardized energy efficiency and sustainable resource indexes.

Nonlinear causality between crude oil price and exchange rate: A comparative study of China and India

- Energy Economics---2015---Debi Prasad Bal, Badri Narayan Rath

While several studies have examined the linear causal relationship between oil prices and exchange rates, little is known about the nonlinear causality between these two variables. The present paper tries to fill this research gap in the context of India and China. By applying the Hiemstra and Jones (1994) nonlinear Granger causality test to the VAR residuals, the study finds a significant bi-directional nonlinear Granger causality between oil prices and exchange rates in both countries. The findings suggest that the nonlinearity of oil price influences the exchange rate irrespective of the exchange rate regimes. Further, to check robustness, the persistence in the variance of oil price and exchange rate is taken into account using a GARCH (1, 1) model. While the results consistently hold in the case of India, with respect to China, a unidirectional causality runs from exchange rate to oil price. However, the oil price in China does not Granger cause exchange rate.

Retail price effects of feed-in tariff regulation

- Energy Economics---2015---Maria Costa-Campi, Elisa Trujillo-Baute

The feed-in tariff regulation is the widest spread instrument used to promote electricity generation from renewable energy sources in the EU, with the costs of resources devoted to this promotion usually being borne by final consumers. Two components of the electricity retail price are expected to be influenced by the feed-in tariff regulation: the incentive to those firms producing electricity from renewable energy sources and the wholesale price of electricity. In this study we analyze the effects that the feed-in tariff regulation has

on the electricity retail price for industrial consumers. We estimate the relative intensity of the impact of the cost of support electricity generation under the feed-in tariff and the electricity wholesale price on the Spanish industrial retail price. Special attention is devoted to technology-specific considerations, as well as short and long run effects. The results show that there is not a strong link between the retail and wholesale market for Spanish industrial consumers. Moreover, the results indicate that an increase of solar generation leads to a higher increase in the industrial retail price than in the case of a proportional increase of wind generation. This suggests that, when evaluating the feed-in tariff regulation impact on the retail price, the cost of incentives effect prevails over the wholesale price effect, and this is stronger for solar than for wind generation.

Electricity consumption and economic growth in Nigeria: A revisit of the energy-growth debate

- Energy Economics---2015---Bernard Njindan Iyke

This paper examines the dynamic causal linkages between electricity consumption and economic growth in Nigeria within a trivariate VECM, for the period 1971–2011. The paper obviates the variable omission bias, and the use of cross-sectional techniques that characterise most existing studies. The results show that there is a distinct causal flow from electricity consumption to economic growth: both in the short run and in the long run. This finding supports the electricity-led growth hypothesis that has been conjectured in the literature. The paper urges policy-makers in Nigeria to implement policies which enhance the generation and consumption of electricity in order to engineer economic growth. Appropriate monetary policies must also be put in place, in order to moderate inflation, thus enhancing growth.

An empirical model comparison for valuing crack spread options

- Energy Economics---2015---Steffen Mahringer, Marcel Prokopczuk

In this paper, we investigate the pricing of crack spread

options. Particular emphasis is placed on the question of whether univariate modeling of the crack spread or explicit modeling of the two underlyings is preferable. Therefore, we contrast a bivariate GARCH volatility model for cointegrated underlyings with the alternative of modeling the crack spread directly. Conducting an empirical analysis of crude oil/heating oil and crude oil/gasoline crack spread options traded on the New York Mercantile Exchange, the more simplistic univariate approach is found to be superior with respect to option pricing performance.

The feasibility, costs, and environmental implications of large-scale biomass energy

- Energy Economics---2015---Niven Winchester, John Reilly

What are the feasibility, costs, and environmental implications of large-scale bioenergy? We investigate this question by developing a detailed representation of bioenergy in a global economy-wide model. We develop a scenario with a global carbon dioxide price, applied to all anthropogenic emissions except those from land use change, that rises from \$25 per metric ton in 2015 to \$99 in 2050. This creates market conditions favorable to biomass energy, resulting in global non-traditional bioenergy production of ~150 exajoules (EJ) in 2050. By comparison, in 2010, global energy production was primarily from coal (138 EJ), oil (171 EJ), and gas (106 EJ). With this policy, 2050 emissions are 42% less in our Base Policy case than our Reference case, although extending the scope of the carbon price to include emissions from land use change would reduce 2050 emissions by 52% relative to the same baseline. Our results from various policy scenarios show that lignocellulosic (LC) ethanol may become the major form of bioenergy, if its production costs fall by amounts predicted in a recent survey and ethanol blending constraints disappear by 2030; however, if its costs remain higher than expected or the ethanol blend wall continues to bind, bioelectricity and bioheat may prevail. Higher LC ethanol costs may also result in the expanded production of first-generation biofuels (ethanol from sugarcane and corn) so that they

remain in the fuel mix through 2050. Deforestation occurs if emissions from land use change are not priced, although the availability of biomass residues and improvements in crop yields and conversion efficiencies mitigate pressure on land markets. As regions are linked via international agricultural markets, irrespective of the location of bioenergy production, natural forest decreases are largest in regions with the lowest barriers to deforestation. In 2050, the combination of carbon price and bioenergy production increases food prices by 3.2%–5.2%, with bioenergy accounting for 1.3%–3.5%.

Forecasting gasoline prices in the presence of Edgeworth Price Cycles

- Energy Economics---2015---Michael D. Noel,Lanlan Chu

Forecasting is a central theme in economics. The ability to forecast prices enables economic agents to make optimal decisions for the present and future. In this article, we investigate if and how gasoline prices can be forecast in retail gasoline markets that are subject to high-frequency, asymmetric price cycles known as Edgeworth Price Cycles. We examine a series of purchase timing decision rules and a series of feasible forecasting algorithms for updating those rules over time. We find that, in the presence of cycles, agents in our five Australian markets can systematically reduce purchase prices below market average the equivalent of 11 to 15 U.S. cents per gallon, using simple decision rules and feasible forecasting algorithms.

Fine structure of the price–demand relationship in the electricity market: Multi-scale correlation analysis

- Energy Economics---2015---Dmitriy Afanasyev,Elena A. Fedorova,Viktor U. Popov

In this research we investigate the problems of dynamic relationship between electricity price and demand over different time scales for two largest price zones of the Russian wholesale electricity market. We use multi-scale correlation analysis based on a modified method of

time-dependent intrinsic correlation and the complete ensemble empirical mode decomposition with adaptive noise for this purpose. Three hypotheses on the type and strength of correlations in the short-, medium- and long-runs were tested. It is shown that price zones significantly differ in internal price–demand correlation structure over the comparable time scales, and not each of the theoretically formulated hypotheses is true for each of them. We can conclude that the answer to the question whether it is necessary to take into account the influence of demand-side on electricity spot prices over different time scales, is significantly dependent on the structure of electricity generation and consumption on the corresponding market.

Convergence of carbon dioxide performance across Swedish industrial sectors: An environmental index approach

- Energy Economics---2015---Runar Brännlund,Tommy Lundgren,Patrik Söderholm

The overall objective of the paper is to analyze convergence of CO₂ emission intensity across manufacturing sectors in Sweden. Our approach differs from previous work on carbon convergence in that it employs a theoretical framework to construct a CO₂ performance index, which explicitly takes into account that industrial firms produce good as well as bad outputs. This index is then used as the dependent variable in a growth-type regression equation. We employ a data set covering 14 industrial sectors over the time period 1990–2008. The results suggest the presence of conditional β -convergence in CO₂ performance among the industrial sectors in Sweden. Moreover, the speed of convergence varies significantly in the sense that the higher the capital intensity is, the lower is the convergence rate to the different steady states. This is likely to reflect the importance of – and in part the costs associated with – capital turnover to achieve a transition towards lower CO₂ emission paths.

Electric sector capacity planning under uncertainty: Climate policy and natural gas in the US

- Energy Economics---2015---John Bistline

This research investigates the dynamics of capacity planning and dispatch in the US electric power sector under a range of technological, economic, and policy-related uncertainties. Using a two-stage stochastic programming approach, model results suggest that the two most critical risks in the near-term planning process of the uncertainties considered here are natural gas prices and the stringency of climate policy. Stochastic strategies indicate that some near-term hedging from lower-cost wind and nuclear may occur but robustly demonstrate that delaying investment and waiting for more information can be optimal to avoid stranding capital-intensive assets. Hedging strategies protect against downside losses while retaining the option value of deferring irreversible commitments until more information is available about potentially lucrative market opportunities. These results are explained in terms of the optionality of investments in the electric power sector, leading to more general insights about uncertainty, learning, and irreversibility. The stochastic solution is especially valuable if decision-makers do not sufficiently account for the potential of climate constraints in future decades or if fuel price projections are outdated.

Driving factors behind carbon dioxide emissions in China: A modified production-theoretical decomposition analysis

- Energy Economics---2015---Qunwei Wang, Yung-Ho Chiu, Ching-Ren Chiu

Research on the driving factors behind carbon dioxide emission changes in China can inform better carbon emission reduction policies and help develop a low-carbon economy. As one of important methods, production-theoretical decomposition analysis (PDA) has been widely used to understand these driving factors. To avoid the infeasibility issue in solving the linear programming, this study proposed a modified

PDA approach to decompose carbon dioxide emission changes into seven drivers. Using 2005–2010 data, the study found that economic development was the largest factor of increasing carbon dioxide emissions. The second factor was energy structure (reflecting potential carbon), and the third factor was low energy efficiency. Technological advances, energy intensity reductions, and carbon dioxide emission efficiency improvements were the negative driving factors reducing carbon dioxide emission growth rates. Carbon dioxide emissions and driving factors varied significantly across east, central and west China.

Effects of oil price shocks on the stock market performance: Do nature of shocks and economies matter?

- Energy Economics---2015---Thai-Ha Le, Youngho Chang

The main focus of this study is to examine how oil price fluctuations influence the performance of stock markets. This study used the causality approach developed by Toda and Yamamoto (1995) to explore the causality between oil prices and stock prices in the long-run and their short-term impact. The generalized impulse response functions were applied to the monthly data in the period from January 1997 to July 2013. In this study, to capture the different characteristics of oil refining, exporting and importing, three Asian economies were examined. The results indicate that the manner in which a market reacts to hikes in oil prices varies between different markets and periods. This depends on differences in the oil characteristics of the economy and the nature of the shock in oil prices.

Does foreign direct investment impede environmental quality in high-, middle-, and low-income countries?

- Energy Economics---2015---Muhammad Shahbaz, Samia Nasreen, Faisal Abbas, Anis Omri

Under a multivariate framework, this paper aims to investigate the nonlinear correlation between foreign direct investment and environmental degradation for

high-, middle-, and low-income countries with economic growth and energy consumption as additional determinants of environmental degradation. All variables were found to be nonstationary and cointegrated based on recent panel data unit-root tests and cointegration techniques. On applying fully modified ordinary least squares (FMOLS), the long-run results suggest the presence of an environmental Kuznets curve. In turn, foreign direct investment increases environmental degradation, thus confirming the pollution haven hypothesis (PHH). Moreover, the bidirectional causality between CO₂ emissions and foreign direct investment is observed globally. The findings are sensitive to different income groups and regional analyses. In particular, these empirical findings aid sound economic policymaking for improving environmental quality and sustainable economic development.

Bidding behavior in the Chilean electricity market

- Energy Economics---2015---Javier Bustos Salvagno, Javier Bustos Salvagno

Contracts in power markets are usually obscure. From recently public auctions of long-term supply contracts we can obtain information on how contract prices are determined. To understand generators' bidding behavior, this paper examines the Chilean experience from 2006 to 2011. Using a divisible good auction model we provide a theoretical framework that explains bidding behavior in terms of expected spot prices and contracting positions. Empirical estimations indicate heterogeneity in the cost of over-contracting depending on incumbency, bringing evidence of significant barriers to entry.

Linear and nonlinear Granger causality investigation between carbon market and crude oil market: A multi-scale approach

- Energy Economics---2015---Lean Yu, Jingjing Li, Ling Tang, Shuai Wang

This paper investigates the causality between carbon market and crude oil market using a multi-scale analysis approach, in which two main steps are involved:

multi-scale analysis and causality testing. In multi-scale analysis, bivariate empirical mode decomposition (BEMD) is employed to decompose the two series of market returns at different time-scales. In causality testing, a linear and nonlinear integrated Granger test is formulated to investigate the relationship among each pair of matched components on a similar time-scale. With the European Union emission allowance (EUA) futures and Brent futures as study samples, some interesting findings can be obtained. (1) At the original data level (without multi-scale decomposition), this study finds evidence supporting a neutrality hypothesis, i.e., no Granger causality between the carbon and crude oil markets. (2) On small time-scale (within one week excluding non-work days), the two markets might be uncorrelated and driven by their own respective supply-demand disequilibria. (3) For medium time-scale (above one week but below one year), there is a strong bi-directional linear and nonlinear spillover effect between the two markets, due to certain extra factors with medium-term effects, e.g., significant events and policy changes. (4) For long time-scale, the long-term trends of the two markets appear an obvious linear relationship.

Trading on mean-reversion in energy futures markets

- Energy Economics---2015---Thorben Lubnau, Neda Todorova

We study whether simple technical trading strategies enjoying large popularity among practitioners can be employed profitably in the context of hedge portfolios for Crude Oil, Natural Gas, Gasoline and Heating Oil futures. The strategies tested are based on mean-reverting calendar spread portfolios established with dynamic hedge ratios. Entry and exit signals are generated by so-called Bollinger Bands. The trading system is applied to twenty-two years of historical data from 1992 to 2013 for various specifications, taking transaction costs into account. The significance of the results is evaluated with a bootstrap test in which randomly generated orders are compared to orders placed by the trading system. Whereas we find most combinations

involving the front-month and second-month futures to be significantly profitable for all commodities tested, the best results for the risk-adjusted Sharpe Ratio are obtained for WTI Crude Oil and Natural Gas, with Sharpe Ratios in excess of 2 for most combinations and a rather smooth performance for all calendar spreads. Based on our results, there is a serious doubt whether energy futures markets can be considered weakly efficient in the short-term.

A dynamic multi-stage data envelopment analysis model with application to energy consumption in the cotton industry

- Energy Economics---2015---Kaveh Khalili-Damghani, Madjid Tavana, Francisco J. Santos-Arteaga, Sima Mohtasham

Data envelopment analysis (DEA) is a non-parametric method for evaluating the relative efficiency of homogeneous decision making units (DMUs) with multiple inputs and outputs. In this paper, we present a dynamic multi-stage DEA (DMS-DEA) approach to evaluate the efficiency of cotton production energy consumption. In the proposed model, the farms which consume resources (i.e., fertilizers, seeds, and pesticides) to produce cotton are assumed to be the DMUs. Inputs not consumed during a planning period are carried over to the next period in the planning horizon. Initially, a DMS-DEA model is used to determine the overall efficiency of the DMUs with dynamic inputs. Next, the efficiency score of each DMU is calculated for each time period in the planning horizon. We demonstrate the applicability of the proposed method and exhibit the efficacy of the procedures and algorithms with a real-life case study of energy consumption in the cotton industry.

DEA environmental assessment in time horizon: Radial approach for Malmquist index measurement on petroleum companies

- Energy Economics---2015---Toshiyuki Sueyoshi, Mika Goto

The climate change and various pollutions have been

influencing our societies and economies. The environmental assessment, to be discussed in this study, is increasingly important because it serves as an initial step toward pollution prevention. Corporate leaders, policy makers, researchers and individuals who are interested in environmental protection have been paying attention to the assessment so that they can prepare policy suggestions on the global warming and climate change. As a methodology for the assessment, this study proposes a use of Data Environment Analysis (DEA) in a time horizon. Most of data sets on the climate change are sampled in a time series where the performance of organizations fluctuates every moment. In applying the DEA environmental assessment to such a data set, it is necessary for us to classify outputs into desirable (e.g., oil production) and undesirable (e.g., CO₂ emission) categories because all organizations usually produce not only desirable but also undesirable outputs as a result of their economic activities. To unify the two different types of outputs, this study incorporates the concept of natural and managerial disposability into the computational framework of DEA and extends them into a time horizon. For the research purpose, this study incorporates Malmquist index into the proposed DEA environmental assessment to examine an occurrence of a frontier shift among multiple periods. The frontier shift indicates a technology progress and/or managerial innovation during an observed period. The index is further separated into four subcomponents in a time horizon. These subcomponents are differently expressed under the natural and managerial disposability. Thus, eight different subcomponents on the Malmquist index are proposed to measure the frontier shift. As an application, this study uses the proposed DEA approach to examine whether the frontier shift (due to technology progress) occurs or not in the petroleum industry from 2005 to 2009. Our empirical study finds that the industry has not exhibited any major frontier shift under natural disposability, but showing a considerable frontier shift under managerial disposability. In other words, the petroleum firms have improved their environmental performance by eco-technology to reduce an amount of CO₂ emission during the observed annual periods.

Investigating the value of fusion energy using the Global Change Assessment Model

- Energy Economics---2015---D. Turnbull,A. Glaser,R.J. Goldston

The availability of fusion energy could prove valuable in meeting carbon mitigation targets over the course of the century. We use recent cost estimates for future fusion power plants in order to incorporate fusion into the Global Change Assessment Model (GCAM), a long-term energy and environment model used to study the interaction between technology, climate, and public policy. Results show that fusion's growth will depend on: the chosen carbon mitigation target (if any); the availability of competing carbon-neutral options for the provision of baseload electrical power, in particular nuclear fission as well as carbon capture and storage; the chosen discount rate; the initial year of availability; and the assumed costs of fusion electricity. We quantify the present value of the fusion option while varying the assumptions about these other parameters, and we find that it is, in general for our range of assumptions, significantly larger than the estimated cost of a comprehensive R&D plan to develop fusion energy. The results emphasize the wisdom in hedging against uncertainty in future technology availability by pursuing the development of multiple options that could feasibly play a major role in the latter half of the century.

The effect of global oil price shocks on China's agricultural commodities

- Energy Economics---2015---Chuanguo Zhang,Xuqin Qu

This paper studied the effect of global oil price shocks on agricultural commodities in China, including strong wheat, corn, soybean, bean pulp, cotton and natural rubber. We regarded oil price volatility process as a combination of continuous process and jump process. We not only separated oil price shocks into positive and negative categories to identify different effects on agricultural commodities in continuous process, but also investigated how jump behavior influenced these

agricultural commodities. We found that the oil price was characterized by volatility clustering and jump behavior. At the same time, oil price shocks had different effects on agricultural commodities. In addition, the shocks on most agricultural commodities were asymmetric. Only natural rubber was under influence of the jump intensity of the oil price, in contrast to strong wheat, corn, soybean, bean pulp and cotton.

Hydro resource management, risk aversion and equilibrium in an incomplete electricity market setting

- Energy Economics---2015---Pablo Rodilla,Javier García-González,Álvaro Baíllo,Santiago Cerisola,Carlos Batlle

Since the outset of power system reform, one of the main objectives of regulation has been to assess whether the market, of its own accord, can induce agents to adopt decisions that maximise social welfare.

Modelling interregional links in electricity price spikes

- Energy Economics---2015---Adam Clements,Rodrigo Herrera,Stan Hurn

Abnormally high price spikes in spot electricity markets represent a significant risk to market participants. As such, a literature has developed that focuses on forecasting the probability of such spike events, moving beyond simply forecasting the level of price. Many univariate time series models have been proposed to deal with spikes within an individual market region. This paper is the first to develop a multivariate self-exciting point process model for dealing with price spikes across connected regions in the Australian National Electricity Market. The importance of the physical infrastructure connecting the regions on the transmission of spikes is examined. It is found that spikes are transmitted between the regions, and the size of spikes is influenced by the available transmission capacity. It is also found that improved risk estimates are obtained when inter-regional linkages are taken into account.

Selective reporting and the social cost of carbon

- Energy Economics---2015---Tomas Havranek,Zuzana Irsova,Karel Janda,David Zilberman

We examine potential selective reporting (publication bias) in the literature on the social cost of carbon (SCC) by conducting a meta-analysis of 809 estimates of the SCC reported in 101 studies. Our results indicate that estimates for which the 95% confidence interval includes zero are less likely to be reported than estimates excluding negative values of the SCC, which might create an upward bias in the literature. The evidence for selective reporting is stronger for studies published in peer-reviewed journals than for unpublished papers. We show that the findings are not driven by the asymmetry of the confidence intervals surrounding the SCC and are robust to controlling for various characteristics of study design and to alternative definitions of confidence intervals. Our estimates of the mean reported SCC corrected for the selective reporting bias range between USD 0 and 134 per ton of carbon at 2010 prices for emission year 2015.

Renewable energy, subsidies, and the WTO: Where has the ‘green’ gone?

- Energy Economics---2015---Patrice Bougette,Christophe Charlier

Faced with the energy transition imperative, governments have to decide about public policies to promote renewable electrical energy production and to protect domestic power generation equipment industries. These policies can generate trade frictions. For example, in the Canadian renewable energy dispute the EU and Japan claimed that Feed in Tariff (FIT) programs in Ontario constitute discriminatory subsidies because of a local content requirement (LCR) clause that is incompatible with World Trade Organization obligations. This paper investigates this issue using an international quality differentiated duopoly model in which power generation equipment producers compete on price. FIT programs including those with a LCR are compared for their impacts on trade, profits, amount

of renewable electricity produced, and welfare. When sales are taken into account, the results confirm discrimination. However, introducing a difference in the quality of the power generation equipment produced on both sides of the border has a moderating effect on the results. Finally, the results enable discussion of the question of whether environmental protection can be a reason for subsidizing renewable energy producers in light of the SCM Agreement.

Regional distribution of photovoltaic deployment in the UK and its determinants: A spatial econometric approach

- Energy Economics---2015---Nazmiye Balta-Ozkan,Julide Yildirim,Peter M. Connor

Photovoltaic (PV) panels offer significant potential for contributing to the UK's energy policy goals relating to decarbonisation of the energy system, security of supply and affordability. The substantive drop in the cost of panels since 2007, coupled with the introduction of the Feed-in Tariff (FiT) Scheme in 2010, has resulted in a rapid increase in installation of PV panels in the UK, from 26.5MWp in 2009 to over 5GW by the end of 2014. Yet there has been no comprehensive analysis of the determinants of PV deployment in the UK. This paper addresses this gap by employing spatial econometrics methods to a recently available data set at a fine geographical detail. Following a traditional regression analysis, a general to specific approach has been adopted where spatial variations in the relationships have been examined utilising the spatial Durbin model using the cross-sectional data relating to the UK NUTS level 3 data. Empirical results indicate that demand for electricity, population density, pollution levels, education level of households and housing types are among the factors that affect PV uptake in a region. Moreover Lagrange Multiplier test results indicate that the spatial Durbin model may be properly applied to describe the PV uptake relationship in the UK as there are significant regional spillover effects.

Forecasting day ahead electricity spot prices: The impact of the EXAA to other European electricity markets

- Energy Economics---2015---Florian Ziel,Rick Steinert,Sven Husmann

In our paper we analyze the relationship between the day-ahead electricity price of the Energy Exchange Austria (EXAA) and other day-ahead electricity prices in Europe. We focus on markets, which settle their prices after the EXAA, which enables traders to include the EXAA price into their calculations. For each market we employ econometric models to incorporate the EXAA price and compare them with their counterparts without the price of the Austrian exchange. By employing a forecasting study, we find that electricity price models can be improved when EXAA prices are considered.

Driving factors of carbon embodied in China's provincial exports

- Energy Economics---2015---Youguo Zhang,Zhipeng Tang

In this paper, we use the multi-regional input-output model (MRIO) and logarithm mean Divisia index approach to analyze the changes in China's carbon embodied in exports (CEE) at the national and provincial levels. The results indicate that the total CEE and the CEE of 17 provinces, including all eastern provinces, decreased between 2007 and 2010. The largest decrease in total CEE is caused by an input structural effect, which decreases the CEE of most of the provinces. The technique effect arising from changes in provincial carbon intensities causes the second largest decrease in total CEE and it effectively reduces the CEE of most of the provinces, especially the eastern provinces. Changes in the export composition of most of the provinces also decrease the provincial CEE. A change in the provincial distribution of exports decreases the CEE in 11 provinces on the one hand and increases the CEE in 19 provinces on the other hand. A change in export volume increases the CEE of each province and the whole country, but its total effect is evidently

lower than the input structural effect and the technique effect.

Extreme risk spillovers between crude oil and stock markets

- Energy Economics---2015---Limin Du,Yanan He

This paper investigates the spillovers of extreme risks between crude oil and stock markets using daily data of the S&P 500 stock index and West Texas Intermediate (WTI) crude oil futures returns. Based on the method of Granger causality in risk, Value at Risk (VaR) is employed to measure market risk, and a class of kernel-based tests is used to detect negative and positive risk spillover effects. Empirical results reveal that there are significant risk spillovers between the two markets. Extreme movements, past or current, in one market may have a significant predictive power for those in the other market. Prior to the recent financial crisis, there are positive risk spillovers from stock market to crude oil market, and negative spillovers from crude oil market to stock market. After the financial crisis, bidirectional positive risk spillovers are strengthened markedly. The risk spillovers may occur instantaneously, and/or with a (long) time delay. Both positive and negative risk spillover effects exhibit asymmetric correlations.

Firm ownership, China's export related emissions, and the responsibility issue

- Energy Economics---2015---Xuemei Jiang,Dabo Guan,Jin Zhang,Kunfu Zhu,Christopher Green

China's CO₂ emissions and those embodied in its exports have been extensively studied. One often neglected aspect is the prevalence of foreign-invested enterprises (FIEs) in China's exports, for which a substantial portion of benefits return to the investing countries. In this paper, we revisit China's export-related CO₂ emission responsibilities by viewing them from a "new", gross national income perspective. Using a recently developed environmental input-output framework, one which distinguishes firms by ownership and trade mode, we find that China's CO₂ emissions responsibility for each Yuan of national income from

FIE exports, is actually higher than that attributable to Chinese owned enterprise (COE) exports. The result has a somewhat surprising implication: it suggests another source of conflict between China's and global interest in reducing CO2 emissions. From a purely Chinese (as opposed to global) standpoint, a higher share of exports by COEs rather than FIEs is favorable, even though COEs emit more CO2 when producing each unit of exports. This finding should sound an additional warning to those who still think that global climate change mitigation can be effectively pursued by allocating country-by-country emissions responsibility.

The determinants of residential gas demand in Ireland

- Energy Economics---2015---Jason Harold,Sean Lyons,John Cullinan

This paper examines the determinants of residential gas demand in Ireland using a micro-econometric analysis of the daily gas consumption panel data from Ireland's Smart Metering Gas Consumer Behavioural Trial. It also investigates the effectiveness of the demand side management stimuli that were tested during the Smart Metering Trial. The analysis is based on a sample of 1181 households over 539 days in the period from 1st December 2009 to 30th May 2011. The results provide evidence that weather, together with the structural characteristics of the dwellings and the socio-economic characteristics of the households, are significant factors in explaining residential gas demand. More specifically, weather is found to be the most influential factor on household's daily gas consumption. Finally, the demand side management stimuli employed in the Smart Metering Trial were found to reduce daily household gas use on average.

Infrastructure investments for power trade and transmission in ASEAN+2: Costs, benefits, long-term contracts and prioritized developments

- Energy Economics---2015---Yanfei Li,Youngho Chang

This study establishes a systemic approach in assessing the feasibility of power infrastructure investment for GMS and APG in the ASEAN+2 (ASEAN plus China and India) region. It aims to identify the financial and finance-related institutional barriers of implementing such a regional power interconnection. A whole-system simulation model is built to assess the financial viability as well as commercial viability, which imply bankability for financiers and profitability for investors respectively, of new transmission projects under the optimized pattern of power trade. It also determines the optimized planning of new transmission capacities. According to our results, the existing development plan of power transmission infrastructure in the region, so called APG+, appears to stand as a financially and commercially viable plan. However, there is room for improvement in the planning in terms of timing, routes and capacity of the cross-border transmission lines and the GMS-related projects should be prioritized.

Directional shadow price estimation of CO2, SO2 and NOx in the United States coal power industry 1990–2010

- Energy Economics---2015---Chia-Yen Lee,Peng Zhou

Shadow prices, also termed marginal abatement costs, provide valuable guidelines to support environmental regulatory policies for CO2, SO2 and NOx, the key contributors to climate change. This paper complements the existing models and describes a directional marginal productivity (DMP) approach to estimate directional shadow prices (DSPs) which present substitutability among three emissions and are jointly estimated. We apply the method to a case study of CO2, SO2 and NOx produced by coal power plants operating between 1990 and 2010 in the United States. We find that DSP shows 1.1 times the maximal shadow prices estimated in the current literature. We conclude that estimating the shadow prices of each by-product separately may lead to an overestimation of the marginal productivity and an underestimation of the shadow prices.

Hedging strategies in energy markets: The case of electricity retailers

- Energy Economics---2015---Raphaël Homaïoun Boroumand, Stéphane Goutte, Simon Porcher, Thomas Porcher

As market intermediaries, electricity retailers buy electricity from the wholesale market or self-generate for re(sale) on the retail market. Electricity retailers are uncertain about how much electricity their residential customers will use at any time of the day until they actually turn switches on. While demand uncertainty is a common feature of all commodity markets, retailers generally rely on storage to manage demand uncertainty. On electricity markets, retailers are exposed to joint quantity and price risk on an hourly basis given the physical singularity of electricity as a commodity. In the literature on electricity markets, few articles deal on intra-day hedging portfolios to manage joint price and quantity risk whereas electricity markets are hourly markets. The contributions of the article are twofold. First, we define through a VaR and CVaR model optimal portfolios for specific hours (3am, 6am, . . . , 12pm) based on electricity market data from 2001 to 2011 for the French market. We prove that the optimal hedging strategy differs depending on the cluster hour. Secondly, we demonstrate the significantly superior efficiency of intra-day hedging portfolios over daily (therefore weekly and yearly) portfolios. Over a decade (2001–2011), our results clearly show that the losses of an optimal daily portfolio are at least nine times higher than the losses of optimal intra-day portfolios.

Dynamic steam coal market integration: Evidence from rolling cointegration analysis

- Energy Economics---2015---Monika Papi  , S  awomir   miech

The aim of the paper is twofold: first, to assess the dynamics of the integration process of the international steam coal prices and, second, to investigate the changes in the roles of particular coal prices in this market in the light of changes in the structure of supply and demand. The analysis is based on steam coal

prices set by the largest world exporters and importers on both the Atlantic and the Pacific markets. We use weekly data spanning from October 5, 2001 to March 28, 2014. The aim is achieved in two stages. During the first one, we use the rolling trace test to identify the integration of the steam coal market, and during the second one, we apply the rolling weak exogeneity test to determine the roles of the participants of the international steam coal market, namely price setters and price takers. Our main findings can be summarized in two observations. Firstly, the main world steam coal prices are integrated and during the period when freight costs are higher, the coal market integration is weaker, and when the costs are lower, the integration is stronger. Secondly, the role of particular coal prices is not stable in time. Generally, price setters appear in the market which covers greater shares in the physical coal trade. Although Indonesia and Russia have a great share in the global export, their prices remain price takers during the whole period. As a consequence, although Russia remains the largest coal exporter of the steam coal to the European market, it cannot dictate its prices in this market.

Differentiated products, increasing returns to scale and heterogeneous firms in a CGE model of the Australian coal sector

- Energy Economics---2015---Robert Waschik

We use a Computable General Equilibrium (CGE) model to re-evaluate the effects of the introduction of a tax on CO₂ emissions in Australia after incorporating a number of important aspects of Australian coal production. While other studies (for example, Commonwealth of Australia (2008a), Clarke and Waschik (2012)) model coal as a single aggregate sector, we disaggregate coal into black and brown coals. Brown coal is non-traded while most black coal is exported, and brown coal has a higher emission intensity than black coal. Coal is a differentiated product whose production is characterized by the existence of very large fixed costs and considerable differences in the ratio of capital expenditures to capacity between coal mines, so we use Balistreri and Rutherford (2012) and

Melitz (2003) to incorporate increasing returns to scale production technology and heterogeneous productivities between monopolistically competitive coal firms. We find that while the aggregate effects of achieving a given level of abatement are largely unaffected by disaggregation of coal, the effects within the black and brown coal sectors are very different. The introduction of increasing returns to scale and heterogeneous firms does have important effects on the aggregate welfare costs of achieving a given level of abatement. When monopolistically competitive coal producers face more inelastic demand, welfare costs rise, firm exit falls, and the carbon price needed to achieve a given level of abatement falls.

Methods for including income distribution in global CGE models for long-term climate change research

- Energy Economics---2015---Bas van Ruijven,O' Neill, Brian C.,Jean Chateau

The consequences of climate policy and the impacts of climate change vary among different types of households depending on their income level, expenditure pattern, and other socioeconomic characteristics. Global economy-environment models that are used to assess climate change issues traditionally do not distinguish households by income or other attributes. To facilitate progress in this area, we review and assess literature on methods to include household heterogeneity in global long-term Computable General Equilibrium (CGE) models. We distinguish among three categories of approaches: 1) the explicit modeling of multiple household types within the CGE framework, 2) micro-simulation modeling, and 3) direct modeling of income distribution. For each of these approaches we describe the method, key assumptions, limitations and several prominent examples from the literature. Moreover, we discuss data needs, including the contents of household survey data, their availability and processing. We conclude with an overview of what each method could provide for global, long-term climate-related research.

Should we resurrect 'TIPP flottante' if oil price booms again? Specific taxes as fuel consumer price stabilizers

- Energy Economics---2015---Marina Di Giacomo,Massimiliano Piacenza,Francesco Scervini,Gilberto Turati

As an answer to soaring oil prices, stabilization mechanisms based on specific taxes, such as the French 'TIPP flottante', have been discussed and introduced in some countries in early 2000s, but then soon abandoned. Our contribution aims at analyzing the excise pass-through and the cost shifting in a comprehensive European context to understand whether such a mechanism could actually reach its target. Our results show that, on average, fuel tax reductions are effective in stabilize consumer price, but the measure is particularly costly for public budgets.

Splitting nuclear parks or not? The third party liability role

- Energy Economics---2015---G rard Mondello

This paper studies how the combination of strict liability regime, a stringent control from regulatory agencies and insurance companies could help in defining the highest prevention level concerning ultra-hazardous industries. It presents a model extended from two to n nuclear power stations and shows that the institutional conditions (cap on operator's liability and insurance compensation) play a fundamental role in inducing whether or not to centralize the management of a nuclear park. It reaches conclusive results in defining the critical ratios that induce either a centralized or a decentralized management.

Emission permits and the announcement of realized emissions: Price impact, trading volume, and volatilities

- Energy Economics---2015---Steffen Hitzemann,Marliese Uhrig-Homburg,Karl-Martin Ehrhart

This paper investigates the impact of the yearly announcement of realized emissions on the European carbon permit market. We find that this event generally leads to significant absolute abnormal returns on the event day, which are accompanied by increased trading volumes and high intraday volatilities. To the contrary, trading is particularly calm on the days before the event, as suggested by significantly lower trading volumes and volatilities. The high event-day volatility is expected by the market and incorporated in emission permit option prices. In line with these significant market reactions, we provide evidence that the emissions announcement has an outstanding information content for the market compared to other relevant news events.

Assessing environmental performance trends in the transport industry: Eco-innovation or catching-up?

- Energy Economics---2015---Mercedes Beltrán-Esteve, Andres Picazo-Tadeo

This paper analyses the change in environmental performance that took place in the transport industry of 38 countries between the years 1995 and 2009. Data Envelopment Analysis techniques and directional distance functions are employed to compute Luenberger productivity indicators for the change in environmental performance and its determinants, namely, environmental technical change resulting from eco-innovation and catching-up with best available environmental technologies. Eight air pollutants account for the environmental contaminants from transport activities, and these are aggregated into three main categories of environmental pressures, namely, global warming, tropospheric ozone formation and acidification potentials. Furthermore, performance evaluation is based on how these specific environmental pressures are managed. Our principal findings show that there has been a noticeable improvement in environmental performance since the 1990s, primarily as a result of eco-innovations; moreover, this improvement has been markedly greater in low- and middle-income economies, bolstered, in this case, by both environmental technical progress and catching-

up. These results reveal the need for policy measures aimed at encouraging catching-up with best available technologies, particularly in more developed countries.

Why have greenhouse emissions in RGGI states declined? An econometric attribution to economic, energy market, and policy factors

- Energy Economics---2015---Brian C. Murray, Peter Maniloff

The Regional Greenhouse Gas Initiative (RGGI) is a consortium of northeastern U.S. states that limit carbon dioxide emissions from electricity generation through a regional emissions trading program. Since RGGI started in 2009, regional emissions have sharply dropped. We use econometric models to quantify the emissions reductions due to RGGI and those due to other factors such as the recession, complementary environmental programs, and lowered natural gas prices. The analysis shows that after the introduction of RGGI in 2009 the region's emissions would have been 24% higher without the program, accounting for about half of the region's emissions reductions during that time, which were far greater than those achieved in the rest of the United States.

Oil volatility shocks and the stock markets of oil-importing MENA economies: A tale from the financial crisis

- Energy Economics---2015---Elie Bouri

The role of oil price volatility in predicting the stock-market volatility of small oil-importing countries that have a substantial number of investors from neighboring oil-exporting countries remains unexplored. To refine our basic understanding of this role, this paper proposes a methodological extension of the recently developed causality-in-variance procedure and considers the case of Lebanon and Jordan. These two heavy importers of oil are interesting in the sense that they are located in a region with a large number of rich oil-exporting countries, so their stock markets are tied to oil-exporters by way of foreign investors. The conditional mean and variance of returns are modeled within

an ARMAX–GARCH framework that accommodates three salient features of the data, namely: autocorrelation, day-of-the-week effects, and movements in international markets. For comparison purposes, the stock markets of Morocco and Tunisia are also included in the study. Empirical analyses highlight the dynamic effects of the global financial crisis on the volatility spillovers between oil and the stock markets of oil-importing countries and provide more insights into the seemingly contradictory effects of being oil-importers while having investors from oil-exporting countries. The main results indicate that the volatility spillover is much more apparent from the world oil market to the stock market of Jordan than the other way around, whereas oil volatility is not a good predictor of Lebanese stock market volatility. Finally, policy/practical implications and conclusions for future research are drawn.

Forecasting the real prices of crude oil under economic and statistical constraints

- Energy Economics---2015---Yudong Wang,Li Liu,Xundi Diao,Chongfeng Wu

Forecasting the real oil prices is important but notoriously difficult. In this paper, we apply both economic and statistical restrictions to parameters of predictive regressions of real oil prices. We employ two popular criteria, mean predictive error (MSPE) and success ratio, to evaluate forecasting accuracy. Our out-of-sample results show that the benchmark of no-change model can be significantly outperformed by a model selection strategy with restricted models for longer horizons. The revealed predictability is further demonstrated to be robust to the adjustment of estimation windows and to an alternative benchmark model.

Revealing the political decision toward Chinese carbon abatement: Based on equity and efficiency criteria

- Energy Economics---2015---Jinlan Ni,Chu Wei,Limin Du

China's economic reform over the past 30years has allowed the free market to drive economic development.

However, government still plays a key role in the energy sector by allocating energy conservation and emissions abatement. How does the government make an equity decision as a tradeoff to market efficiency? This is an unanswered question. The purpose of this paper is to illustrate the government's preference toward equity and efficiency. Using the provincial level CO2 intensity allocation data, we investigate the political decision that the government made based on the equity and efficiency criteria. We find that the equity index plays a more important role than the efficiency index in determining the CO2 intensity target. In addition, political factors such as social stability are found to be important factors.

Taxation of nuclear rents: Benefits, drawbacks, and alternatives

- Energy Economics---2015---J. Morbee,P. Himpen,Stef Proost

This paper studies the taxation of nuclear energy using a stylized model of the electricity sector, with one dominant nuclear producer and a competitive fringe of non-nuclear plants. First, we find that the optimal nuclear tax is different depending on the time horizon: the optimal short-run tax has the same order of magnitude as the nuclear taxes imposed in Belgium and Germany, while in the long run the optimal tax may be negative, i.e. a subsidy. Second, government credibility is important: when a government cannot credibly commit, the mere possibility of a short-run tax could severely harm incentives for future investments in lifetime-extending refurbishment or new plants. Third, when there is natural scarcity in nuclear potential, other policies like inviting multiple competitive bidders for lifetime extension franchises or for investments in new plants, may be more efficient ways to increase government revenue.

Global energy use: Decoupling or convergence?

- Energy Economics---2015---Zsuzsanna Cserekllyei,David Stern

We examine the key factors driving change in energy use globally over the past four decades. We test for

both strong decoupling where economic growth has less effect on energy use as income increases, and weak decoupling where energy use declines overtime in richer countries, *ceteris paribus*. Our econometric approach is robust to the presence of unit roots, unobserved time effects, and spatial effects. Our key findings are that the growth of per capita energy use has been primarily driven by economic growth, convergence in energy intensity, and weak decoupling. There is no sign of strong decoupling.

Modeling oil price–US stock nexus: A VARMA–BEKK–AGARCH approach

- Energy Economics---2015---Afees Salisu, Tirimisiyu Oloko

This study adds to the existing literature on oil price–US stock nexus in three ways. First, it employs the VARMA–AGARCH model developed by McAleer et al. (2009) within the context of BEKK framework using West Texas Intermediate (WTI) and Brent as proxies for oil market and S&P stocks as a proxy for US stock market. Secondly, it modifies the model to include endogenously determined structural break using the general structure for analyzing breaks with unit roots in Perron (2006). Third, it uses the adopted model to compute optimal portfolio weight and hedge ratios between oil price and US stocks using different sample data based on the break date. On average, our empirical evidence suggests a significant positive return spillover from US stock market to oil market and bi-directional shock spillovers between the two markets. In addition, there is significant own asymmetric shock effect in both markets while volatility spillover from oil market to stock market became pronounced after the break which coincides with the period of global economic slowdown. Similarly, the results of portfolio management differ across the sample data. More importantly, we find that ignoring structural break when it exists may exaggerate hedging effectiveness.

Environmental Kuznets curve for CO2 emissions: The case of Arctic countries

- Energy Economics---2015---Jungho Baek

The main new contribution of this paper is to examine the Environmental Kuznets curve (EKC) hypothesis using time series data at individual country levels. Empirical focus is on the assessment of income per capita on CO2 emissions in the Arctic countries by taking into account the role of energy consumption. An autoregressive distributed lag (ARDL) modeling approach to cointegration is applied to annual data for the period 1960–2010. The results provide little evidence of the existence of the EKC hypothesis for the Arctic countries. We also find that economic growth has a beneficial effect on the environment only in some Arctic countries. Finally, energy consumption is found to have a detrimental effect on the environment in most countries.

Measuring eco-efficiency based on green indicators and potentials in energy saving and undesirable output abatement

- Energy Economics---2015---Kamran Rashidi, Reza Farzipoor Saen

Nowadays, majority of organizations are seeking to achieve sustainable development with respect to “green” concept. One of the main criteria for assessing green performance is eco-efficiency. To identify all aspects of the eco-efficiency, inputs should be divided into energy and non-energy and outputs should be divided into good and bad outputs. To deal with this issue, a data envelopment analysis (DEA) model is developed to divide inputs into both energy and non-energy and outputs into both desirable (good) and undesirable (bad) outputs. Likewise, variables are separated into both discretionary and non-discretionary factors. Accordingly, a bounded adjusted measure (BAM) based on green indicators is developed to calculate the eco-efficiency of decision making units (DMUs). Besides, energy saving potentials and undesirable output abatement potentials are calculated to show correlation coefficient between energy consumption and undesirable output. Finally, proposed model is validated by assessing the eco-efficiency of some selected members of organization for economic cooperation and development (OECD). Australia, Finland, Ireland, New Zealand,

and Switzerland are recognized as eco-efficient countries and the rest of countries are inefficient in terms of the eco-efficiency. High and positive Spearman correlation coefficient between energy consumption and undesirable outputs addresses that the more use of energy inputs, the more undesirable outputs.

Predicting gasoline prices using Michigan survey data

- Energy Economics---2015---Hamid Baghestani

This study investigates the predictive power of Michigan Surveys of Consumers (MSC) data for gasoline prices. Specifically, we utilize the MSC data on both expected inflation and consumer sentiment to construct a vector autoregressive (VAR) model for forecasting gasoline prices for 2003–2014. Our findings indicate that the VAR forecasts are superior to the comparable benchmark forecasts obtained from a univariate integrated moving average (MA) model in terms of both predictive information content and directional accuracy. As such, we conclude that the MSC data on both expected inflation and consumer sentiment have significant predictive information for gasoline prices. Further inspection reveals that the VAR forecasts are particularly accurate for the period since 2008, reinforcing the notion that consumers are “economically” rational.

The pricing behavior of Italian gas stations: Some evidence from the Cuneo retail fuel market

- Energy Economics---2015---Marco Alderighi,Marco Baudino

This paper studies how gas stations adjust their gasoline and diesel prices in response to their neighboring competitors. The empirical analysis relies on data collected from January to August 2011 on the daily prices of 20 gas stations located in Cuneo, Italy. These data show significant price uniformity, especially within the same geographical area of the town. Approximately one-third of gas stations responded within a day to targeted competitors’ price changes, indicating some evidence of price matching behavior in the industry.

Additionally, there is some, but discontinuous, geographical price propagation, testifying to the presence of a weak domino effect. Finally, spatial econometric analysis suggests that there is spatial dependence between gas stations up to about 1.1km.

How do U.S. stock returns respond differently to oil price shocks pre-crisis, within the financial crisis, and post-crisis?

- Energy Economics---2015---Chun-Li Tsai

We use a long time series of daily data for 682 firms over a period from January, 1990 to December, 2012. Each firm includes 5,772 daily observations. Our sample involves a total of 3,936,504 observations to investigate how U.S. stock returns respond differently to oil price shocks prior to, during, and after a financial crisis. We provide evidence that U.S. stock returns in turn respond positively to the changes in oil prices during and after such a crisis. We use firm-level data to find that positive and negative oil price shocks have asymmetric effects on stock returns during the crisis and after the crisis. Then, we examine whether the effect of an oil price shock on stock returns varies across oil-intensive industries. Within the crisis and post-crisis, our results indicate that stock returns in response to oil price shocks across industries are heterogeneous, and the stock returns of some energy-intensive manufacturing industries respond more positively to oil price shocks compared with less energy-intensive manufacturing industries. We use total assets, total revenue, and the number of employees as proxy variables to measure each firm’ s size and then examine whether oil price shocks affect stock returns differently across firm sizes. We find that big firms are the most strongly and negatively influenced by an oil price shock prior to the crisis. On the other hand, our results indicate that an oil price shock in the post-financial crisis period is positively amplified in the case of medium-sized firms.

Relationship between ethanol and gasoline: AIDS approach

- Energy Economics---2015---Frank Tenkorang,Bree L. Dority,Deborah Bridges,Eddery Lam

Ethanol production in the United States has increased significantly due to government support, which has begun to dwindle. Ethanol now seems to compete with gasoline for vehicle fuel but because ethanol is mostly sold as a blend, gasoline and ethanol could be complementary fuel sources. The study investigates the true relationship between these fuels since it has policy implications. Results of LA/AIDS estimation show the two fuels were substitutes before the rapid expansion of ethanol production but have become complements overtime due to increasing share of ethanol in fuel consumption.

Crude oil trade and current account deficits

- Energy Economics---2015---Hillard Huntington

This paper provides an empirical exploration into the relationship between crude oil trade and a nation's current account for 91 countries over the 1984–2009 period. Reduced oil import dependence may initially reduce a country's general trade deficit under certain conditions. The analysis probes the nature of this relationship and whether it holds equally to oil-importing and oil-exporting countries, after controlling for other exogenous drivers. We find that net oil exports are a significant factor in explaining current account surpluses but that net oil imports often do not influence current account deficits. Among all oil importers the one exception applies to relatively rich countries, where higher oil imports appear to contribute to greater current account deficits. One explanation for these trends is that oil exporters and wealthier oil importers may view oil income gains and losses as temporary income sources that influence their savings patterns.

Economic and environmental impact analysis of carbon tariffs on Chinese exports

- Energy Economics---2015---Yanli Dong,Masanobu Ishikawa,Taiji Hagiwara

As an alternative measure for the proposal of border tax adjustments (BTAs) advocated by the countries that seek to abate CO₂ emissions (hereafter referred to as ‘abating countries’), export carbon tax (ECT)

voluntarily conducted by the developing countries has been widely discussed in recent years. This paper uses the multi-regional and multi-commodity computable general equilibrium (CGE) model and the GTAP8.1 database to investigate the economic and environmental effects of carbon tariffs on Chinese exports. The following three policy scenarios are considered: 1) the abating countries implement cap-and-trade emission programs without BTAs; 2) the unilaterally abating countries levy import tariffs and export subsidies on non-abating countries; and, 3) the abating countries implement unilateral climate policies combined with ECT imposed by China. The ECT policy of China is evaluated with a carbon price set at 17US\$/t-CO₂. Results illustrate that the ECT voluntarily implemented by China is ineffective in reducing its domestic CO₂ emissions. Moreover, ECT merely has a minor impact on global emissions. Finally, the competitiveness of China's energy-intensive and trade-exposed (EITE) industries suffers substantial losses if export tariffs are imposed. However, China's gains in terms of welfare and gross domestic product (GDP) would be slightly improved if an ECT policy is implemented, compared to the scenario where China is subjected to BTAs levied by the abating coalition. In the light of the tradeoff between tariff revenue for welfare and competitiveness losses of the EITE industries, it is therefore difficult to conclude that carbon tariff on Chinese exports is an alternative policy to BTAs.

Measuring energy rebound effect in the Chinese economy: An economic accounting approach

- Energy Economics---2015---Boqiang Lin,Kerui Du

Estimating the magnitude of China's economy-wide rebound effect has attracted much attention in recent years. Most existing studies measure the rebound effect through the additional energy consumption from technological progress. However, in general technological progress is not equivalent to energy efficiency improvement. Consequently, their estimation may be misleading. To overcome the limitation, this paper develops an alternative approach for estimating energy rebound effect. Based on the proposed approach,

China's economy-wide energy rebound effect is revisited. The empirical result shows that during the period 1981–2011 the rebound effects in China are between 30% and 40%, with an average value of 34.3%.

Coal mining, economic development, and the natural resources curse

- Energy Economics---2015---Michael Betz,Mark Partridge,Michael Farren,Linda Lobao

Coal mining has a long legacy of providing needed jobs in isolated communities but it is also associated with places that suffer from high poverty and weaker long-term economic growth. Yet, the industry has greatly changed in recent decades. Regulations, first on air quality, have altered the geography of coal mining, pushing it west from Appalachia. Likewise, technological change has reduced labor demand and has led to relatively new mining practices, such as invasive mountain-top approaches. Thus, the economic footprint of coal mining has greatly changed in an era when the industry appears to be on the decline. This study investigates whether these changes along with coal's "boom/bust" cycles have affected economic prosperity in coal country. We separately examine the Appalachian region from the rest of the U.S. due to Appalachia's unique history and different mining practices. Our study takes a new look at the industry by assessing the winners and losers of coal development around a range of economic indicators and addressing whether the natural resources curse applies to contemporary American coal communities. The results suggest that modern coal mining has rather nuanced effects that differ between Appalachia and the rest of the U.S. We do not find strong evidence of a resources curse, except that coal mining has a consistent inverse association with measures linked to population growth and entrepreneurship, and thereby future economic growth.

How price inelastic is demand for gasoline in fuel-subsidizing economies?

- Energy Economics---2015---Mohammad Arza-ghi,Jay Squalli

In recent years, governments that have historically subsidized domestic fuel consumption face an ever-growing challenge in maintaining fuel subsidies and have embarked on subsidy reform. This paper estimates the price and income elasticity of demand for gasoline in countries where fuel prices are government-subsidized. We make use of biennial panel road-sector data for 32 countries over the 1998–2010 period and find demand for gasoline to be price inelastic both in the short run and long run. We estimate the short-run price and income elasticities at 0.05 and 0.16 and the long-run price and income elasticities at 0.25 and 0.81, respectively. It is our contention that concerned governments should play an active role in identifying and committing to a road map to progressively abandoning fuel subsidies. They should also not be discouraged by relatively small consumption corrections in the short run. A reduction in subsidies can eventually release considerable amount of resources for more crucial and potentially growth-enhancing public services such as education and health.

Environmental assessment on coal-fired power plants in U.S. north-east region by DEA non-radial measurement

- Energy Economics---2015---Toshiyuki Sueyoshi,Mika Goto

This study discusses a new use of DEA (Data Envelopment Analysis) environmental assessment to measure unified (operational and environmental) and scale efficiencies among inputs, desirable and undesirable outputs. In particular, the measurement of scale efficiency is discussed by two non-radial models. That is a new methodological contribution. To discuss these efficiency measures, this study first examines a concept of disposability from the perspective of corporate strategies to adapt a regulation change on undesirable outputs. The concept is separated into natural and managerial disposability. After discussing how to measure the degree of scale efficiency within the non-radial approach, this study applies the proposed DEA environmental assessment to measure the performance of coal-fired power plants in the U.S. north-east

region. The region has been long producing a large amount of coal from the Appalachian Mountains. The coal mining industry has supported U.S. energy utility and other industries. Because of the long history, the quality of coal became worse and the coal-fired power plants have been producing a large amount of undesirable gases. This study has statistically confirmed that there is a significant difference between the two types (BIT: bituminous coal and SUB: subbituminous coal) of coal-fired power plants in terms of their unified efficiency measures, including their scale efficiencies, under the concept of managerial disposability (the first priority: environment performance and the second priority: operational performance). In contrast, under the natural disposability (the first priority: operational performance and the second priority: environmental performance), this study cannot find such a statistical significance between them. The fact, in which BIT outperforms SUB in terms of their unified and scale efficiencies, suggests the policy implication that these power plants need to shift their coal combustions from SUB to BIT in the United States. Besides the empirical finding, this study cannot confirm the other hypothesis on whether coal-fired power plants with small operation (less than 50% in plant capacity factor) outperform ones with large operation (more than 50% in plant capacity factor), and vice versa, in terms of their unified and scale efficiency measures under natural and managerial disposability. An exception is found in environmental performance under variable returns to scale. The rationale is because their plant operations are frequently monitored by regulatory agencies. As a consequence, this study cannot find such a statistical difference between them on operational performance. This result implies that the regulation on coal-fired power plants has been effective on their unified performance but large power plants may have a potential to improve their environmental performance.

Carbon dioxide emission standards for U.S. power plants: An efficiency analysis perspective

- Energy Economics---2015---Benjamin Hampf,Kenneth Løvold Rødseth

On June 25, 2013, President Obama announced his plan to introduce carbon dioxide emission standards for electricity generation. This paper proposes an efficiency analysis approach that addresses which emission rates (and standards) would be feasible if the existing generating units adopt best practices. A new efficiency measure is introduced and further decomposed to identify different sources' contributions to emission rate improvements. Estimating two Data Envelopment Analysis (DEA) models – the well-known joint production model and the new materials balance model – on a dataset consisting of 160 bituminous-fired generating units, we find that the average generating unit's electricity-to-carbon dioxide ratio is 15.3% below the corresponding best-practice ratio. Further examinations reveal that this discrepancy can largely be attributed to non-discretionary factors and not to managerial inefficiency. Moreover, even if the best practice ratios could be implemented, the generating units would not be able to comply with the EPA's recently proposed carbon dioxide standard.

European natural gas seasonal effects on futures hedging

- Energy Economics---2015---Beatriz Martínez,Hipolit Torro

This paper is the first to discuss the design of futures hedging strategies in European natural gas markets (NBP, TTF and Zeebrugge). A common feature of energy prices is that conditional mean and volatility are driven by seasonal trends due to weather, demand, and storage level seasonalities. This paper follows and extends the Ederington and Salas (2008) framework and considers seasonalities in mean and volatility when minimum variance hedge ratios are computed. Our results show that hedging effectiveness is much higher when the seasonal pattern in spot price changes is approximated with lagged values of the basis (futures price minus spot price). This fact remains true for short (a week) and long (one, three and six months) hedging periods. Furthermore, volatility of weekly price changes also has a seasonal pattern and is higher in winter than in summer. A simple volatility seasonal model that is

based on sinusoidal functions on the basis improves the risk reduction obtained by strategies in which hedging ratios are estimated with linear regressions. Seasonal hedging strategies, linear regression based strategies, or even a naïve position, perform better than more sophisticated statistical methods.

Breaks, trends, and unit roots in spot prices for crude oil and petroleum products

- Energy Economics---2015---Jingwei Sun,Wendong Shi

This study examines the trend properties in energy price series using weekly spot price data for crude oil, heating oil, and regular gasoline. In particular, the procedures proposed by Perron and Yabu (2009b) are employed to test for a one-time break in the trend function of each price series with no prior knowledge of whether the noise component is stationary or has an autoregressive unit root. Based on the results of the break estimate, the unit root test developed by Kim and Perron (2009) is performed to examine the stationarity of the prices. Finally, we extend the one-break analysis to the case with multiple breaks by employing the break test proposed by Kejriwal and Perron (2010) and the unit root test of Carrion-i-Silvestre et al. (2009). The results consistently demonstrate evidence of structural breaks and reject the unit root null hypothesis for all the price series, suggesting that energy prices are persistently influenced by long-term economic fundamentals instead of temporal policy changes.

Consumers' willingness to pay for renewable and nuclear energy: A comparative analysis between the US and Japan

- Energy Economics---2015---Kayo Murakami,Takanori Ida,Makoto Tanaka,Lee Friedman

This paper examines consumers' willingness to pay for nuclear and renewable electricity as two alternatives to fossil fuels for the reduction of greenhouse gas emissions. We conduct a choice experiment of consumer-stated preferences on the basis of an online survey in four US

states and Japan after the Fukushima nuclear plant accident. First, the results suggest that US consumers' willingness to pay for a 1% decrease in greenhouse gas emissions is \$0.31 per month, which is similar to the results for the US a decade ago. Japanese consumers show a slightly lower willingness to pay of \$0.26 per month. Second, the average consumer in both countries expresses a negative preference for increases in nuclear power in the fuel mix (to a greater extent in Japan). Third, renewable energy sources were endorsed by both US and Japanese consumers, who show a willingness to pay \$0.71 and \$0.31 per month for a 1% increase in the use of renewable source energy. This study also examines the differences in respondents' characteristics. Approximately 60% of the US respondents who did not change their perception concerning the use of nuclear energy subsequent to the Fukushima nuclear crisis have almost no preference for variation in nuclear power, which is in stark contrast to the Japanese respondents' opposition to nuclear energy.

Preference and lifestyle heterogeneity among potential plug-in electric vehicle buyers

- Energy Economics---2015---Jonn Axsen,Joseph Bailey,Marisol Andrea Castro

We characterize heterogeneity in preferences and motivations regarding plug-in electric vehicles (PEVs)—including plug-in hybrids (PHEVs) and electric vehicles (EVs). Using survey data collected from 1754 new vehicle buying households in Canada in 2013, we segment respondents using two approaches that prove to be complementary. Preference-based segments were constructed using latent-class analysis of discrete choice experiment data. Potential PEV buyers were split into a “PEV-enthusiast” segment (8% of the sample) with extremely high valuation of PEVs and a broader “PHEV-oriented” segment (25%) that expressed moderately positive valuation of PHEVs. Preference-based segments also varied by respondents' valuation of specific attributes such as fuel savings. Our second approach constructed lifestyle-based segments using cluster analysis on a subset of potential early PEV buyers (33% of the total sample). The six lifestyle-

based clusters varied in engagement in environment- and technology-oriented lifestyles, environmental concern and openness to change. Overall preferences were fairly similar across the clusters, though apparent motivations varied substantially by cluster as indicated by their differing engagement in lifestyles and environmental concern. Taken together, both approaches suggest that PHEVs are the most likely PEV to have broad market appeal and that car buyers have high degrees of heterogeneity in both preferences and motivations.

A static deterministic linear peak-load pricing model for the electricity industry: Application to the Peruvian case

- Energy Economics---2015---Hans Alayo,Raul Garcia Carpio

This article presents a static deterministic linear peak-load pricing model which finds the optimal mix of generation technologies for a given duration curve. The main contribution of the article is the idea of discretizing the duration curve. Since any real duration curve can be approximated by a discretized one, the optimal capacity mix for real world situation can be derived using a linear programming software. Then, for the model with the discretized duration curve, we derive the centralized optimal solution. Also, we show that applying marginal cost pricing allows for the recovery of all generation costs when the mix of technologies is optimal. Finally, we present an application of the proposed model to the Peruvian case; we comment and compare the results with the real capacity mix of the system for the years 2008–2013.

A multi-factor model with time-varying and seasonal risk premiums for the natural gas market

- Energy Economics---2015---Chengwu Shao,Ramaprasad Bhar,David B. Colwell

In this paper, we develop a quantitative model of the US natural gas market that explores its multi-factor structure and its time-varying and seasonal risk premiums. With weekly spot and futures prices we show

that three factors are preferred to describe the futures term structure, and the time-varying risk premiums are also significant. Moreover, we found that the market implies a seasonal risk premium with two peaks and troughs in one year, which is important to correctly price the futures by maturity month. Finally, we link this seasonal risk premium to the uncertainty of the US natural gas demand and find a positive relationship between them. These results reveal the complex aspect of the market, and may have useful applications for other commodity sectors.

Energy import resilience with input–output linear programming models

- Energy Economics---2015---Peijun He,Tsan Sheng Ng,Bin Su

In this work we develop a new approach to study the energy import resilience of an economy using linear programming and economic input–output analysis. In particular, we propose an energy import resilience index by examining the maximum level of energy import reduction that the economy can endure without sacrificing domestic demands. A mixed integer programming model is then developed to compute the resilience index efficiently. The methodology is applied to a case study using China input–output data to study the energy import resilience under different power generation portfolio assumptions. We demonstrate how our models can be used to uncover important inter-sectoral dependencies, and to guide decision-makers in improving the energy resilience in a systematic manner.

Forecasting day-ahead electricity prices: Utilizing hourly prices

- Energy Economics---2015---Eran Raviv,Kees E. Bouwman,Dick van Dijk

The daily average price of electricity represents the price of electricity to be delivered over the full next day and serves as a key reference price in the electricity market. It is an aggregate that equals the average of hourly prices for delivery during each of the 24 individual hours. This paper demonstrates that the

disaggregated hourly prices contain useful predictive information for the daily average price in the Nord Pool market. Multivariate models for the full panel of hourly prices significantly outperform univariate models of the daily average price, with reductions in Root Mean Squared Error of up to 16%. Substantial care is required in order to achieve these forecast improvements. Rich multivariate models are needed to exploit the relations between different hourly prices, but the risk of overfitting must be mitigated by using dimension reduction techniques, shrinkage and forecast combinations.

Small might be beautiful, but bigger performs better: Scale economies in “green” refurbishments of apartment housing

- Energy Economics---2015---Claus Michelsen,Sebastian Rosenschon,Christian Schulz

The energy efficiency of the residential housing stock plays a key role in strategies to mitigate climate change and global warming. In this context, it is frequently argued that private investment and the quality of thermal upgrades are too low in the light of the challenges faced and the potential energy cost savings. While many authors address the potential barriers for investors to increase energy efficiency, studies on the capabilities of different investors to reduce energy requirements of their property are scarce. This study investigates potential advantages of housing company's size, i.e. economies of scale, economies of scope and institutional learning in thermal upgrades of residential housing. Based on unique data on energy consumption in 102,307 apartment buildings in Germany, we present new evidence for the advantages and disadvantages of a housing company's size in “green” retrofitting projects. Our estimations show, that large housing companies outperform private landlords by far in high effort refurbishment projects. In contrast, private landlords appear to have advantages in low effort, incremental refurbishment activities. We demonstrate that a substantial share of the advantages of larger firms can be associated with specialization (i.e. re-

peated projects). The results offer new options for policy makers to refine the support schemes toward a low carbon housing stock.

An assessment of proposed energy resource tax reform in Russia: A static general equilibrium analysis

- Energy Economics---2015---Anton Orlov

A large part of government revenues in Russia comes from royalties and export taxes on crude oil, oil products, and gas. Recently, the Russian government has considered reducing export taxes on crude oil and oil products compensated by an increase in the royalty on crude oil. The objective of the paper is to analyse the economy-wide effects of this proposal. Moreover, a hypothetical replacement of export taxes and royalties with a pure rent tax is analysed. A static, single-country, multi-sector computable generation equilibrium (CGE) model is employed. The primary findings are as follows. A replacement of export taxes on crude oil and oil products with a royalty on crude oil provides substantial allocative efficiency gains, but this policy is not a superior one. Welfare could be substantially improved when the export taxes and royalty are replaced with a pure rent tax that can be implemented in the form of a cash-flow tax. On the negative side, reducing export taxes on crude oil and oil products results in a strong appreciation of the currency. As a result, domestic producers become less competitive in domestic markets, and there is a massive increase in import demand.

Equity market implied volatility and energy prices: A double threshold GARCH approach

- Energy Economics---2015---Steven J. Cochran,Iqbal Mansur,Babatunde Odusami

This study investigates the role of VIX in determining the returns and return volatilities of oil, heating oil, gasoline, and natural gas. A double threshold GARCH(1,1) methodology is utilized where the VIX index is used as the threshold regime change indicator. Daily data from January 4, 1999, to December 31, 2013,

are used. A sub-period analysis covering only the financial crisis period of January 2, 2007, to December 31, 2009, is also performed. This study provides evidence that the level of equity market volatility (i.e., VIX) that triggers a regime shift is commodity specific. The results also indicate that the threshold VIX values are time varying. Furthermore, natural gas prices appear to withstand considerably more volatility in the equity market than do the prices of other energy commodities. This relationship is even more pronounced during the financial crisis period. Approximately 70% and 50% of the estimated coefficients display asymmetric sensitivities due to regime changes during the entire period and the crisis period, respectively. The findings have practical implications as the underlying volatility of an asset plays a significant role in determining its associated activity in the futures markets.

Economic modelling of energy services: Rectifying misspecified energy demand functions

- Energy Economics---2015---Lester Hunt,David Ryan

Although it is well known that energy demand is derived, since energy is required not for its own sake but for the energy services it produces – such as heating, lighting, and motive power – energy demand models, both theoretical and empirical, often fail to take account of this feature. In this paper, we highlight the misspecification that results from ignoring this aspect, and its empirical implications – biased estimates of price elasticities and other measures – and provide a relatively simple and empirically practicable way to rectify it, which has a strong theoretical grounding. To do so, we develop an explicit model of consumer behaviour in which utility derives from consumption of energy services rather than from the energy sources that are used to produce them. As we discuss, this approach opens up the possibility of examining many aspects of energy demand in a theoretically sound way that have not previously been considered on a widespread basis, although some existing empirical work could be interpreted as being consistent with this type of

specification. While this formulation yields demand equations for energy services rather than for energy or particular energy sources, these are shown to be readily converted, without added complexity, into the standard type of energy demand equation(s) that is (are) typically estimated. The additional terms that the resulting energy demand equations include, compared to those that are typically estimated, highlight the misspecification that is implicit when typical energy demand equations are estimated. A simple solution for dealing with an apparent drawback of this formulation for empirical purposes, namely that information is required on typically unobserved energy efficiency, indicates how energy efficiency can be captured in the model, such as by including exogenous trends and/or including its possible dependence on past energy prices. The approach is illustrated using an empirical example that involves estimation of an aggregate energy demand function for the UK with data over the period 1960–2011.

Drivers of cost reduction in solar photovoltaics

- Energy Economics---2015---Unni Pillai

Using a new dataset of costs, output, sales, technical characteristics, and capital expenditures of firms in the solar industry during 2005–2012, this paper investigates the factors that have contributed to the decline in the cost of producing solar panels. While previous studies have attributed learning-by-doing and economies of scale as important drivers of cost reduction, these do not have any significant effect on cost once four other factors are taken into account, namely, (i) reduction in the cost of a principal raw material, (ii) increasing presence of solar panel manufacturers from China, (iii) technological innovations, and (iv) increase in investment at the industry level. These findings suggest that the upstream industries that supply the solar panel industry with raw materials and capital equipment have been important contributors to the reduction in the production cost of solar panels.

Carbon emissions embodied in demand–supply chains in China

- Energy Economics---2015---Hongguang Liu, Weidong Liu, Xiaomei Fan, Wei Zou

Using the multi-regional input–output model (MRIO), the paper distinguishes the carbon emissions embodied in commodities for domestic final consumption (CBEs, consumption-based emissions) and those for export (EBEs, export-based emissions), and then calculates carbon emissions embodied in the demand–supply chains for consumption and export based on technical coefficients matrix of the MRIO for one country. Taking China as an example, we provide a dynamic analysis of CBEs, EBEs, and carbon emissions embodied in consumption and export demand–supply chains at the sub-national level based on the MRIO tables for 1997 and 2007. The results show that, in China, the transferred carbon emissions embodied in demand–supply chains driven by consumption and export both showed rapid growth during 1997–2007. And the net transferred carbon emissions embodied in the demand–supply chains showed an increasing trend as well. Less developed regions with abundant fossil fuels tend to net flow out carbon emissions.

Energy trade efficiency and its determinants: A Malmquist index approach

- Energy Economics---2015---Yu Sheng, Yanrui Wu, Xunpeng Shi, Dandan Zhang

This paper adopts the Malmquist index approach to investigate multi-product energy trade efficiency and its determinants from an empirical perspective. Using trade statistics of coal, oil and gas of 40 countries over the period of 1995 to 2008, we found that the efficiency of bilateral energy trade ranged between 0.26 and 0.35 when imperfect substitution between different energy products is taken into account. This measure is significantly lower than those obtained from traditional gravity models. It suggests that the ability of cross-product substitution affects trade efficiency improvement which results from regional market integration and related trade policy. The results provide

useful insights on predicting the pattern of future energy trade and hence have important implications for relevant countries to prioritize product-specific trade policies.

Market power issues in the reformed Russian electricity supply industry

- Energy Economics---2015---Nadia Chernenko

The paper examines long-run and short-run levels of market power in the liberalised Russian electricity market. We observe that despite potential for market power abuse, actual exercise of market power remained low. We attribute the result to the bid-at-cost rule implemented as a part of a special unit commitment procedure on the day-ahead market. We first look at the industry restructuring and subsequent mergers and acquisitions. The M&A were undertaken in different market zones and did not seem to increase concentration although planned zone integration may worsen competition in the long run. We then examine short-run aspect of market power by estimating hourly price–cost mark-ups and assessing their dynamics in 2010 and 2011, a year preceding and following the market liberalisation, respectively. The hypothesis of actual market power abuse is tested, and rejected, using time series AR models. Further, a Tobit regression shows that the liberalisation decreased the mark-ups by about 1.66 percentage points.

The impact of outages on prices and investment in the U.S. oil refining industry

- Energy Economics---2015---Matthew Chesnes

This paper considers the effects of refinery outages (due to planned turn-arounds or unplanned events) on current petroleum product prices and future refinery investment. Empirical evidence on these relationships is mixed and highly dependent on the size and duration of the outage, the geographic area considered, the level of inventories available at the time of the outage, and the tightness of the market as measured by the capacity utilization rate. Using a detailed database of plant-level refinery outages for both upstream and

downstream refining units, I estimate the effects of outages on product prices controlling for the crude oil price and the ability of operating plants to respond to the outage. I also consider the effect of current market profitability on the likelihood of planned refinery outages and the effects of high utilization rates and planned maintenance on the prospects for unplanned outages. I then use plant-level capacity data to analyze the effects of outages, profitability, and utilization rates on future investment decisions of the refinery.

An approach to computing marginal land use change carbon intensities for bioenergy in policy applications

- Energy Economics---2015---Marshall Wise,Elke L. Hodson,Bryan K. Mignone,Leon Clarke,Stephanie Waldhoff,Patrick Luckow

Accurately characterizing the emissions implications of bioenergy is increasingly important to the design of regional and global greenhouse gas mitigation policies. Market-based policies, in particular, often use information about carbon intensity to adjust relative deployment incentives for different energy sources. However, the carbon intensity of bioenergy is difficult to quantify because carbon emissions can occur when land use changes to expand production of bioenergy crops rather than simply when the fuel is consumed as for fossil fuels. Using a long-term, integrated assessment model, this paper develops an approach for computing the carbon intensity of bioenergy production that isolates the marginal impact of increasing production of a specific bioenergy crop in a specific region, taking into account economic competition among land uses. We explore several factors that affect emissions intensity and explain these results in the context of previous studies that use different approaches. Among the factors explored, our results suggest that the carbon intensity of bioenergy production from land use change (LUC) differs by a factor of two depending on the region in which the bioenergy crop is grown in the United States. Assumptions about international land use policies (such as those related to forest protection) and crop yields also significantly impact carbon

intensity. Finally, we develop and demonstrate a generalized method for considering the varying time profile of LUC emissions from bioenergy production, taking into account the time path of future carbon prices, the discount rate and the time horizon. When evaluated in the context of power sector applications, we found electricity from bioenergy crops to be less carbon-intensive than conventional coal-fired electricity generation and often less carbon-intensive than natural-gas fired generation.

Applied econometrics and implications for energy economics research

- Energy Economics---2015---Russell Smyth,Paresh Narayan

Developments in applied econometrics, particularly with regard to unit root tests and cointegration tests, have motivated a rich empirical literature on energy economics over the last decade. This study reviews recent developments in time series econometrics applications in the energy economics literature. We first consider the literature on the integration properties of energy variables. We begin with a discussion of the implications of whether energy variables contain a unit root and proceed to examine how results differ according to the specific unit root or stationarity test employed. We then proceed to examine recent developments in the literature on cointegration, Granger causality and long-run estimates between (disaggregated) energy consumption and economic growth. We review both single country and panel studies and pay particular attention to studies which have expanded the literature through adding variables such as financial development and trade, in addition to energy consumption to the augmented production function, as well as studies which have extended the literature through examining disaggregated energy consumption by type. In each case we highlight best practice in the literature, point to limitations in the literature, including econometric modeling challenges, and suggest recommendations for future research. A key message of our survey is that the profession needs to guard against ‘overload’ of research in these areas as most applied

studies are no longer adding anything more to what is already known.

On the use of panel cointegration tests in energy economics

- Energy Economics---2015---Joachim Westerland,Kannan Thuraishamy,Susan Sharma

There is a burgeoning literature based on using panel cointegration techniques to study the relationship between energy consumption and GDP. Most panel cointegration tests employed take no cointegration as the null hypothesis. The current paper illustrates how a rejection by such a test cannot be taken as evidence of cointegration for the panel as a whole, a fact that seems to have gone largely unnoticed in the literature. Hence, even if the no cointegration null is rejected, this evidence is not enough to ensure that the relationship can be meaningfully estimated, as most (if not all) estimators in the literature require that the panel is cointegrated as a whole.

OPEC and non-OPEC oil production and the global economy

- Energy Economics---2015---Ronald Ratti,Joaquin Vespignani

Hamilton identifies 1973 to 1996 as “the age of OPEC” and 1997 to the present as “a new industrial age.” During 1974–1996 growth in non-OPEC oil production Granger causes growth in OPEC oil production. OPEC oil production decreases significantly with positive shocks to non-OPEC oil production in the earlier period, but does not do so in the “new industrial age” . In the “new industrial age” OPEC oil production rises significantly with an increase in oil prices, unlike during “the age of OPEC” period. OPEC oil production responds significantly to positive innovations in global GDP throughout. Over 1997:Q1–2012:Q4 the negative effect on real oil price of positive shocks to non-OPEC oil production is larger in absolute value than that of positive shocks to OPEC oil production. The cumulative effects of structural shocks to non-OPEC oil production and to real oil

price on OPEC oil production are large. The cumulative effects of structural shocks to OPEC production and real oil price on non-OPEC production are small. Results are robust to changes in model specification. An econometric technique to predict growth in OPEC oil production provides support for the results from the SVAR analysis. Results are consistent with important changes in the global oil market.

Do oil spot and futures prices move together?

- Energy Economics---2015---Chun-Ping Chang,Chien-Chiang Lee

This paper investigates the time-varying correlation and the causal relationship between crude oil spot and futures prices using a newly developed approach — wavelet coherency analysis in time–frequency domain. First, we find evidence of a long-run cointegration relationship between oil spot and futures prices. Moreover, the short-run causality is more significant in shorter maturity pairs versus longer maturity pairs in the vector error correction framework. Second, the results from wavelet coherency analysis show significant dynamic correlations between variables in the time–frequency domain. Third, the illustration of the phase-difference series around zero suggests that spot and futures prices contribute to the dynamics of the long-run equilibrium. Fourth and finally, we provide reasons for the structural changes in oil prices and also recommend investment strategies corresponding to risk diversification. Future studies focusing on the behavior of oil prices should consider the characteristics of the time–frequency space and lead–lag dynamic relationships.

A unit root model for trending time-series energy variables

- Energy Economics---2015---Paresh Narayan,Ruipeng Liu

In this paper, we propose a GARCH-based unit root test that is flexible enough to account for; (a) trending variables, (b) two endogenous structural breaks, and (c) heteroskedastic data series. Our proposed model is applied to a range of time-series, trending,

and heteroskedastic energy variables. Our two main findings are: first, the proposed trend-based GARCH unit root model outperforms a GARCH model without trend; and, second, allowing for a time trend and two endogenous structural breaks are important in practice, for doing so allows us to reject the unit root null hypothesis.

Rockets and feathers meet Joseph: Reinvestigating the oil–gasoline asymmetry on the international markets

- Energy Economics---2015---Ladislav Křišťoufek, Petra Lunackova

We reinvestigate the “rockets and feathers” effect between retail gasoline and crude oil prices in a new framework of fractional integration, long-term memory and borderline (non)stationarity. The most frequently used error-correction model is examined in detail and we find that the prices return to their equilibrium value much more slowly than would be typical for the error-correction model. Such dynamics is usually referred to as “the Joseph effect”. The standard procedure is shown to be troublesome and we introduce two new tests to investigate possible asymmetry in the price adjustment to equilibrium under these complicated time series characteristics. On the dataset of seven national gasoline prices, we find no statistically significant asymmetry. The proposed methodology is not limited to the gasoline and crude oil case but it can be utilized for any asymmetric adjustment analysis.

Review of cost estimates for uranium recovery from seawater

- Energy Economics---2015---Harry Lindner, Erich Schneider

The 4.5 billion tonnes of uranium in seawater is sufficient to power the world’s reactor fleet for 13,000 years. For decades, the transformative potential of this enormous resource has prompted interest in technologies for recovering uranium from seawater. Since the 1960s, though, cost analyses of such technologies have failed

to convincingly demonstrate a cost-competitive alternative to conventional uranium recovery from terrestrial mining. Hence, uranium from seawater has come to be considered as a backstopping technology that has the potential to establish a price ceiling for the uranium resource. Such an upper bound is valuable because it removes uncertainty surrounding uranium prices when developing and deploying nuclear power systems. This paper reviews cost estimates as the technology has evolved over the past five decades. During this time, systems that actively moved seawater gave way to those where the adsorbent sits passively in seawater. The adsorbent material changed from hydrous titanium oxide to the higher-capacity amidoxime ligand. Early efforts used amidoxime grafted onto an acrylic substrate, which was later replaced by polyethylene because of its increased durability and lower cost. The review shows that capacity, in grams of U per kilogram of adsorbent, is a strong driver of cost along with reusability of the adsorbent. The most recent estimates reviewed are seen to place the U production cost at \$400–\$1000/kg of U, several times higher than the 2014 spot market price, which has remained near or below \$100/kg of U.

Investigating dynamic conditional correlation between crude oil and fuels in non-linear framework: The financial and economic role of structural breaks

- Energy Economics---2015---Alexander Souza Block, Marcelo Brutti Righi, Sérgio Guilherme Schlender, Daniel Arruda Coronel

To understand the crude oil volatility has been a challenge. The non-linear behavior, the skewed and leptokurtic returns, the presence of structural breaks and the constant political instability in suppliers’ countries evidence the necessity of complex models to capture the market volatility. At the same time, crude oil is the raw material for several fuels such as jet fuel, gasoline, diesel and others, having a strong influence over their prices. Thus, this study aims to verify the presence of structural breaks in the volatility series and in the correlations between WTI return and the returns of Gasoline, Kerosene Jet Fuel, Diesel, Heating

Oil, Propane and Natural Gas. To reach this objective, we identified which model presents the best fit to estimate the conditional mean between WTI and each fuel and we used a Copula–DCC–GARCH model to estimate the conditional volatility avoiding the frequently unrealistic presumptions of normality. Our main results indicate the necessity of a different model for each analyzed pair and the presence of at least one structural break in the conditional volatility and in the correlation between WTI and each fuel, usually preceded by a structural break in WTI return series.

Energy-saving and emission-abatement potential of Chinese coal-fired power enterprise: A non-parametric analysis

- Energy Economics---2015---Chu Wei, Andreas Löschel, Bing Liu

In the context of soaring demand for electricity, mitigating and controlling greenhouse gas emissions is a great challenge for China's power sector. Increasing attention has been placed on the evaluation of energy efficiency and CO₂ abatement potential in the power sector. However, studies at the micro-level are relatively rare due to serious data limitations. This study uses the 2004 and 2008 Census data of Zhejiang province to construct a non-parametric frontier in order to assess the abatement space of energy and associated CO₂ emission from China's coal-fired power enterprises. A Weighted Russell Directional Distance Function (WRDDF) is applied to construct an energy-saving potential index and a CO₂ emission-abatement potential index. Both indicators depict the inefficiency level in terms of energy utilization and CO₂ emissions of electric power plants. Our results show a substantial variation of energy-saving potential and CO₂ abatement potential among enterprises. We find that large power enterprises are less efficient in 2004, but become more efficient than smaller enterprises in 2008. State-owned enterprises (SOE) are not significantly different in 2008 from 2004, but perform better than their non-SOE counterparts in 2008. This change in performance for large enterprises and SOE might be driven by the "top-1000 Enterprise Energy Conservation Action"

that was implemented in 2006.

A regime switching approach for hedging tanker shipping freight rates

- Energy Economics---2015---Amir H. Alizadeh, Chih-Yueh Huang, Stefan van Dellen

Tanker shipping is the primary means for the transportation of petroleum and petroleum products around the world and thus plays a crucial role in the energy supply chain. However, the high volatility of tanker freight rates has been a major concern for market participants and led to the development of the tanker freight derivatives in the form of forward freight agreements (FFAs). The aim of this paper is to investigate the performance of these instruments in managing tanker freight rate risk. Using a data set for six major tanker routes covering the period between 2005 and 2013, we examine the effectiveness of alternative hedging methods, including a bivariate Markov Regime Switching GARCH model, in hedging tanker freight rates. The regime switching GARCH specification links the concept of equilibrium freight rate determination underlying different market conditions and the dynamics of the conditional second moments across high and low volatility regimes. Overall, we find evidence supporting the argument that the tanker freight market is characterized by different regimes. However, while the use of a regime switching model allows for a significant improvement in the performance of the hedge in-sample, out-of-sample results are mixed.

Expected commodity returns and pricing models

- Energy Economics---2015---Gonzalo Cortazar, Ivo Kovacevic, Eduardo S. Schwartz

Stochastic models of commodity prices have evolved considerably in terms of their structure and the number and interpretation of the state variables that model the underlying risk. Using multiple factors, different specifications and modern estimation techniques, these models have gained wide acceptance because of their success in accurately fitting the observed commodity futures' term structures and their dynamics. It is not

well emphasized however that these models, in addition to providing the risk neutral distribution of future spot prices, also provide their true distribution. While the parameters of the risk neutral distribution are estimated more precisely and are usually statistically significant, some of the parameters of the true distribution are typically measured with large errors and are statistically insignificant. In this paper we argue that to increase the reliability of commodity pricing models, and therefore their use by practitioners, some of their parameters — in particular the risk premium parameters — should be obtained from other sources and we show that this can be done without losing any precision in the pricing of futures contracts. We show how the risk premium parameters can be obtained from estimations of expected futures returns and provide alternative procedures for estimating these expected futures returns.

Predictability of price movements in deregulated electricity markets

- Energy Economics---2015---Olga Y. Uritskaya, Vadim M. Uritsky

In this paper we investigate predictability of electricity prices in the Canadian provinces of Alberta and Ontario, as well as in the US Mid-C market. Using scale-dependent detrended fluctuation analysis, spectral analysis, and the probability distribution analysis we show that the studied markets exhibit strongly anti-persistent properties suggesting that their dynamics can be predicted based on historic price records across the range of time scales from 1h to one month. For both Canadian markets, the price movements reveal three types of correlated behavior which can be used for forecasting. The discovered scenarios remain the same on different time scales up to one month as well as for on- and off-peak electricity data. These scenarios represent sharp increases of prices and are not present in the Mid-C market due to its lower volatility. We argue that extreme price movements in this market should follow the same tendency as the more volatile Canadian markets. The estimated values of the Pareto indices suggest that the prediction of these events can

be statistically stable. The results obtained provide new relevant information for managing financial risks associated with the dynamics of electricity derivatives over time frame exceeding one day.

Downstream integration of natural gas prices across U.S. states: Evidence from deregulation regime shifts

- Energy Economics---2015---Nicholas Apergis, Nicholas Bowden, James Payne

This study examines the cointegration between city-gate and residential retail natural gas prices at the U.S. state level using monthly data from 1989:1 to 2012:12. Both price series are tested for unit roots using the Harris (2009) procedure to endogenously identify structural breaks related to deregulation associated with FERC Order No. 636. The endogenously determined structural breaks are then used in the Saikkonen and Lütkepohl (2000a, 2000b, 2000c) maximum likelihood approach to test cointegration of the series. Tests show cointegration of the two price series for all 50 states. Estimates of the long-run relationship in the pre- and post-structural break periods result in mixed evidence about the degree of perfect market integration induced by deregulation, although the magnitude and variation of parameters indicate increased integration. A vector error correction model is used to infer causality in the short and long-run dynamics for the pre and post-structural break periods for each state. The post-break period exhibits bidirectional causality in both short and long-run dynamics for all states, an indication of greater downstream integration of the natural gas market.

The rebound effect for automobile travel: Asymmetric response to price changes and novel features of the 2000s

- Energy Economics---2015---Kent M. Hymel, Kenneth A. Small

Previous research suggests that the elasticity of light-duty motor vehicle travel with respect to fuel cost, known as the “rebound effect,” is modest in size and

probably declined in magnitude between the 1960s and the late 1990s. However, turmoil in energy markets during the early 2000s has raised new questions about the stability of this elasticity. Using panel data on U.S. states, we revisit the simultaneous-equations methodology of Small and Van Dender (2007) and Hymel et al. (2010) to see whether structural parameters have changed. Using data through 2009, we confirm the earlier finding of a rebound effect that declines in magnitude with income, but we also find an upward shift in its magnitude of about 0.025 during the years 2003–2009. In addition, we find that the rebound effect is much greater in magnitude in years when gasoline prices are rising than when they are falling. It is also greater during times of media attention and price volatility, which explains about half the upward shift just mentioned.

China's energy saving potential from the perspective of energy efficiency advantages of foreign-invested enterprises

- Energy Economics---2015---Xuemei Jiang,Kunfu Zhu,Christopher Green

The paper investigates the energy saving potential associated with firm ownership-related differences in energy efficiency such as those between domestically and foreign-owned firms. Because of a gap in official statistics this topic has barely been touched upon in the scholarly literature. This paper employs a new energy input–output table that distinguishes firm ownership (Chinese owned enterprises, COEs; and foreign-invested enterprises, FIEs) and trade mode (export processing and normal goods production) to analyze the energy efficiency advantage of FIEs in China in 2007. The results show that the total energy intensities of COEs in the industrial sector are generally 5%–35% higher than that of FIEs across industry groups. At an aggregate level, China could save up to 20.3% of its energy use, if industrial COEs could duplicate the energy use efficiency and production technology of FIEs. This gain would require major technology upgrades among COEs.

Productivity growth, technical change and economies of scale of Korean fossil-fuel generation companies, 2001–2012: A dual approach

- Energy Economics---2015---Dong-hyun Oh

This paper examines total factor productivity (TFP) growth, technical change and economies of scale measure of Korean fossil-fuel power generation companies (GENCOs) between 2001 and 2012. For the empirical investigation, we estimated the cost function along with specification tests in order to find the most appropriate empirical model. Empirical results show TFP deterioration, technical regress, and economies of scale for the study period. The optimal size of the Korean GENCOs was also found, which is employed in developing policies regarding TFP growth and technical advance.

Tariff regulation with energy efficiency goals

- Energy Economics---2015---Laura Abrardi,Carlo Cambini

We study the optimal tariff structure that could induce a regulated utility to promote energy efficiency by its customers given that it is privately informed about the effectiveness of its effort on demand reduction. The regulator should optimally offer a menu of incentive compatible two-part tariffs. If the firm's energy efficiency activities have a high impact on demand reduction, the consumer should pay a high fixed fee but a low per unit price, approximating the tariff structure to a decoupling policy, which strengthens the firm's incentives to pursue energy conservation. Instead, if the firm's effort to adopt energy efficiency actions is scarcely effective, the tariff is characterized by a low fixed fee but a high price per unit of energy consumed, thus shifting the incentives for energy conservation on consumers. The optimal tariff structure also depends on the cost of the consumer's effort (in case the consumer can also adopt energy efficiency measures) and on the degree of substitutability between the consumer's and the firm's efforts.

Oil price risk exposure and the cross-section of stock returns: The case of net exporting countries

- Energy Economics---2015---Riza Demirer,Shrikant P. Jategaonkar,Ahmed Khalifa

The main goal of this paper is to examine whether oil price risk is systematically priced in the cross-section of stock returns in net oil-exporting countries even after controlling for market and firm-level risk factors. Using firm-level data from the Gulf Arab stock markets, we find that stocks that are more sensitive to oil price changes indeed yield significantly higher returns, suggesting that oil price exposure can serve as a return predictor in these stock markets. However, we also find that it is the absolute exposure of a stock that drives returns, suggesting fluctuations in the oil price as a source of stock return premia in these markets. Our tests further suggest that a portfolio strategy based on a stock's absolute exposure to oil price risk yields significant positive subsequent returns as well, suggesting an investment strategy based on the absolute oil price risk exposure of stocks in net exporting nations.

The mitigating effect of strategic behavior on the net benefits of a direct load control program

- Energy Economics---2015---Corey Lang,Edson Okwelum

Demand response is an important tool for utilities to manage load during peak periods. While the effects of demand response programs on peak load reductions are well studied and intuitive, assessments typically fail to recognize the potential for off-peak behavioral responses that may mitigate the total benefits of the program. Using smart meter consumption data on residential air conditioning units enrolled in a direct load control program, this paper examines the changes in consumption prior to and after curtailment events. The results suggest substantial increases in off-peak consumption, which reduce energy, monetary, and environmental benefits of the program by over 40%.

An empirical analysis of energy cost pass-through to CO2 emission prices

- Energy Economics---2015---Shawkat Ham-moudeh,Amine Lahiani,Duc Khuong Nguyen,Ricardo Sousa

We use the nonlinear autoregressive distributed lag (NARDL) model to analyze the asymmetric and non-linear pass-through effects of changes in crude oil prices, natural gas prices, coal prices and electricity prices on the CO2 emission allowance prices. We find that: (i) the crude oil prices have a long-run negative and asymmetric effect on the CO2 allowance prices; (ii) the decreases in the coal prices have a stronger impact on the carbon prices in the short-run than the increases; (iii) the natural gas prices and electricity prices have a symmetric effect on the carbon prices, but this effect is negative for the former and positive for the latter. These findings are robust when using both monthly and daily data and when considering bivariate and multivariate models.

Short-term uncertainty in long-term energy system models — A case study of wind power in Denmark

- Energy Economics---2015---Pernille Seljom,Asgeir Tomasgard

When wind power constitutes a larger share of the electricity production mix, credible and reliable modelling of its operation in long-term investment models becomes increasingly important. In this paper the intermittent characteristics of wind power are modelled as a stochastic parameter in a long-term TIMES model of the Danish heat and electricity sector. To our knowledge, this is not a common approach in long-term investment models, and has not been done previously in TIMES, where the short-term uncertainty of wind power is normally taken into account by a deterministic constraint that ensures excess back-up capacity. In our model, the stochasticity gives lower total energy system costs, significant lower investments in wind power, less expected electricity export and higher expected biomass consumption compared to using the

traditional deterministic approach. Also, the deterministic investment strategy can be insufficient in periods with poor wind conditions. Based on our findings, we recommend using a stochastic representation of intermittent renewables in long-term investment models to provide more solid results for decision makers.

Do manufacturing firms react to energy prices? Evidence from Italy

- Energy Economics---2015---Rossella Bardazzi,Filippo Oropallo,Maria Grazia Pazienza

The reaction of energy demand to price changes is a key policy issue as it describes the economy's response to changes in market conditions or to policy interventions. The issue is even more important for the Italian economy, highly exposed to energy price changes, given its almost complete fossil fuel-related energy dependence, environmental sensitivity and highly fragmented industrial structure. Besides the policy issue, there is also an important methodological debate, concerning the best way to evaluate energy demand elasticities, looking at alternative models, data and elasticity definitions. After a discussion of the main methodological issues and the related empirical literature, this paper presents an estimation of factor and fuel demand elasticities for Italian industrial firms, by using a microeconomic panel in a two-stage translog model. Using cross-price and Morishima elasticities, we obtain information on the magnitude and asymmetry of firms' responses to price changes. Moreover, the use of a micro-dataset allows the high heterogeneity of Italian firms to be considered: the results are discussed according to technology intensity, sector and firm size. Our findings show that energy is the most elastic input for all sectors and that capital and energy are substitutes in the low technology sector and weak complements in all others. Estimated interfuel elasticities show a high degree of demand sensitivity to fuel price changes and the vast majority of cross-price elasticities exhibit substitutability. Appropriate fiscal policies can thus be identified to give an effective impulse in influencing the industrial energy mix by changing relative prices. These findings constitute an important foundation for

analysing energy demand by Italian industrial firms, given that empirical literature is particularly rare on the Italian case study.

Regionally-varying and regionally-uniform electricity pricing policies compared across four usage categories

- Energy Economics---2015---Seong-Hoon Cho,Taeyoung Kim,Hyun Jae Kim,Kihyun Park,Roland Roberts

The objective of our research is to predict how electricity demand varies spatially between status quo regionally-uniform electricity pricing and hypothetical regionally-varying electricity pricing across usage categories. We summarize the empirical results of a case study of electricity demand in South Korea with three key findings and their related implications. First, the price elasticities of electricity demand differ across usage categories. Specifically, electricity demands for manufacturing and retail uses are price inelastic and close to unit elastic, respectively, while those for agricultural and residential uses are not statistically significant. This information is important in designing energy policy, because higher electricity prices could reduce electricity demands for manufacturing and retail uses, resulting in slower growth in those sectors. Second, spatial spillovers in electricity demand vary across uses. Understanding the spatial structure of electricity demand provides useful information to energy policy makers for anticipating changes in demand across regions via regionally-varying electricity pricing for different uses. Third, simulation results suggest that spatial variations among electricity demands by usage category under a regionally-varying electricity-pricing policy differ from those under a regionally-uniform electricity-pricing policy. Differences in spatial changes between the policies provide information for developing a realistic regionally-varying electricity-pricing policy according to usage category.

Electricity consumption and economic development: Are countries converging to a common trend?

- Energy Economics---2015---Young Se Kim

This paper studies the dynamic behavior of electricity consumption with special emphasis on their convergence patterns. Individual electricity indicators are modeled by allowing for apparent heterogeneous transitions. Log t convergence test results indicate that all 109 countries converge to a common stochastic trend for electricity intensity while per capita electricity consumption is better explained by a multiple-component model. In the case of 24 advanced economies, there is a strong tendency towards a common component for both indicators. The application of clustering algorithm confirms the presence of club convergence for per capita electricity consumption. In terms of clustering pattern, per capita electricity consumption appears to be remarkably similar to per capita income, widely used measure of economic development.

Large scale scenario analysis of future low carbon energy options

- Energy Economics---2015---Olaitan Olaleye,Erin Baker

In this study, we use a multi-model framework to examine a set of possible future energy scenarios resulting from R&D investments in Solar, Nuclear, Carbon Capture and Storage (CCS), Bio-fuels, Bio-electricity, and Batteries for Electric Transportation. Based on a global scenario analysis, we examine the impact on the economy of advancement in energy technologies, considering both individual technologies and the interactions between pairs of technologies, with a focus on the role of uncertainty. Nuclear and CCS have the most impact on abatement costs, with CCS mostly important at high levels of abatement. We show that CCS and Bio-electricity are complements, while most of the other energy technology pairs are substitutes. We also examine for stochastic dominance between R&D portfolios: given the uncertainty in R&D outcomes, we examine

which portfolios would be preferred by all decision-makers, regardless of their attitude toward risk. We observe that portfolios with CCS tend to stochastically dominate those without CCS; and portfolios lacking CCS and Nuclear tend to be stochastically dominated by others. We find that the dominance of CCS becomes even stronger as uncertainty in climate damages increases. Finally, we show that there is significant value in carefully choosing a portfolio, as relatively small portfolios can dominate large portfolios.

Exploring the drivers' side of the "blend wall" : U.S. consumer preferences for ethanol blend fuels

- Energy Economics---2015---Francisco X. Aguilar,Zhen Cai,Phillip Mohebalian,Wyatt Thompson

Analysis of stated preferences from over 2300 U.S. respondents shows that general attitudes nationwide favor the use of ethanol as a motor fuel but a sizeable segment (~20%) indicated strong unwillingness to buy ethanol blend fuels. Results from a discrete choice experiment analyzed using mixed logit regressions show that, all else constant, price-per-gallon and miles-per-gallon dominated preferences for fuel attributes but ethanol content made the average consumer more likely to choose a blend fuel. Findings provide strong evidence of heterogeneity in preferences driven by attitudes but also affected by age and income. At a point of price per mile equivalence for ethanol and gasoline, in a market where gasoline, E20 and E85 were available with no regulatory, supply or technological constraints, E85 would dominate market share. In this case ethanol would account for 56% of volume of motor fuels consumed. Our results show a high level of consumer substitutability of gasoline with ethanol and willingness to choose high ethanol blend fuels – which could help expand ethanol use beyond the current regulatory and technological limits of the blend wall.

Do exchange rates respond asymmetrically to shocks in the crude oil market?

- Energy Economics---2015---Bebonchu Atems, Devin Kapper, Eddery Lam

The paper argues that exchange rates respond asymmetrically to different shocks to the crude oil market. We apply Kilian's (2009) methodology to disentangle shocks to the crude oil market into distinct demand and supply shocks, and examine the response of the U.S. real and nominal trade-weighted U.S. dollar exchange rate indexes, as well as six other bilateral exchange rates to these shocks. Our analysis indicates that oil supply shocks have no significant effects on exchange rates, while global aggregate demand and oil-specific demand shocks lead to depreciations. We further show that exchange rates respond asymmetrically to shocks in the crude market depending on whether the shocks are large versus small, or positive versus negative.

China's regional sustainability and diversified resource allocation: DEA environmental assessment on economic development and air pollution

- Energy Economics---2015---Toshiyuki Sueyoshi, Yan Yuan

Environmental protection, including the prevention of air pollution and health hazard materials such as PM2.5 and PM10, is now a very serious policy issue in China after attaining the rapid economic growth and development. The PM stands for "Particular Matter", indicating the size of both solid particles and liquid droplets found in air. Unfortunately, the economic development has produced a serious healthcare problem in not only China and other surrounding nations. To enhance people's healthcare and appeal a good national image to the world, China is recently looking for the new industrial and environmental policy direction to attain social sustainability in terms of economic development and environmental prevention. To discuss policy implications on the new policy direction, this study utilizes Data Envelopment Analysis (DEA) for assessment on its regional performance by incorporating

PM2.5 and PM10 as undesirable outputs, along with two disposability concepts (i.e. natural disposability and managerial disposability). No previous DEA study has incorporated the amount of PM2.5 and PM10 in empirical investigation. Using a simulated data set for the period of 2013–2014, this study measures the efficiency of municipality cities under four different types of regional classifications. The empirical results indicate that the Chinese government should distribute its economic resources to cities, which locate in the north-west region (including Lanzhou, Xining, Yinchuan and Urumqi), and reinforce more strict regulation on energy consumptions for environmental prevention in major cities (e.g. Beijing, Tianjin, Shanghai and Chongqing). The industrial policy change from the economic growth to the environment protection is essential for the future of China, which is currently the second largest economic power in the world. The environmental protection can enhance the China's image of contributing in economics, industry and environmental protection to all other nations. It can be envisioned that the new policy effort reduces the regional imbalance and increases the social sustainability in China. The empirical findings and policy implications discussed in this study are applicable to not only China but also other industrial and developing nations and those are useful in guiding their industrial and environmental policy development.

Common risk factors of infrastructure investments

- Energy Economics---2015---Semir Ben Amar, Martin Eling

The risk of infrastructure investments is driven by unique factors that cannot be well described by standard asset class factor models. We thus create a nine-factor model based on infrastructure-specific risk exposure, i.e., market risk, size, value, momentum, cash flow volatility, leverage, investment growth, term risk, and default risk. We empirically test our model on a large dataset of U.S. infrastructure stocks in different subsectors (utility, telecommunication, and transportation) and over a long period of time (1983 to 2011).

The new factor model is able to capture the variation of infrastructure returns better than the Fama/French three-factor, the Carhart four-factor or the extended Fung/Hsieh eight-factor models. Thus, our model helps to improve the evaluation of infrastructure funds and to better determine the cost of capital of infrastructure firms, something that is increasingly relevant in light of the growing need for privately financed infrastructure projects.

Decomposing changes in CO2 emission inequality over time: The roles of re-ranking and changes in per capita CO2 emission disparities

- Energy Economics---2015---Mauro Mussini, Luigi Grossi

This paper analyzes the effects of changes in country ranking and per capita CO2 emissions on the change in CO2 emission inequality over time. For this purpose, we introduce a three-term decomposition of the change occurring in the Gini index of per capita CO2 emissions when moving from an initial to a final per capita CO2 emission distribution. The decomposition explains the link between the inequality trend and the changes in country ranking, population size, and per capita CO2 emission disparities. We show that all components of inequality change can be further decomposed by subgroup. This provides analysts with a decomposition technique detecting the within-group and between-group contributions to each component of inequality change. The decomposition is used to analyze the change in per capita CO2 emission inequality in Europe over the 1991–2011 period.

While visitors conserve, residents splurge: Patterns and changes in energy consumption, 1997-2007

- Energy Economics---2015---Iman Nasseri, Djeto Assané, Denise Konan

This study analyzes changes in energy consumption in Hawaii ‘i between 1997 and 2007 using input-output analysis. Residents increase their energy use by 33%

in electricity and 18% in fuel, largely due to direct consumption. In contrast, visitors contract energy demand by 9% and 4% in electricity and fuel, respectively. The findings are robust at per-capita levels. Key drivers are the significant drops in energy intensity of primarily three industries: air transportation, hotels, and restaurants. Further analysis decomposes the change to evaluate the underlying factors.

The overnight risk premium in electricity forward contracts

- Energy Economics---2015---Stein-Erik Fleten, Liv Aune Hagen, Maria Tandberg Nygård, Ragnhild Smith-Sivertsen, Johan M. Sollie

We analyze the risk premium on electricity forward contracts traded for the Nordic and German/Austrian electricity markets. We argue that finding risk premiums by analyzing overnight returns is more relevant than the frequently used ex post approach. The derivatives in these markets can be characterized as trading products and hedging products. Each contract shows a clear increase in trading volume and liquidity when approaching maturity. We link this to a testable hypothesis where financial traders are compensated for holding price risk, and where the sign and magnitude of the risk premium changes depending on the hedging pattern of producers and retailers. Incorporating this in regressions we find that there are higher risk premiums in the period before the forwards become front products, compared to the risk premiums in the front period. Quarterly and monthly contracts show the most significant results.

Drought, ethanol, and livestock

- Energy Economics---2015---Na Hao, Gregory Colson, Byeongchan Seong, Cheolwoo Park, Michael Wetzstein

The 2012 drought in the U.S. Midwest resulted in volatile crop prices. With field crops constituting a major input in livestock production, livestock producers sought a waiver to Renewable Fuel Standard biofuel mandates. They believed such a waiver would mitigate

crop-price volatility; given crops are major inputs in biofuel production. The U.S. Environmental Protection Agency (EPA) denied the waiver under the belief that the waiver would have minimal if any impact on mitigating price volatility. Employing a VECM, the objective is to investigate if it was prudent for the EPA to reject the waiver. Results generally support EPA's conclusion that the waiver relaxing the biofuel mandate would have minimal impact.

Competitiveness assessment of Iran's restructured electricity market

- Energy Economics---2015---Ali Nazemi,Mehdi Mashayekhi

Iran's electricity market was restructured mostly to enhance its production efficiency. Nonetheless, the experience of liberalized electricity markets indicates that market establishment would be insufficient to produce competitive results. To determine whether the restructured market is moving toward competition, this paper assesses production efficiency in Iran's electricity market during high demand periods in 2006 as the first year of the restructured market's performance, and in 2012 as the last year with available data. We compared counterfactual benchmark outcomes to the actual dispatches to determine the production efficiency. Moreover, Iran's power market is a discriminatory, day-ahead auction; therefore, we considered the market design in the competitive benchmark. We found that the production was inefficient in both 2006 and 2012. More importantly, the production in the market is becoming increasingly inefficient over time due to exercising market power and distortion of the market's production by strategic firms. Not only were strategic firms distorting the market's production, but they were also learning to exercise more non-competitive behavior because these firms distorted the production in 2012 eight times more than they did in 2006.

Regime switching model of US crude oil and stock market prices: 1859 to 2013

- Energy Economics---2015---Mehmet Balilar,Rangan Gupta,Stephen Miller

This paper examines the relationship between US crude oil and stock market prices, using a Markov-Switching vector error-correction model and a monthly data set from 1859 to 2013. The sample covers the entire modern era of the petroleum industry, which typically begins with the first drilled oil well in Titusville, Pennsylvania in 1858. We estimate a two-regime model that divides the sample into high- and low-volatility regimes based on the variance-covariance matrix of the oil and stock prices. We find that the high-volatility regime more frequently exists prior to the Great Depression and after the 1973 oil price shock caused by the Organization of Petroleum Exporting Countries. The low-volatility regime occurs more frequently when the oil markets fell largely under the control of the major international oil companies from the end of the Great Depression to the first oil price shock in 1973. Using the National Bureau of Economic research business cycle dates, we also find that the high-volatility regime more likely occurs when the economy experiences a recession.

The stochastic effects on the Brazilian Electrical Sector

- Energy Economics---2015---Pedro Guilherme Costa Ferreira,Fernando Luiz Cyrino Oliveira,Reinaldo Castro Souza

The size and characteristics of the Brazilian Electrical Sector (BES) are unique. The system includes a large-scale hydrothermal power system with many hydroelectric plants and multiple owners. Due to the historical harnessing of natural resources, the National Interconnected System (NIS) was developed outside of the economic scale of the BES. The central components of the NIS enable energy generated in any part of Brazil to be consumed in distant regions, considering certain technical configurations. This interconnection results in a large-scale complex system and is controlled by robust computational models, used to support the planning and operation of the NIS. This study presents a different vision of the SEB, demonstrating the intrinsic relationship between hydrological stochasticity and the activities executed by the system, which is an

important sector of the infrastructure in Brazil. The simulation of energy scenarios is crucial to the optimal manner to operate the sector and to supporting decisions about whether expansion is necessary, thus, avoiding unnecessary costs and/or losses. These scenarios are an imposing factor in the determination of the spot cost of electrical energy, given that the simulated quantities of water in the reservoirs are one of the determinants for the short-term energy price.

Incentive mechanisms to promote energy efficiency programs in power distribution companies

- Energy Economics---2015---Karim Osorio,Enzo Sauma

Power distribution companies (DISCOs) play an important role in promoting energy efficiency (hereafter EE), mainly due to the fact that they have detailed information regarding their clients' consumption patterns. However, under the traditional regulatory framework, DISCOs have disincentives to promote EE, due to the fact that a reduction in sales also means a reduction in their revenues and profits. Most regulatory policies encouraging EE have some embedded payment schemes that allow financing EE programs. In this paper, we focus on these EE-programs' payment schemes that are embedded into the regulatory policies. Specifically, this paper studies two models of the Principal-Agent bi-level type in order to analyze the economic effects of implementing different payment schemes to foster EE in DISCOs. The main difference between each model is that uncertainty in energy savings is considered by the electricity regulatory institution in only one of the models. In terms of the results, it is observed that, in general terms, it is more convenient for the regulator to adopt a performance-based incentive mechanism than a payment scheme financing only the fixed costs of implementing EE programs. However, if the electricity regulatory institution seeks a higher level of minimum expected utility, it is optimal to adopt a mixed system of compensation, which takes into account the fixed cost compensation and performance-based incentive payments.

Exogenous impacts on the links between energy and agricultural commodity markets

- Energy Economics---2015---Liyan Han,Yimin Zhou,Libo Yin

The main purpose of this paper is to identify the effects of exogenous factors, which have been somewhat controversial, on the price links between the energy and agricultural commodity markets. Our study differs from other studies by employing multivariate normal mixture models to capture the structural properties of the price dependencies in the underlying states. This paper investigates price dependencies from both quantitative and structural perspectives. By analyzing the overall dependencies and structural heterogeneity in the empirical results, we conclude that the global financial crisis is the most influential shock on the price links between energy and agricultural commodities. Because price links are vulnerable to financial shocks, our results also suggest introducing state-based analysis to risk management and portfolio diversification across the energy and agriculture markets during times of turmoil.

Multi-objective regulations on transportation fuels: Comparing renewable fuel mandates and emission standards

- Energy Economics---2015---D. Rajagopal,R. Plevin,Gal Hochman,David Zilberman

We compare two types of fuel market regulations — a renewable fuel mandate and a fuel emission standard — that could be employed to simultaneously achieve multiple outcomes such as reduction in fuel prices, fuel imports and greenhouse gas (GHG) emissions. We compare these two types of regulations in a global context taking into account heterogeneity in carbon content of both fossil fuels and renewable fuels. We find that although neither the ethanol mandate nor the emission standard is certain to reduce emissions relative to a business-as-usual baseline, at any given level of biofuel consumption in the policy region, a mandate, relative to an emission standard, results in higher GHG emissions, smaller expenditure on fuel imports, lower

price of ethanol-blended gasoline and higher domestic fuel market surplus. This result holds over a wide range of values of model parameters. We also discuss the implications of this result to a regulation such as the US Renewable Fuel Standard given recent developments within the US such as increase in shale and tight oil production and large increase in average vehicle fuel economy of the automotive fleet.

Economic curtailment of intermittent renewable energy sources

- Energy Economics---2015---Arthur Henriot

In a power system featuring a large share of intermittent renewables and inflexible thermal generators, efficiency gains could be achieved by curtailing the production of renewables. However, as renewables feature very low variable production costs, over-curtailment can be costly. In this article, we use a stylised analytical model to assess this trade-off. We show that while curtailing renewables when their variability is high and the system flexibility is low can reduce generation costs, the different stakeholders will not necessarily benefit from such measures. As a consequence, leaving this decision to generators will lead to a sub-optimal level of curtailment. Either incentives to provide accurate RES availability forecasts or alternatively centralised forecasting should be put into place to solve the resulting problem of asymmetry of information.

Sources of production inefficiency and productivity growth in China: A global data envelopment analysis

- Energy Economics---2015---Zhao-Hua Wang,Chao Feng

The current mode of production in China is extensive and inefficient and has caused great stress on both resources and the environment. This paper focuses on analyzing the sources of production inefficiency and productivity growth in China. Here, a developed slacks-based measure is utilized to decompose production inefficiency into three components: input inefficiency,

economic output inefficiency, and environmental inefficiency. Furthermore, by applying a method based on global data envelopment analysis, we take a further step to analyze the key factors responsible for the change of environmental productivity during 2003–2011 from the point of view of technical progress, productive scale, and management level. The results show that, redundancy in energy and labor inputs, and excessive emission of sulfur dioxide, chemical oxygen demand, and ammonia nitrogen, are the main sources of production inefficiency in China. During the sample period, the efficiency in all inputs and environmental emissions has improved (except for capital input efficiency, which had a decreasing trend). Further analysis shows that the overall environmental productivity in China has begun to follow an ascending path. Technical progress is the most powerful contributor to China's productivity growth, while the decreases in scale and management efficiency are the two main obstacles preventing productivity improvement.

Does urbanization affect energy intensities across provinces in China?Long-run elasticities estimation using dynamic panels with heterogeneous slopes

- Energy Economics---2015---Ben Ma

Although there has been extensive debate in the literature that addresses the impact of urbanization on total energy use, the relative magnitude of each impact channel has not been empirically examined and urbanization's effects on energy transition dynamics in China remains unknown. Using panel datasets at the provincial level from 1986 to 2011, this paper employs dynamic models to investigate both the long-run and short-run elasticities of urbanization on energy intensities and the most significant impact channel is identified. Coal intensity and electricity intensity are also modeled to reveal energy transition dynamics driven by urbanization. A set of newly developed regression techniques, namely well-performed common correlated effects mean group (CCEMG) and augmented mean group (AMG) estimators, are used to treat residual cross-sectional dependence, nonstationary residuals,

and unlikely-to-hold homogeneous slope assumptions. The results obtained verify that the net effects of urbanization on overall energy intensity and electricity intensity are statistically positive, with long-run elasticities of 0.14% to 0.37% and 0.23% to 0.29%, respectively, whereas China's urbanization does not significantly increase coal intensity. The fact that short-run elasticities account for a majority of corresponding long-run values indicates that the short-run effect, that is, indirect energy use induced by urban infrastructures is the most significant impact channel of urbanization on energy use in China. An energy transition from high-pollution coal to clean electricity is also present in China, although the fundamental transition to renewable energy is still in its infancy. From a regional perspective, urbanization exerts asymmetric impacts on provincial energy use so that energy policies associated with urbanization should be province-specific. The findings also illustrate that for a panel dataset on regional dimension within large and fast-growing economies such as China, error cross-sectional dependence and residual nonstationarity must be tested and properly treated to avoid size distortion and biased estimators.

The cost of solar-centric renewable portfolio standards and reducing coal power generation using Arizona as a case study

- Energy Economics---2015---Timothy J. Conside,Edward J.M. Manderson

This paper develops an econometric forecasting system of energy demand coupled with engineering-economic models of energy supply. The framework is used to quantify the impact of a state-level renewable portfolio standard (RPS) achieved predominately with solar generation. We perform the analysis using Arizona's RPS as a case study over the period 2012–2035. We find if Arizona implements its RPS when supplying future electricity demand, there will be an increase in electricity rates (relative to a business-as-usual scenario of reliance on gas-fired generation). Extending the current regime of tax credits greatly reduces this increase, at the taxpayers' expense. We find that by

2025 Arizona's RPS will implicitly abate carbon dioxide emissions at a cost between \$58 and \$82 per metric ton, and by 2035 abatement costs are between \$22 and \$69 per metric ton (depending on the future evolution of nature gas prices). The RPS always leads to a negative impact on social welfare under low gas prices, but after 2029 the welfare impact is positive under high gas prices. In contrast, phasing out Arizona's existing coal-fired generation always has positive welfare impacts.

Productive energy use and economic growth: Energy, physical and human capital relationships

- Energy Economics---2015---Maria Pablo-Romero,Antonio Sánchez-Braza

Ecological and biophysical economists and historians of economics consider that availability of energy inputs has played a key role in driving economic growth in industrialized and emerging economies. Nevertheless, being very sensitive to structural characteristics or stages of economic development, the strength of this link differs among countries. This study analyzes the role of energy in economic growth from a geographical standpoint by estimating an aggregate translog production function, with human and physical capital and productive energy use as production factors, within a growth framework. Panel data of 38 major countries for the period from 1995 to 2007 were used. The strength of the link between energy and growth is analyzed for the whole sample and the following relevant country groups: OECD, BRIC, NAFTA, East Asian, East European and EU15 countries. Obtained results show that the calculated productivity elasticities with respect to energy use are positive for all country groups. BRIC countries have higher elasticities, around 0.37, and EU15 countries have lower elasticities, around 0.12. Weak substitutability relationships between energy and capital are observed for all groups, except for BRIC and East European countries, which show complementarity relationships.

Understanding rig rate formation in the Gulf of Mexico

- Energy Economics---2015---Petter Osmundsen, Knut Einar Rosendahl, Terje Skjerpen

We examine the largest cost component in offshore development projects, rig rates. High rig rates in recent years have restricted development of new oil and gas fields, as well as IOR projects and thus increased the cost for importing countries. Thus, it is important to understand developments in rig rates. Using econometric analysis, we examine the effects on jackup rig rates from gas and oil prices, rig capacity utilisation, contract length and lead time, and rig-specific characteristics like drilling depth capacities and rig classification. Having access to a unique data set from the Gulf of Mexico (GoM), containing contract information, we are able to estimate how contract parameters crucial to the relative bargaining power between rig owners and oil and gas companies affect rig rates. We find that increasing lead times and contract lengths enhance the bargaining power of the rig companies and are likely to be associated with higher rates for new contracts. Further, we find that gas prices are more important for jackup rig rates in the GoM area than oil prices — ten percent increase in gas prices leads to nine percent increase in rig rates in the long run, according to our results.

Residential energy expenditures and the relevance of changes in household circumstances

- Energy Economics---2015---Simonetta Longhi

This paper analyses the impact that dwelling characteristics and characteristics and behaviours of household members have on per capita energy expenditures. It also analyses whether changes in household socio-economic circumstances translate in changes in energy expenditures. Socio-economic characteristics have a moderate impact, while dwelling characteristics and especially household size have much larger impacts. The largest changes in energy expenditures are due to changes in household size.

A method for analyzing pollution control policies: Application to SO₂ emissions in China

- Energy Economics---2015---Xu Li, Xiaole Wu, Fuqiang Zhang

Market-based pollution control mechanisms such as pollution levy and cap and trade have received increasing attention from both academics and practitioners. A good understanding of the optimal pollution price under these mechanisms is a premise for regulators to make sound pollution control policies. In this paper, we propose a method for deriving the optimal pollution price for a given pollution target. This method consists of two steps that integrate cost function estimation and market equilibrium analysis: First, historical data is used to estimate the pollution abatement cost functions of the polluters; second, market models are used to solve the equilibrium pollution price under each control mechanism. For illustration, we apply the method to investigate SO₂ emission control policies in China, using a dataset of SO₂ emissions and abatement costs from three major industry sectors (Electricity, Gas, and Water Supply; Manufacturing; and Mining). Our analysis shows that the optimal levy rate is significantly higher than the actual rate adopted by the Chinese government. For example, the optimal levy rate should be 4.92RMB/kg, while the actual rate is 1.26RMB/kg in 2010. As a result, the actual emission structure is much less efficient: The overall cost savings would be 49.7% for all three sectors during 2006–2010 if the optimal emission structure is achieved. These findings have useful policy implications for the Chinese government. In addition, the method may be applied to analyze control policies at different aggregate levels (for example, provincial economies) or for other pollutants (for example, CO₂ and chemical oxygen demand).

The role of energy productivity in U.S. agriculture

- Energy Economics---2015---V.E. Ball, R. Färe, S. Grosskopf, D. Margaritis

This paper investigates the role of energy on U.S. agricultural productivity using panel data at the state

level for the period 1960–2004. We first provide a historical account of energy use in U.S. agriculture. To do this we rely on the Bennet cost indicator to study how the price and volume components of energy costs have developed over time. We then proceed to analyze the contribution of energy to productivity in U.S. agriculture employing the Bennet–Bowley productivity indicator. An important feature of the Bennet–Bowley indicator is its direct association with the change in (normalized) profits. Thus our study is also able to analyze the link between profitability and productivity. Panel regression estimates indicate that energy prices have a negative effect on profitability in the U.S. agricultural sector. We also find that energy productivity has generally remained below total farm productivity following the 1973–1974 global energy crisis.

Socio-economic determinants of charcoal expenditures in Tanzania: Evidence from panel data

- Energy Economics---2015---D'Agostino, Anthony L.,Johannes Urpelainen,Alice Xu

Compared to firewood, charcoal is a relatively clean and convenient fuel. Nevertheless, the mass production of charcoal can contribute substantially to deforestation, rendering it imperative to regulate charcoal use. This article uses nationally representative panel data on Tanzania conducted in 2008 and 2010 to examine how charcoal expenditures change over time within any given household. The focus of the analysis will be on identifying certain socio-economic factors that affect charcoal use at the household level. The framing of the analysis on variation in time within each household addresses the omitted variable bias that often undermines inference from comparisons across different households. We find that while charcoal expenditures increase with household income, the rise in charcoal use with income is relatively gradual. Household size is unrelated to charcoal expenditures, but urban–rural differences in fuel choice are large even though we include household fixed effects in all specifications. In this regard, policymakers and urban planners need to pay particular attention to the role of urbanization in predicting

trends in charcoal expenditures in developing countries like Tanzania.

The impact of advanced biofuels on aviation emissions and operations in the U.S

- Energy Economics---2015---Niven Winchester,Robert Malina,Mark D. Staples,Steven R.H. Barrett

We analyze the economic and emissions impacts on U.S. commercial aviation of the Federal Aviation Administration's renewable jet fuel goal when met using advanced fermentation (AF) fuel from perennial grasses. These fuels have recently been certified for use in aircraft and could potentially provide greater environmental benefits than aviation biofuels approved previously. Due to uncertainties in the commercialization of AF technologies, we consider a range of assumptions concerning capital costs, energy conversion efficiencies and product slates. In 2030, estimates of the implicit subsidy required to induce consumption of AF jet fuel range from \$0.45 to \$20.85 per gallon. These correspond to a reference jet fuel price of \$3.23 per gallon and AF jet fuel costs ranging from \$4.01 to \$24.41 per gallon. In all cases, as renewable jet fuel represents around 1.4% of total fuel consumed by commercial aviation, the goal has a small impact on aviation operations and emissions relative to a case without the renewable jet fuel target, and emissions continue to grow relative to those in 2005. Costs per metric ton of carbon dioxide equivalent abated by using biofuels range from \$42 to \$652.

An assessment of optimal gas pricing in Russia: A CGE approach

- Energy Economics---2015---Anton Orlov

Domestic gas prices in Russia are administratively regulated, and they are substantially lower than export netback prices. The administrative price regulation operates as an implicit subsidy on domestic gas consumption. The Russian government aims to liberalise domestic wholesale gas prices in the long term. While the “export netback parity” is defined as a political

objective, it seems not to be a necessary target anymore. The export netback parity is not economically rational for Russia because the average export netback price of gas is higher than the marginal cost due to Gazprom's market power in export gas markets. An optimal domestic gas price is still not well-defined. This paper addresses this question by employing a comparative static, single-country, multi-sector Computable Generation Equilibrium model (CGE). The administrative regulation of domestic gas prices is explicitly modelled. The main findings are as follows. An increase in the domestic gas price provides economic efficiency gains: the more elastic the export and domestic demand for gas, the larger the welfare gains. The optimal domestic gas price should be approximately 55% of the export netback price. Increasing the domestic gas price provides additional government revenues, which can be used to reduce distortionary taxes. On sectoral effects, the structure of the Russian economy shifts from energy toward non-energy intensive sectors in response to an increase in the domestic gas price. There is an increase in the export supply of gas. Furthermore, an increase in the domestic gas price leads to a reduction in total CO₂ emissions.

White certificates — Energy efficiency programs under private information of consumers

- Energy Economics---2015---Franz Wirl

Energy efficiency is an objective of public interventions at least since the Public Utility Regulatory Policy Act of 1978 (PURPA). Recently, conservation has received considerable attention in the United States and in particular in the European Union but this time in order to mitigate global warming. Policy measures include regulations at the technical level and the introduction of white certificates in order to force utilities and firms to invest into conservation in a way similar to the already existing renewable energy quota. This paper derives the optimal mechanism if utilities must deal with white certificates facing consumers holding private information. The optimal mechanism has some theoretically interesting features like restricted participation and a discontinuity.

Effects of energy price rise on investment: Firm level evidence from Indian manufacturing sector

- Energy Economics---2015---Anver C. Sathath,Rajesh H. Acharya

This paper analyses the effects of the rising prices of energy products on the investment of a large panel of manufacturing firms in India during 1993–2013. The prime motivation behind this study is the absence of an empirical study into this research issue exclusively on Indian economy. The empirical results obtained by estimating an Error Correction Model (ECM) using Generalized Method of Moments (GMM) show that energy price rise has negative effect on the investment of firms in the manufacturing sector. The negative effect is transmitted to the firm's investment through both demand-side and supply-side factors. The transmission also depends upon factors such as the energy intensity of production. The results also show that the sales–growth–investment relationship becomes weak in the face of the rising prices of the energy which could be due to the cautious approach to investment adopted by the firms. Therefore, it calls for the attention of the policy makers to evolve a comprehensive energy-policy to ensure continuous supply of energy at affordable prices to the manufacturers.

The dark side of the sun: How solar power production affects the market value of solar and gas sources

- Energy Economics---2015---Stefano Clo,Gaetano D'Adamo

Using daily data for the Italian wholesale day-ahead power market over the period 2008–2013, we assess the impact of solar production on the market value of solar and gas sources, defined using the concepts of value factor and unit revenues. We find that, on average, solar generation negatively affects the solar source market value, causing a departure from the grid parity condition and mining their competitiveness once public incentives are removed. This negative relation is not constant over time and becomes stronger for

increasing solar penetration in the energy mix. Interestingly, the opposite is found when looking at gas. While the relation between solar production and the gas market value is negative or not significant when the former is low, it turns positive for higher levels of solar production. This is the result of a change in gas producers' bidding strategies. Indeed, in the Italian power market the highest hourly price has shifted from the peak daytime, when solar production is concentrated, to the off-peak nighttime, when solar is absent from the market and gas can exploit temporary market power.

Emission abatement: Untangling the impacts of the EU ETS and the economic crisis

- Energy Economics---2015---Germà Bel,Stephan Joseph

In this study we use historical emission data from installations under the European Union Emissions Trading System (EU ETS) to evaluate the impact of this policy on greenhouse gas emissions during the first two trading phases (2005–2012). As such the analysis seeks to disentangle two causes of emission abatement: that attributable to the EU ETS and that attributable to the economic crisis that hit the EU in 2008/09. To do so, we use a dynamic panel data approach. Our results suggest that, by far, the biggest share of abatement was attributable to the effects of the economic crisis. This finding has serious implications for future policy adjustments affecting core elements of the EU ETS, including the distribution of EU emission allowances.

Analyzing volatility spillovers and hedging between oil and stock markets: Evidence from wavelet analysis

- Energy Economics---2015---Rabeh Khalfaoui,M. Boutahar,H. Boubaker

This paper examines the linkage of crude oil market (WTI) and stock markets of the G-7 countries. We study the mean and volatility spillovers of oil and stock market prices over various time horizons. We propose a new approach incorporating both multivariate GARCH

models and wavelet analysis: wavelet-based MGARCH approach. We combine a bivariate GARCH-BEKK model with wavelet multiresolution analysis in order to capture the multiscale features of mean and volatility spillovers between time series. For optimal portfolio allocation decisions, we analyze the multiscale behavior of hedge ratio. Empirical results show strong evidence of significant volatility spillovers between oil and stock markets, as well as time-varying correlations for various market pairs. However, results of wavelet coherence indicate that in most, the WTI market was leading. In addition, it is stated that the decomposed volatility spillovers permit investors to adapt their hedging strategies.

Modeling the dynamics of carbon emission performance in China: A parametric Malmquist index approach

- Energy Economics---2015---Boqiang Lin,Kerui Du

This paper contributes to the existing literature on the methodology of modeling the dynamic of carbon emission performance. Based on the analytical framework of Zhou et al. (Energy Economics, 32, 194–201, 2010), we develop a parametric Malmquist index approach that takes into account statistical noises. Moreover, the fixed-effect panel stochastic frontier model is employed to deal with regional heterogeneity. The proposed approach is applied to analyze the dynamics of carbon emission performance in 30 Chinese provinces during the period of 2000–2010. The main findings are as follows. First, the carbon emission performances of 30 provinces as a whole improved by 4.1% annually during the sample period, which was mainly driven by efficiency change component. Second, the east area shows the best performance with an average Malmquist CO₂ emissions performance index (MCPI) of 1.108, followed by the central area (1.039). Unlike the east and central areas, the west area experienced deterioration in carbon emission performance. More effective environmental policies should be implemented to change the situation. Third, compared with the proposed approach, the non-parametric approach tends to underestimate China's MCPI and gives rise to volatile results.

Lowering Saudi Arabia's fuel consumption and energy system costs without increasing end consumer prices

- Energy Economics---2015---Walid Matar,Frederic Murphy,Axel Pierru,Bertrand Rioux

Using a multi-sector equilibrium model of the Saudi energy system that handles administered prices in a mixed-complementarity formulation, we present results from a set of policy scenarios that lower oil consumption in the country. Some of these scenarios are the solutions to Mathematical Programs subject to Equilibrium Constraints (MPECs) that maximize the net economic gain for the Saudi economy. The policies examined have the potential to generate economic gains exceeding 23 billion USD in 2011, or about 4% of Saudi Arabia's GDP. This economic gain comes mainly from inter-sectoral fuel pricing policies that incentive shifting the mix in technologies that generate electricity and produce water from energy intensive technologies to more efficient ones. We show that when complemented by credits for investments in solar and nuclear power generation capacities, a modest increase in the transfer prices of fuels among sectors is sufficient to produce economic gains close to those achieved by deregulating transfer prices. The approach we develop here is an alternative to the classic recommendation of deregulating inter-sectoral fuel prices in situations where the conditions for successful liberalized markets do not exist. It is a template for introducing the notions of incentivizing behavior using prices into countries that rely more on administrative procedures than markets, leading to a deeper understanding of how markets can lead to economic gain.

Asymmetric impacts of the determinants of energy intensity in Nigeria

- Energy Economics---2015---Philip Adom

This study analysed the problem of energy intensity determinants in Nigeria based on the fully modified OLS and canonical cointegration regressions. These methods were preferred since they are able to deal effectively with the second-order bias problems, an often

characteristics of time series data. The impacts of price of crude oil, FDI, trade openness and industry structure are asymmetric which suggests the presence of structural effects in parameters. The impact of crude oil price is negative but becomes stronger post-1989 saving .126% more in energy consumption relative to pre-1989. Also, the impacts of FDI and trade openness are negative and significant but become stronger post-1989 saving 11.2% and 0.8% more in energy consumption relative to the baseline, respectively for every one percentage point increase in FDI and trade openness. The impact of industry value-added is positive and significant but weakens after 1989 consuming 1.8% less in energy for every one percentage point increase in industry value-added relative to the baseline. The energy reducing effect of industry value-added post-1989 reflects improvements in the technical characteristics of industrial sector in Nigeria. Last, the result showed that the absorptive capability and industry characteristics of Nigeria are important determinants of how FDI affects energy intensity. This implies that a more integrated FDI programme (considering the country characteristics) rather than a 'one-fit-all' programme is preferable.

Boom or bust? Mapping out the known unknowns of global shale gas production potential

- Energy Economics---2015---Jérôme Hilaire,Nico Bauer,Robert J. Brecha

To assess the global production costs of shale gas, we combine global top-down data with detailed bottom-up information. Studies solely based on top-down approaches do not adequately account for the heterogeneity of shale gas deposits and hence, are unlikely to appropriately capture the extraction costs of shale gas. We design and provide an expedient bottom-up method based on publicly available US data to compute the levelized costs of shale gas extraction. Our results indicate the existence of economically attractive areas but also reveal a dramatic cost increase as lower-quality reservoirs are exploited. At the global level, our best estimate suggests that, at a cost of 6US\$/GJ, only

39% of the technically recoverable resources reported in top-down studies should be considered economically recoverable. This estimate increases to about 77% when considering an optimistic recovery of resources but could be lower than 12% when considering pessimistic ones. The current lack of information on the heterogeneity of shale gas deposits as well as on the development of future production technologies leads to significant uncertainties regarding recovery rates and production costs. Much of this uncertainty may be inherent, but for energy-system planning purposes, with or without climate change mitigation policies, it is crucial to recognize the full ranges of recoverable quantities and costs.

How do correlations of crude oil prices co-move? A grey correlation-based wavelet perspective

- Energy Economics---2015---Xiaoliang Jia,Haizhong An,Wei Fang,Xiaoqi Sun,Xuan Huang

Previous research on the oil market has focused mainly on the static relationship between bivariate oil prices, ignoring the dynamic correlation of bivariate or multivariate oil prices. This study provides a novel perspective on multivariate dynamic correlations for studying the oil market by using an optimal wavelet analysis on the basis of grey correlation. We used China-Daqing and its three reference benchmark oil prices (Brent, Dubai and Minas) as empirical data. Our main findings are as follows. First, the time-frequency phenomena of the analysis results from one-to-one and many-to-one correlation time series support the hypothesis of the regional and global characteristics of the oil market, respectively. Second, the U-shaped wavelet variance plot indicates that the fluctuation intensity of the shortest and longest time-frequency domains plays a leading role in the dynamic process of oil price correlation. For the Chinese government, the oil price adjustment strategy in the short term should reduce the reference weights of Brent, and the long-term strategy should reduce the reference weights of Minas to avoid the risk of a single reference. The investor's portfolio management should pay more attention to the leading oil price of

the corresponding period to make clear market timing. Third, the significant lead-lag relationships of oil price correlations showed a time-varying spread phenomenon of benchmark oil prices' relative influence on Daqing, which provides a useful time reference when crafting an oil price adjustment strategy and intertemporal arbitrage.

A new approach to measuring the rebound effect associated to energy efficiency improvements: An application to the US residential energy demand

- Energy Economics---2015---Luis Orea,Manuel Llorca,Massimo Filippini

This paper brings attention to the fact that the energy demand frontier model introduced by Filippini and Hunt (2011, 2012) is closely connected to the measurement of the so-called rebound effect associated with improvements in energy efficiency. In particular, we show that their model implicitly imposes a zero rebound effect, which contradicts most of the available empirical evidence on this issue. We relax this restrictive assumption through the modelling of a rebound-effect function that mitigates or intensifies the effect of an efficiency improvement on energy consumption. We illustrate our model with an empirical application that aims to estimate a US frontier residential aggregate energy demand function using panel data for 48 states over the period 1995 to 2011. Average values of the rebound effect in the range of 56–80% are found. Therefore, policymakers should be aware that most of the expected energy reduction from efficiency improvements may not be achieved.

Local employment impact from competing energy sources: Shale gas versus wind generation in Texas

- Energy Economics---2015---Peter Hartley,Kenneth Medlock,Ted Temzelides,Xinya Zhang

The rapid development of both wind power and of shale gas has been receiving significant attention both in the media and among policy makers. Since these

are competing sources of electricity generation, it is informative to investigate their relative merits regarding local job creation. We use a panel econometric model to estimate the historical job-creating performance of wind versus that of shale oil and gas. The model is estimated using monthly county level data from Texas from 2001 to 2011. Both first-difference and GMM methods show that shale-related activity has brought strong employment to Texas. For example, based on the 5482 new directional/fractured wells drilled in Texas in 2011, the estimates imply that between 25,000 and 125,000 net jobs were created in that year alone. We did not, however, find a corresponding impact on wages. Our estimations did not identify a non-negligible impact from the wind industry on either local employment or wages.

Measuring fuel poverty in France: Which households are the most fuel vulnerable?

- Energy Economics---2015---Bérangère Legendre, Olivia Ricci

Fuel poverty is a growing concern in France. Following a hike in energy prices that started in 2004, the problem of energy affordability for low-income households entered the political debate with the “Grenelle de l’environnement” in 2007. According to the standard UK definition (more than 10% of income spent on domestic energy) 3.8 million households were subject to fuel poverty in France in 2006 however, this is according to one precise computation and other computations may offer differing conclusions. We question the way fuel poverty is currently measured and compare the impact of different existing measurement approaches on the extent and composition of fuel poverty in France. We then identify fuel vulnerable households as those households that are not ordinarily poor when considering income net of housing costs, but turn poor because of their domestic fuel expenses. A logit, a C log-log and a mixed effect logit model are used to analyse which factors influence the probability of being fuel vulnerable. Data analysis indicates that the proportion of fuel poor people and their characteristics differ significantly depending on the fuel poverty measure chosen.

The econometric results show that the probability of being fuel vulnerable is higher for those who are retired, living alone, rent their home, use an individual boiler for heating, cook with butane or propane and have poor roof insulation.

On the relationships between CO2 emissions, energy consumption and income: The importance of time variation

- Energy Economics---2015---Ahdi Noomen Ajmi, Shawkat Hammoudeh, Duc Khuong Nguyen, João Ricardo Sato

The environment that governs the relationships between energy consumption, carbon dioxide (CO2) emissions and gross domestic product (GDP) in the G7 countries changes over time due to variations in economic growth, regulatory policy and technology. Using a novel approach that may detect causalities when the time-constant hypothesis is rejected, we find significant time-varying Granger causalities among the variables under consideration. There is bidirectional causality between GDP and energy consumption for Japan, unidirectional causality running from GDP to energy consumption for Italy, and unidirectional causality running from energy consumption to GDP for the resource country Canada. Moreover, the results also show a bidirectional time-varying causality between energy consumption and CO2 emissions for the United States, and causality from energy consumption to CO2 emissions for France. Finally, while we find significant time-varying causalities running from GDP to CO2 emissions for Italy and Japan, the finding of inverted N-shaped curves (Italy and Japan) lends no support to the traditional Environmental Kuznets Curve (EKC) hypothesis for these countries. It implies that environmental policy and economic growth should go hand in hand. Other policy implications of the empirical results have been proposed.

What drives the formation of global oil trade patterns?

- Energy Economics---2015---Hai-Ying Zhang, Qiang Ji, Ying Fan

In this paper, the spatial characteristics of current global oil trade patterns are investigated by proposing a new indicator Moran-F. Meanwhile, the factors that influence the formation of oil trade patterns are identified by constructing four different kinds of spatial econometric models. The findings indicate that most oil exporters have an obvious export focus in North America and a relatively balanced export in Europe and the Asia-Pacific region. Besides supply and demand factors, technological progress and energy efficiency have also significantly influenced the oil trade. Moreover, there is a spillover effect of trade flow among different regions, but its impact is weak. In addition, oil importers in the same region have the potential to cooperate due to their similar import sources. Finally, promotion of oil importers' R&D investments can effectively reduce the demand for global oil trade.

A novel hybrid method for crude oil price forecasting

- Energy Economics---2015---Jin-Liang Zhang, Yue-Jun Zhang, Lu Zhang

Forecasting crude oil price is a challenging task. Given the nonlinear and time-varying characteristics of international crude oil prices, we propose a novel hybrid method to forecast crude oil prices. First, we use the ensemble empirical mode decomposition (EEMD) method to decompose international crude oil price into a series of independent intrinsic mode functions (IMFs) and the residual term. Then, the least square support vector machine together with the particle swarm optimization (LSSVM-PSO) method and the generalized autoregressive conditional heteroskedasticity (GARCH) model are developed to forecast the nonlinear and time-varying components of crude oil prices, respectively. Next, the forecasted crude oil prices of each component are summed as the final forecasted results of crude oil prices. The results show that, the newly proposed hybrid method has a strong forecasting capability for crude oil prices, due to its excellent performance in adaptation to the random sample selection, data frequency and structural breaks in samples. Furthermore, the comparison results also indicate that the

new method proves superior in forecasting accuracy to those well-recognized methods for crude oil price forecasting.

Risk management and the stated investment costs by independent power producers

- Energy Economics---2015---Bahman Kashi

Evidence presented in this article suggests that in less developed countries the independent power producers (IPPs) have an incentive to overstate the investment cost as an instrument to mitigate the country risk in greenfield electricity generation projects. This technique is an effective risk mitigation strategy under the conventional financing and contractual arrangements in such markets. It, however, promotes the use of less efficient power plants. The distortion in the choice of technology results in economic losses over the life of the plants. The findings of this research have important policy implications that can assist regulatory bodies, governments, and international financing agencies to adopt a more informed approach to the integration of private investment into the electricity generation capacity of developing countries.

Oil prices and the global economy: A general equilibrium analysis

- Energy Economics---2015---Govinda R. Timilsina

A global computable general equilibrium model is used to analyze the economic impacts of rising oil prices with endogenously determined availability of biofuels to mitigate those impacts. The negative effects on the global economy are comparable to those found in other studies, but the impacts are unevenly distributed across countries/regions or sectors. The agricultural sectors of high-income countries, which are relatively energy intensive, would suffer more from a rising oil prices than that in lower-income countries, whereas the reverse is true for the impacts across manufacturing sectors. The impacts are especially strong for oil importers with relatively energy-intensive manufacturing and trade, such as India and China. While the availability of biofuels does mitigate some of the negative impacts of

rising oil prices, the benefit is small because capacity of biofuels to economically substitute for fossil fuels on a large scale remains limited.

Impact of policies and subsidies in agribusiness: The case of oil palm and biofuels in Colombia

- Energy Economics---2015---Carmenza Castiblanco,Alvaro Moreno,Andrés Etter

We analyze the economic impacts of policies supporting biodiesel production in Colombia, such as subsidies and mandates for compulsory fuel mixtures. In the major biodiesel source being palm oil, we seek to establish the impact of these policies on oil palm producer incomes, prices and production levels of crude palm oil (CPO) and biodiesel, as well as the impacts on demand for land for oil palm plantation expansion.

Assessing the role of renewable energy policies in landfill gas to energy projects

- Energy Economics---2015---Shanjun Li,Han Kyul Yoo,Molly Macauley,Karen Palmer,Jhih-Shyang Shih

Methane (CH₄) is the second most prevalent greenhouse gas and has a global warming potential at least 28 times as high as carbon dioxide (CO₂). In the United States, Municipal Solid Waste (MSW) landfills are reported to be the third-largest source of human-made methane emissions, responsible for 18% of methane emissions in 2011. Capturing landfill gas (LFG) for use as an energy source for electricity or heat produces alternative energy as well as environmental benefits. A host of federal and state policies encourage the development of landfill gas to energy (LFGE) projects. This research provides the first systematic economic assessment of the role of these policies on adoption decisions. Results suggest that Renewable Portfolio Standards and investment tax credits have contributed to the development of these projects, accounting for 13 of 277 projects during our data period from 1991 to 2010. These policy-induced projects lead to 10.4 MMTCO₂e reductions in greenhouse gas emissions and a net benefit of \$41.8 million.

Commodity price excess co-movement from a historical perspective: 1900–2010

- Energy Economics---2015---Viviana Fernandez

Pindyck and Rotemberg (1990)'s excess co-movement hypothesis states that commodity prices move together beyond what fundamentals can explain, reflecting possibly traders' herding or liquidity constraints. We test for price excess co-movement in 12 commodities — 11 non-energy ones and oil — spanning over a hundred years: 1900–2010. To this end, we approximate commodity demand/supply factors by their apparent consumption. We carry out several tests and find some evidence in favor of excess co-movement, but its nature appears to be time-dependent. In particular, we conclude that excess co-movement with oil is generally present, particularly in the industrial metal class. We also explore the interdependence between portfolio investment decisions and excess co-movement for three unrelated assets: cotton, copper, and petroleum. Based on Conditional Value-at-Risk (CVaR) optimization, we found some correlations between the two, when short sales are excluded, during 1971, 1999–2004, and 2008.

Does the use of renewable energy sources mitigate CO₂ emissions? A reassessment of the US evidence

- Energy Economics---2015---Mohammad Jaforullah,Alan King

Previous research on the determinants of CO₂ emissions has concluded that, although increasing nuclear energy consumption can help to mitigate emissions, increasing use of renewable energy sources is not effective in this regard. These studies, however, do not consider energy prices as a possible driver of energy demand (and hence of emissions) and we find that this omission and the choice of functional form materially alters the outcome in the US case. Specifically, our cointegration and Granger-causality test results indicate that CO₂ emission levels are negatively related to the use of renewable energy, but are unrelated to nuclear energy consumption.

Performance of utility based hedges

- Energy Economics---2015---John Cotter,Jim Hanly

Hedgers as investors are concerned with both risk and return. However when measuring hedging performance, the role of returns and investor risk aversion has generally been neglected in the literature, by its focus on minimum variance hedging. In this paper we address this by using utility based performance metrics to evaluate the hedging effectiveness of utility based hedges for hedgers with both moderate and high risk aversion together with the more traditional minimum variance approach. To examine this for an energy hedger, we apply our approach to WTI Crude Oil, for three different hedging horizons, daily, weekly and monthly. We find significant differences between the minimum variance and utility based hedging strategies in-sample for all frequencies. However performance differentials between the different strategies are small and not economically significant. Out-of-sample results support these findings across all frequencies.

A note on using the Hodrick–Prescott filter in electricity markets

- Energy Economics---2015---Rafał Weron,Michał Zator

Recently, Nowotarski et al. (2013) have found that wavelet-based models for the long-term seasonal component (LTSC) are not only better in extracting the LTSC from a series of spot electricity prices but also significantly more accurate in terms of forecasting these prices up to a year ahead than the commonly used monthly dummies and sine-based models. However, a clear disadvantage of the wavelet-based approach is the increased complexity of the technique, as compared to the other two classes of LTSC models, and the resulting need for dedicated numerical software, which may not be readily available to practitioners in their work environments. To facilitate this problem, we propose here a much simpler, yet equally powerful method for identifying the LTSC in electricity spot price series.

It makes use of the Hodrick–Prescott (HP) filter, a widely-recognized tool in macroeconomics.

Economics of co-firing coal and biomass: An application to Western Canada

- Energy Economics---2015---Craig Johnston,Gerrit van Kooten

Co-firing biomass and coal in retrofitted power plants is an efficient means to reduce carbon dioxide emissions in the energy sector. Under IPCC reporting rules, the impacts of energy produced from biomass would not be reported in the energy sector, thereby effectively lowering the emission intensity of a power plant. In this study, a carbon tax is compared to a feed-in tariff for incentivizing conversion of coal plants to co-fire with biomass. In the application, a model of the Alberta electrical grid with an intertie to British Columbia is linked to a fiber transportation model for these provinces. Results indicate that there is an upper threshold on a carbon tax after which retrofitting of coal plants is less efficient than increasing natural gas generating capacity. This is not the case with a feed-in tariff as it specifically targets biomass energy. Although the optimal generating mix achieved with a carbon tax leads to lower aggregate emissions than the mix achieved using a feed-in tariff, it will result in higher average generating costs. Results indicate that it is optimal for Alberta to retrofit approximately 500MW of current coal capacity (8.6%) to co-fire with biomass, although Alberta wood pellet production acts as a constraint on further conversions.

Has oil price predicted stock returns for over a century?

- Energy Economics---2015---Paresh Narayan,Rangan Gupta

This paper contributes to the debate on the role of oil prices in predicting stock returns. The novelty of the paper is that it considers monthly time-series historical data that span over 150years (1859:10–2013:12) and applies a predictive regression model that accommodates three salient features of the data, namely, a persistent

and endogenous oil price, and model heteroscedasticity. Three key findings are unraveled: first, oil price predicts US stock returns. Second, in-sample evidence is corroborated by out-sample evidence of predictability. Third, both positive and negative oil price changes are important predictors of US stock returns, with negative changes relatively more important. Our results are robust to the use of different estimators and choice of in-sample periods.

Energy distribution and economic growth: An empirical test for China

- Energy Economics---2015---Robert Elliott,Puyang Sun,Qiqin Xu

In this paper we consider whether economic growth in China could be constrained by the physical development of the energy distribution network. Specifically, we structurally test the network theory of electricity distribution of Dalgaard and Strulik (2011) using city level data for China. In their paper they argue that the relationship between the size of the economy, measured by capital per capita, and electricity consumption per capita is governed by a simple power law with capital having an exponent bounded between $\frac{1}{2}$ and $\frac{3}{4}$ depending on the efficiency of the network. We use data for 224 cities in China between 2002 and 2007 to observe whether structural estimates match those of Dalgaard and Strulik (2011) for 50 US states where they find the exponent in the power law connecting capital with electricity to be $\frac{2}{3}$. Our results provide an estimate of the power law component to a little higher than the $\frac{2}{3}$ found for the US which provides broad support for the model. When we look at different time periods we observe what appears to be a fall in the efficiency of the energy distribution network towards the end of our period.

Is there dependence and systemic risk between oil and renewable energy stock prices?

- Energy Economics---2015---Juan Reboredo

We study systemic risk and dependence between oil and renewable energy markets using copulas to char-

acterize the dependence structure and to compute the conditional value-at-risk as a measure of systemic risk. We found significant time-varying average and symmetric tail dependence between oil returns and several global and sectoral renewable energy indices. Our evidence on systemic risk indicates that oil price dynamics significantly contributes around 30% to downside and upside risk of renewable energy companies. These results have important implications for risk management and renewable energy policies.

Structural breaks, dynamic correlations, asymmetric volatility transmission, and hedging strategies for petroleum prices and USD exchange rate

- Energy Economics---2015---Walid Mensi,Shawkat Hammoudeh,Seong-Min Yoon

This paper investigates the influence of structural changes on the asymmetry of volatility spillovers, asset allocation and portfolio diversification between the USD/euro exchange market and each of six major spot petroleum markets including WTI, Europe Brent, kerosene, gasoline and propane. Using the bivariate DCC-EGARCH model with and without structural change dummies, the results provide evidence of significant asymmetric volatility spillovers between the U.S. dollar exchange rate and the petroleum markets. Moreover, the model with the structural breaks reduces the degree of volatility persistence and leads to more appropriate hedging and asset allocation strategies for all pairs considered. Thus, the findings have important implications for financial risk management.

Inner conflict between nuclear power generation and electricity rates: A Japanese case study

- Energy Economics---2015---Takanori Ida,Kosuke Takemura,Masayuki Sato

Since the March 11 earthquake, Japanese households have been facing a trade-off problem between decreasing dependency on nuclear power generation and avoiding an increase in electricity rates. We analyze

this inner conflict quantitatively, adopting two economic-psychological approaches: First, we note that the trade-off causes cognitive dissonance after making a choice that results in a wider desirability gap between the chosen and rejected alternatives. Second, the consumer surplus improves by 11.2% with a no-choice option for suspending judgment in the presence of cognitive dissonance. Third, individual characteristics such as gender and annual household income are significantly correlated with both cognitive dissonance and a preference for the no-choice option.

Environmental taxes and international spillovers: The case of a small open economy

- Energy Economics---2015---Muhammad Shahid Siddiqui

In the existence of trade interaction, a sub-global climate change policy can generate externality, which can cause competitiveness issues for the producers in compliant regimes. However among compliant regions, a small economy also receives a significant spillins effect when a large economy takes some regulatory actions that affect, particularly, the world prices of traded commodities. This externality can have notable impacts on the efficiency and pollution abatement opportunities of the small compliant regime with a trivial converse effect. In some cases, these impacts on the efficiency and emissions abatement can be in opposite directions. We capture these findings by incorporating two protection polices (i.e., border tax adjustment and free emissions allocations to emission-intensive and trade exposed industries) in a multi-region analytical and numerical general equilibrium modeling framework. These results convey that the large economies hold leading strategic positions towards a cooperative global climate change movement because of their policies' influences on the small economies.

Promises and pitfalls in environmentally extended input-output analysis for China: A survey of the literature

- Energy Economics---2015---Jacob Hawkins, Chunbo Ma, Steven Schilizzi, Fan

Zhang

As the world's largest developing economy, China plays a key role in global climate change and other environmental impacts of international concern. Environmentally extended input-output analysis (EE-IOA) is an important and insightful tool seeing widespread use in studying large-scale environmental impacts in China: calculating and analyzing greenhouse gas emissions, carbon and water footprints, pollution, and embodied energy. This paper surveys the published articles regarding EE-IOA for China in peer-reviewed journals and provides a comprehensive and quantitative overview of the body of literature, examining the research impact, environmental issues addressed, and data utilized. The paper further includes a discussion of the shortcomings in official Chinese data and of the potential means to move beyond its inherent limitations.

Holding distribution utilities liable for outage costs

- Energy Economics---2015---Timothy Brennan

Storm-related service outages in electricity and telecommunications have created public controversies regarding the adequacy of ex ante efforts to prevent outages and ex post efforts to restore power. Product liability rules, used to promote quality of service throughout the economy, might seem to offer a solution to this problem in the utility context. Strict liability rules avoid the need for determining whether utilities were appropriately careful but increase ratepayer costs because of moral hazard and, in effect, force ratepayers to buy outage insurance from the utility. By leaving customers exposed to damage, negligence rules can avoid these shortcomings but force upon regulators and courts the need to make difficult decisions regarding efficient care levels. Profit regulation, risk aversion, regulatory commitment failures, and distributional considerations add further complications. Still, the consideration of liability rules may provide worthwhile reminders that increased reliability is neither free nor guaranteed by public provision of service.

Time of day pricing and the levelized cost of intermittent power generation

- Energy Economics---2015---Stefan Reichelstein, Anshuman Sahoo

An important characteristic of most renewable energy sources is intermittency in their ability to generate electricity. Yet, intermittency is usually ignored in life-cycle cost calculations intended to assess the competitiveness of electric power from renewable as opposed to dispatchable energy sources, such as fossil fuels. This paper demonstrates that for intermittent renewable power sources a traditional life-cycle cost calculation should be appended by a correction factor which we term the Co-Variation coefficient. It captures any synergies, or complementarities, between the time-varying patterns of electricity generation and pricing. We estimate the Co-Variation coefficient for specific settings in the western United States. Our estimates imply that the benchmark of cost competitiveness for solar photovoltaic (PV) power is 10 to 15% lower than previous average life-cycle cost analyses have suggested. In contrast, the generation pattern of wind power exhibits complementarities with electricity pricing schedules, yielding a cost assessment that is higher than that suggested by traditional calculations. For the specific settings we study, the corresponding magnitude of the markup is 10 to 15%.

Energy inflation and house price corrections

- Energy Economics---2015---Andreas Breitenfeller, Jesus Crespo Cuaresma, Philipp Mayer

We analyze empirically the role played by energy inflation as a determinant of downward corrections in house prices. Using a dataset for 18 OECD economies spanning the last four decades, we identify periods of downward house price adjustment and estimate conditional logit models to measure the effect of energy inflation on the probability of these house price corrections after controlling for other relevant macroeconomic variables. Our results give strong evidence that increases in energy price inflation raise the probability of such corrective periods taking place. This phenomenon could

be explained by various channels: through the adverse effects of energy prices on economic activity and income reducing the demand for housing; through the particular impact on construction and operation costs and their effects on the supply and demand of housing; through the reaction of monetary policy on inflation withdrawing liquidity and further reducing demand; through improving attractiveness of commodity versus housing investment on asset markets; or through a lagging impact of common factors on both variables, such as economic growth. Our results contribute to the understanding of the pass-through of oil price shocks to financial markets and imply that energy price inflation should serve as a leading indicator for the analysis of macro-financial risks.

Energy savings potential in China's industrial sector: From the perspectives of factor price distortion and allocative inefficiency

- Energy Economics---2015---Xiaoling Ouyang, Chuanwang Sun

China's industrial energy consumption accounted for 70.82% of national and 14.12% of world energy usage in 2011. In the context of energy scarcity and environmental pollution, the industrial sector in China faces unsustainable growth problems. By adopting the stochastic frontier analysis (SFA) framework, this paper analyzes the factor allocative efficiency of China's industrial sector, and estimates the energy savings potential from the perspective of allocative inefficiency. This paper focuses on three issues. The first is examining the factor allocative inefficiency of China's industrial sector. The second is measuring factor price distortion by the shadow price model. The third is estimating the energy savings potential in China's industrial sector during 2001–2009. Major conclusions are thus drawn. First, factor prices of capital, labor and energy are distorted in China due to government regulations. Moreover, energy price is relatively low compared to capital price, while is relatively high compared to labor price. Second, the industry-wide energy savings potential resulted from energy allocative inefficiency was about 9.71% during 2001–2009. The

downward trend of energy savings potential implies the increasing energy allocative efficiency in China's industrial sector. Third, a transparent and reasonable pricing mechanism is conducive to improving energy allocative efficiency.

Energy-tax changes and competitiveness: The role of adaptive capacity

- Energy Economics---2015---Camille Gonseth,Olivier Cadot,Nicole Mathys,Philippe Thalmann

This paper estimates the effect of energy tax (and price) changes on Total Factor Productivity (TFP) and net trade at the industry level, using a panel of industries from European countries covering the period 1990–2003. We investigate the hypothesis that industries with high adaptive capacity (measured by their relative level of labour compensation) are able to mitigate the adverse effects of energy tax rises better than others. We identify the pro-adaptation effect by interacting wage levels (a proxy for human capital) with energy taxes. We find that the negative marginal effect of higher energy taxes on TFP and net trade is significantly reduced for industries with stronger human capital and even turns to an overall positive effect in at least two cases. Up to three low-wage sectors display an overall negative effect. This suggests that human capital is key to adaptation to higher energy costs and climate policy, in some cases making it a win-win.

A Bayesian stochastic frontier analysis of Chinese fossil-fuel electricity generation companies

- Energy Economics---2015---Zhongfei Chen,Carlos Barros,Maria Borges

This paper analyses the technical efficiency of Chinese fossil-fuel electricity generation companies from 1999 to 2011, using a Bayesian stochastic frontier model. The results reveal that efficiency varies among the fossil-fuel electricity generation companies that were analysed. We also focus on the factors of size, location, government ownership and mixed sources of electricity

generation for the fossil-fuel electricity generation companies, and also examine their effects on the efficiency of these companies. Policy implications are derived.

Does energy efficiency matter to home-buyers? An investigation of EPC ratings and transaction prices in England

- Energy Economics---2015---Franz Fuerst,Patrick McAllister,Anupam Nanda,Peter Wyatt

This paper investigates whether energy performance ratings, as measured by mandatory Energy Performance Certificates (EPCs), are reflected in the sale prices of residential properties. This is the first large-scale empirical study of this topic in England involving 333,095 dwellings sold at least twice in the period from 1995 to 2012. Applying hedonic regression and an augmented repeat sales regression, we find a positive relationship between the energy efficiency rating of a dwelling and the transaction price per square metre. The price effects of superior energy performance tend to be higher for terraced dwellings and flats compared to detached and semi-detached dwellings. The evidence is less clear-cut for rates of house price growth but remains supportive of a positive association. Overall, the results of this study suggest that energy efficiency labels have a measurable and significant impact on house prices in England.

Food–energy nexus in Europe: Price volatility approach

- Energy Economics---2015---Fadi Abdelradi,Teresa Serra

The literature on food–biofuel price volatility spillovers is growing. Published articles so far have widely ignored nonlinearities and the influence of exogenous variables on volatility patterns. This article allows for these issues when characterizing EU biodiesel industry price dynamics. While Brazilian and US ethanol markets have been thoroughly investigated, less attention has been paid to EU biodiesel markets. Pure EU biodiesel and rapeseed oil prices are the object of our research. Two different methods are applied to

model these data: a parametric approach and Long et al.'s (2011) semiparametric approach. Empirical results suggest significant asymmetries in volatility spillovers between pure biodiesel and rapeseed oil prices. Rapeseed stock levels and euro/dollar exchange rates are found to play a significant role in reducing food and biofuel price volatilities.

Dynamic demand for residential electricity in Taiwan under seasonality and increasing-block pricing

- Energy Economics---2015---Ming-Feng Hung,Tai-Hsin Huang

This paper studies the dynamic demand for residential electricity in Taiwan employing a monthly panel data set, composed of 19 counties and spanning the period from 2007:01 to 2013:12. The partial adjustment model used addresses the endogeneity of the electricity price that results from the increasing-block pricing. The estimated results show that there is a significant seasonal difference in the demand for electricity between the summer and non-summer periods. Both the adjustment speed and own price elasticity during the summer months are found to be lower than those in the non-summer months due to the hot weather in summer. It is easier for consumers to adjust their electricity consumption in response to the changes in electricity pricing during the non-summer time. The estimated inelastic short-run and long-run income effects show that electricity is a necessity for consumers. Moreover, the controversial electricity-conservation policies are found to be ineffective measures for reducing electricity consumption in Taiwan.

Short- and long-run electricity demand elasticities at the subsectoral level: A cointegration analysis for German manufacturing industries

- Energy Economics---2015---Ronald Bernstein,Reinhard Madlener

We estimate electricity demand elasticities for eight subsectors of the German manufacturing industry us-

ing annual data from EU-KLEMS and the International Energy Agency for 1970–2007. The subsectoral approach allows to retain additional information otherwise blurred by aggregation and to benefit from lower intra-sectoral heterogeneity. By employing a cointegrated VAR approach and accounting for structural breaks, we find long-run relationships for five of the eight subsectors studied. Short-run elasticities are estimated using single-equation error correction modeling. Granger causality tests and an impulse response analysis provide further insights into the relationships and dynamics of the variables, confirming the usefulness of the subsectoral approach adopted.

How industrialization and urbanization process impacts on CO2 emissions in China: Evidence from nonparametric additive regression models

- Energy Economics---2015---Bin Xu,Boqiang Lin

This paper examines the impacts of industrialization and urbanization on CO2 emissions in China using nonparametric additive regression models and provincial panel data from 1990 to 2011. The empirical results show that there is an inverted U-shaped nonlinear relationship between industrialization and CO2 emissions in the three regions in China. Urbanization follows an inverted U-shaped pattern with CO2 emissions in the eastern region, and a positive U-shaped pattern in the central region. However, the nonlinear impact of urbanization on CO2 emissions is insignificant in the western region. As a result, the differential dynamic effects of industrialization and urbanization on CO2 emissions in the three regions should be taken into consideration in reducing China's CO2 emissions.

The political economy of OPEC

- Energy Economics---2015---Gal Hochman,David Zilberman

We develop a conceptual model that captures OPEC pricing behavior, and apply it to explain the large gap observed between domestic fuel prices in OPEC countries and prices in the rest of the world. We model OPEC as a cartel of nations, not firms, and assume

that politicians use two instruments: production quotas and domestic fuel consumption subsidies. The cartel-of-nations model suggests that introduction of alternatives to petroleum products may lead OPEC to reduce exports and increase domestic fuel consumption. The empirical analysis suggests that when OPEC sets production quotas, it places similar weights on consumer and producer surplus. But when OPEC countries set domestic fuel subsidies, on average 6% more weight is given to consumer surplus with some of the OPEC countries pursuing very aggressive domestic cheap fuel policies.

Estimating the Marginal Abatement Cost Curve of CO2 Emissions in China: Provincial Panel Data Analysis

- Energy Economics---2015---Limin Du,Aoife Hanley,Chu Wei

This paper estimates the Marginal Abatement Cost Curve (MACC) of CO2 emissions in China based on a provincial panel for the period of 2001–2010. The provincial marginal abatement cost (MAC) of CO2 emissions is estimated using a parameterized directional output distance function. Four types of model specifications are applied to fit the MAC-carbon intensity pairs. The optimal specification controlling for various covariates is identified econometrically. A scenario simulation of China's 40–45% carbon intensity reduction based on our MACC is illustrated. Our simulation results show that China would incur a 559–623Yuan/t (roughly 51–57%) increase in marginal abatement cost to achieve a corresponding 40–45% reduction in carbon intensity compared to its 2005 level.

Metafroniter energy efficiency with CO2 emissions and its convergence analysis for China

- Energy Economics---2015---Ke Li,Boqiang Lin

This paper measures the energy efficiency performance with carbon dioxide (CO2) emissions in 30 provinces in China during the period of 1997–2011 using a meta-frontier framework with the improved directional dis-

tance function (DDF). We construct a new environmental production possibility set by combining the super-efficiency and sequential data envelopment analysis (DEA) models to avoid “discriminating power problem” and “technical regress” when evaluating efficiency by DDF. Then, it is used in a meta-frontier framework to reflect the technology heterogeneities across east, central and west China. The results indicate that eastern China achieved the highest progress inefficiency relative to the metafrontier, followed by western and the central China. By focusing on technology gaps, we offer some suggestions for the different groups based on group-frontier and meta-frontier analyses. The inefficiency can be attributed to managerial failure for eastern and western China, and technological differences for central China. The convergence analysis shows that energy and CO2 emission governance will produce negative effects on economic growth, and it is suitable and acceptable to introduce rigorous environmental measures in eastern China.

Financial development, environmental quality, trade and economic growth: What causes what in MENA countries

- Energy Economics---2015---Anis Omri,Saida Daly,Christophe Rault,Anissa Chaibi

This paper examines the relationship between financial development, CO2 emissions, trade and economic growth using simultaneous-equation panel data models for a panel of 12 MENA countries over the period 1990–2011. Our results indicate that there is evidence of bidirectional causality between CO2 emissions and economic growth. Economic growth and trade openness are interrelated i.e., bidirectional causality. Feedback hypothesis is validated between trade openness and financial development. Neutrality hypothesis is identified between CO2 emissions and financial development. Unidirectional causality running from financial development to economic growth and from trade openness to CO2 emissions is identified. Our empirical results also verified the existence of environmental Kuznets curve. These empirical insights are of particular interest to policymakers as they help build sound

economic policies to sustain economic development and to improve the environmental quality.

Trade-facilitated technology spillovers in energy productivity convergence processes across EU countries

- Energy Economics---2015---Jun Wan,Kathy Baylis,Peter Mulder

This empirical paper tests for trade-facilitated spillovers in the convergence of energy productivity across 16 European Union (EU) countries from 1995 to 2005. One might anticipate that by inducing specialization, trade limits the potential for convergence in energy productivity. Conversely, by inducing competition and knowledge diffusion, trade may spur sectors to greater energy productivity. Unlike most previous work on convergence, we explain productivity dynamics from cross-country interactions at a detailed sector level and apply a spatial panel data approach to explicitly account for trade-flow related spatial effects in the convergence analysis. Our study confirms the existence of convergence in manufacturing energy productivity, caused by efficiency improvements in lagging countries, while undermined by increasing international differences in sector structure. Further, we find that trade flows explain 30 to 40% of the unobserved variation in energy productivity. Trade continues to explain the unobserved variation in energy productivity even after accounting for geographic proximity. Last, we find that those countries and sectors with higher dependence on trade both have higher energy productivity growth and a higher rate of convergence, further implying that trade can enhance energy productivity. Thus, unlike concerns that trade may spur a ‘race to the bottom’, we find that promoting trade may help stimulate energy efficiency improvements across countries.

Resource externalities and the persistence of heterogeneous pricing behavior in an energy commodity market

- Energy Economics---2015---Derek Bunn,Veli Koc,Sandro Sapio

In competitive product markets, repeated interaction among producers with similar economic characteristics would be expected to result in convergence of their behaviors. If convergence does not occur, it raises fundamental questions related to the sustainability of heterogeneous competitive strategies. This paper examines the prices submitted to the British wholesale electricity market by four coal-fired plants, separately owned, approximately of the same age, size and efficiency, and located in the same transmission network zone. Due to the repetitive nature of the spot market, one would expect convergence in strategies. Yet, we find evidence of persistent price dispersion and heterogeneous strategies. We consider several propositions for these effects including market power, company size, forward commitments, vertical integration and the management of interrelated assets.

The impact of fundamental and financial traders on the term structure of oil

- Energy Economics---2015---Thomas Heidorn,Frieder Mokinski,Christoph Rühl,Christian Schmaltz

We study how the exposure of fundamental and financial traders affects the futures curve of WTI oil and the market integration between WTI and Brent as measured by their price spread. To obtain a parsimonious representation of the futures curve, we decompose it into a level-, a slope- and a curvature factor. In a second step, we separately regress each extracted factor on measures of the market exposure of fundamental and financial traders revealing whether and how the exposure of the two trader groups affects the different dimensions of the futures curve. Spanning from 2006 until 2012, our dataset covers sub-periods of a sharp WTI-price rise as well as a diverging Brent–WTI-spread. Our contribution is threefold: First, we suggest that it is important to distinguish between level and slope as we find that fundamental traders have a measurable impact on the level of the futures curve, but do not play much of a role for its slope or curvature, whereas the exposure of financial traders mainly influences the slope of the futures curve. Despite allegations to the

contrary, we find no evidence of a systematic impact of non-fundamental traders on the level of the futures curve, for example during the 2006–2008 oil price surge. Second, we suggest using relative short- and relative long positions for fundamental and financial traders instead of the net position as the former reflect better the overall economic positioning of each group. Third, we find that the exposure of financials is the key driver of the Brent–WTI spread. It confirms that financial rather than fundamental traders are responsible for integrating the two markets.

A comparison of implied and realized volatility in the Nordic power forward market

- Energy Economics---2015---Ole Henrik Birkelund,Erik Haugom,Peter Molnár,Martin Opdal,Sjur Westgaard

In this paper we study implied and realized volatility for the Nordic power forward market. We create an implied volatility index with a fixed time to maturity. This index is compared to a realized volatility time series calculated from high-frequency data. The results show that the implied volatility has a positive bias against the realized volatility measure indicating that there is a risk premium imposed by option traders. The results are consistent with previous research in other markets.

Distributed solar renewable generation: Option contracts with renewable energy credit uncertainty

- Energy Economics---2015---Yaxiong Zeng,Diego Klabjan,Jorge Arinez

Solar energy is rapidly emerging thanks to the decreasing installation cost of solar panels and the renewable portfolio standard imposed by state governments, which gave birth to the Renewable Energy Credit (REC) and the Alternative Compliance Payment (ACP). To make profits from the REC market in addition to reduced energy costs, more and more home and business owners choose to install solar panels. Recently, third-party financing has become a common

practice in solar panel investments. We discuss optimal timing for the host to potentially buy back the solar panels after being installed for a period of time and how to incorporate the optimal timing into a power purchase agreement between the host and the third-party developer. Because the REC price is a major source of uncertainty and also due to the ACP capping the REC price, we first propose a REC price forecasting model that specifically considers the ACP values. Then by a modified real option structure, we model the buyback contract as a real option and solve it with an approximate dynamic program based Monte Carlo simulation method. We find that as the ACP value increases, the value of the buyback option also increases under optimal timing. The method used does not only apply to solar projects but also to other distributed renewable projects that are third-party financed, such as wind generations.

Gains from emission trading under multiple stabilization targets and technological constraints

- Energy Economics---2015---Shinichiro Fujimori,Toshihiko Masui,Yuzuru Matsuoka

This study quantified the effectiveness of emission trading by considering multiple technological constraints, burden sharing schemes, and climate stabilization targets. We used a global computable general equilibrium model, and evaluated the effectiveness of emission trading using welfare losses associated with climate mitigation for scenarios with and without emission trading, as measured by the Hicksian Equivalent Variation (HEV). We found that emission trading contributed to a reduction in the economic losses associated with climate mitigation for all technological assumptions, burden sharing schemes, and stabilization targets. The net global welfare losses in scenarios without emission trading ranged between 0.7% and 1.9%, whereas emission trading reduced the losses by 0.1% to 0.5%. The range depended on the assumptions in the burden sharing schemes, technological constraints, and stabilization targets. The percentage change in welfare gain from emission trading varied regionally, and was relatively

high in low-income or middle-income countries (0.2% to 1.0% and 0.1% to 1.2%, respectively) compared to high-income countries (0.1% to 0.3%). Some regions displayed negative values with regard to the effectiveness of emission trading, which might be due to the change in goods and service trades associated with emission trading. If the usage of carbon capture and storage was constrained, welfare loss became large and the effectiveness of emission trading ultimately increased. The use of a burden sharing scheme was a significant factor in changing the effectiveness of emission trading, and the per capita emission convergence in 2050 was more effective for emission trading than a per income convergence.

Forecasting excess stock returns with crude oil market data

- Energy Economics---2015---Li Liu,Feng Ma,Yudong Wang

In this paper, we forecast excess stock returns of S&P 500 index from January 1997 to December 2012 using both well-known traditional macroeconomic indicators and oil market variables. Based on a dynamic model selection approach, we find that the forecasting accuracy can be improved after adding oil variables to the traditional predictors. The forecasting gains relative to the benchmark of historical average are statistically and economically significant. Moreover, time-varying parameter models generate more accurate forecasts than constant coefficient models.

The dynamics of returns on renewable energy companies: A state-space approach

- Energy Economics---2015---Julian Inchauspe,Ronald D. Ripple,Stefan Trück,Stefan Trueck

The renewable energy sector has accomplished remarkable growth rates over the last decade. This paper examines the dynamics of excess returns for the Wilder-Hill New Energy Global Innovation Index, which lists firms in the renewable energy sector and is used as a global benchmark. We propose a multi-factor asset

pricing model with time-varying coefficients to study the role of energy prices and stock market indices as explanatory factors. Our results suggest a strong influence of the MSCI World index and technology stocks throughout the sample period. The influence of changes in the oil price is significantly lower, although oil has become more influential from 2007 onwards. We also find evidence for underperformance of the renewable energy sector relative to the considered pricing factors after the financial crisis.

Inventory announcements, jump dynamics, volatility and trading volume in U.S. energy futures markets

- Energy Economics---2015---Johan Bjursell,James E. Gentle,George H.K. Wang

This paper applies nonparametric methods to identify jumps in daily futures prices and intraday jumps surrounding inventory announcements of crude oil, heating oil and natural gas contracts traded on the New York Mercantile Exchange. The sample period of our intraday data covers January 1990 to January 2008. We have obtained several interesting empirical results. (1) Large volatility days are often associated with large jump components, and large jump components are often associated with the Energy Information Administration's inventory announcement dates. (2) The volatility jump component is less persistent than the continuous sample path component. (3) Volatility and trading volume are higher on days with a jump at the inventory announcement than on days without a jump at the announcement. Furthermore, the intraday volatility returns to normal faster following inventory announcements with jumps than after announcements without jumps.

Willingness to supply biomass for bioenergy production: A random parameter truncated analysis

- Energy Economics---2015---Ira Altman,Jason Bergtold,Dwight Sanders,Tom Johnson

This paper presents research results based on data

from two biomass producer surveys collected from mid Missouri and southern Illinois. A series of random parameter truncated regressions are utilized to analyze willingness to supply results under three price scenarios. Marginal effects suggest that producers will supply an additional 1.6 to 2.4% of their biomass production for each one dollar increase in price and that supply for three types of biomass (stover, straw and hay) is elastic. This means commercial developers that are interested in pricing biomass and policy makers considering subsidies could expect modest supply responses for each dollar increase in price.

LNG is linking regional natural gas markets: Evidence from the gravity model

- Energy Economics---2015---Ryan Barnes,Ryan Bosworth

Evidence exists that global natural gas markets have become more integrated over time. One possible explanation for this increased level of integration is that increased liquefied natural gas trade has increased the opportunity for price arbitrage by decreasing transport costs. If this explanation is true, then the natural gas market should become relatively more integrated because countries separated by large distances would be more willing to trade with each other. We employ a gravity model to test whether trade in liquefied natural gas has helped to de-regionalize the total natural gas market, using trade in the compressed natural gas market as a comparison benchmark. The results indicate that liquefied natural gas is indeed a global commodity, whereas the compressed natural gas markets are more regional. Importantly, we find that trade in liquefied natural gas has de-regionalized the total natural gas market.

Monetized value of the environmental, health and resource externalities of soy biodiesel

- Energy Economics---2015---Matthew Winden,Nathan Cruze,Tim Haab,Bhavik Bakshi

This study monetizes the life cycle environmental damage, human health risk, and resource depletion externalities associated with the production and use of biodiesel fuels from soybean feedstock. Applying a framework that couples life cycle damage measurements with social preferences elicited from a conjoint choice experiment allows for comparison of petrodiesel and biodiesel's external damages. The results of the study reveal that production and consumption of soybean based biodiesels produce improvements in environmental, health and resource impacts of \$0.27 per gallon relative to petrodiesel for a 20% blend and \$3.14 per gallon for a 100% blend.

The Clean-Development Mechanism, stochastic permit prices and energy investments

- Energy Economics---2015---Philipp Hieronymi,David Schüller

We analyze the impact on energy investments stemming from different emission permit classes, by considering permits that are allocated inside the European Emission Trading Scheme and secondary Certified Emission Reduction (sCER) permits originating from the Clean Development Mechanism. One price taking firm which is subject to emission regulation has the choice to invest in gas or wind power plant. The firm faces uncertainty regarding stochastically evolving permit prices, while it receives a premium on the electricity price for wind energy. As a first step, we determine the value of the option to invest into a gas power plant over time. Then, we calculate the investment probability of a gas power investment in a range of policy scenarios. We find that allowing the usage of sCER permits in the present policy framework has a positive impact on gas power investment. Decoupling the price processes has a similar effect. If the quota of sCER permits is doubled, the decrease in the investment probability for wind power is large. We carry out sensitivity tests for different parameter values, and find that investment behavior changes significantly with differing interest rates, the wind energy premium and volatility.

Forecasting short-term electricity consumption using a semantics-based genetic programming framework: The South Italy case

- Energy Economics---2015---Mauro Castelli,Leonardo Vanneschi,Matteo De Felice

Accurate and robust short-term load forecasting plays a significant role in electric power operations. This paper proposes a variant of genetic programming, improved by incorporating semantic awareness in algorithm, to address a short term load forecasting problem. The objective is to automatically generate models that could effectively and reliably predict energy consumption. The presented results, obtained considering a particularly interesting case of the South Italy area, show that the proposed approach outperforms state of the art methods. Hence, the proposed approach reveals appropriate for the problem of forecasting electricity consumption. This study, besides providing an important contribution to the energy load forecasting, confirms the suitability of genetic programming improved with semantic methods in addressing complex real-life applications.

Electricity market-clearing prices and investment incentives: The role of pricing rules

- Energy Economics---2015---Ignacio Herrero,Pablo Rodilla,Carlos Batlle

Pricing rules in wholesale electricity markets are usually classified around two major groups, namely linear (aka non-discriminatory) and non-linear (aka discriminatory). As well known, the major difference lies on the way non-convexities are considered in the computation of market prices.

Electricity load level detail in computational general equilibrium – part II – welfare impacts of a demand response program

- Energy Economics---2015---Renato Rodrigues,Pedro Linares

Demand Response (DR) programs send time-based signals to electricity consumers so that they may shift or reduce their loads to better adjust to the system requirements, thus creating interesting benefits for power systems. However, the assessment of these benefits is quite challenging, since it requires combining features from bottom-up and computable general equilibrium (CGE) models. This paper assesses the impacts of a DR program in Spain using a CGE model which includes both technological and temporal disaggregation. The model is able to account for the indirect effects characteristic of CGE models while also mimicking the detailed behavior of the electricity operation and investment available before only in bottom-up detailed models. Our results show clearly the advantages of using this approach for this type of policies.

Multi-country comparisons of energy performance: The index decomposition analysis approach

- Energy Economics---2015---B.W. Ang,X.Y. Xu,Bin Su

Index decomposition analysis (IDA) is a popular tool for studying changes in energy consumption over time in a country or region. This specific application of IDA, which may be called temporal decomposition analysis, has been extended by researchers and analysts to study variations in energy consumption or energy efficiency between countries or regions, i.e. spatial decomposition analysis. In spatial decomposition analysis, the main objective is often to understand the relative contributions of overall activity level, activity structure, and energy intensity in explaining differences in total energy consumption between two countries or regions. We review the literature of spatial decomposition analysis, investigate the methodological issues, and propose a spatial decomposition analysis framework for multi-region comparisons. A key feature of the proposed framework is that it passes the circularity test and provides consistent results for multi-region comparisons. A case study in which 30 regions in China are compared and ranked based on their performance in energy consumption is presented.

Income elasticity of gasoline demand: A meta-analysis

- Energy Economics---2015---Tomas Havranek,Ondrej Kokes

In this paper we quantitatively synthesize empirical estimates of the income elasticity of gasoline demand reported in previous studies. The studies cover many countries and report a mean elasticity of 0.28 for the short run and 0.66 for the long run. We show, however, that these mean estimates are biased upwards because of publication bias—the tendency to suppress negative and insignificant estimates of the elasticity. We employ mixed-effects multilevel meta-regression to filter out publication bias from the literature. Our results suggest that the income elasticity of gasoline demand is on average much smaller than reported in previous surveys: the mean corrected for publication bias is 0.1 for the short run and 0.23 for the long run.

Decomposition of environmental total factor productivity growth using hyperbolic distance functions: A panel data analysis for China

- Energy Economics---2015---Zibin Zhang,Jianliang Ye

This paper extends recently developed parametric hyperbolic distance functions to the analysis of energy and environmental efficiency for a panel data of 29 provinces in China from 1995–2010, and then decomposes the growth of environmental total factor productivity into two component measures, namely, environmental efficiency change and environmental technical change based on the estimated hyperbolic distance functions. We find that there exists a great dispersion in environmental efficiencies across provinces and regions, and the growth of environmental productivity is almost due to the environmental technical change rather than the environmental efficiency change. However, the contribution of the environmental efficiency change has recently become increasingly positive and thus drives up the growth of environmental productivity from slow-down.

Efficient modeling and forecasting of electricity spot prices

- Energy Economics---2015---Florian Ziel,Rick Steinert,Sven Husmann

The increasing importance of renewable energy, especially solar and wind power, has led to new forces in the formation of electricity prices. Hence, this paper introduces an econometric model for the hourly time series of electricity prices of the European Power Exchange (EPEX) which incorporates specific features like renewable energy. The model consists of several sophisticated and established approaches and can be regarded as a periodic VAR-TARCH with wind power, solar power, and load as influences on the time series. It is able to map the distinct and well-known features of electricity prices in Germany. An efficient iteratively reweighted lasso approach is used for the estimation. Moreover, it is shown that several existing models are outperformed by the procedure developed in this paper.

Income and employment effects of shale gas extraction windfalls: Evidence from the Marcellus region

- Energy Economics---2015---Dusan Paredes,Tim Komarek,Scott Loveridge

New technologies combining hydraulic fracturing and horizontal drilling in oil and gas extraction are creating a sudden expansion of production. Residents of places where deep underground oil and gas deposits are found want to know about the broader economic, social, and environmental impacts of these activities that generate windfall income for some residents. We first review the literature on windfall spending patterns. Then, using the Marcellus region, the earliest area to be tapped using the new techniques, we estimate county-level employment and income effects. For robustness, we employ two methods. Using a propensity score matching approach we find no effect of fracking on income or employment. A panel-fixed effect regression approach suggests statistically significant employment effects in six out of seven alternative specifications, but significant income effects in only one out of seven

specifications. In short, the income spillover effects in the Marcellus region appear to be minimal, meaning there's little incentive at the county level to incur current or potential future costs that may be associated with this activity. We conclude with some ideas on how localities might employ policies that would allow natural gas extraction to move forward, benefiting landowners, while establishing some financial safeguards for the broader community.

Forecasting ability of the investor sentiment endurance index: The case of oil service stock returns and crude oil prices

- Energy Economics---2015---Ling T. He,K.M. Casey

Using a binomial probability distribution model this paper creates an endurance index of oil service investor sentiment. The index reflects the probability of the high or low stock price being the close price for the PHLX Oil Service Sector Index. Results of this study reveal the substantial forecasting ability of the sentiment endurance index. Monthly and quarterly rolling forecasts of returns of oil service stocks have an overall accuracy as high as 52% to 57%. In addition, the index shows decent forecasting ability on changes in crude oil prices, especially, WTI prices. The accuracy of 6-quarter rolling forecasts is 55%. The sentiment endurance index, along with the procedure of true forecasting and accuracy ratio, applied in this study provides investors and analysts of oil service sector stocks and crude oil prices as well as energy policy-makers with effective analytical tools.

Costs of certified emission reductions under the Clean Development Mechanism of the Kyoto Protocol

- Energy Economics---2015---Shaikh M. Rahman,Grant A. Kirkman

This paper examines the cost structure of certified emission reductions (CERs) through various types of projects under the Clean Development Mechanism (CDM) of the Kyoto Protocol. Using the CDM project

data, the costs of CERs and their variation across technology and over time and space are estimated by applying alternative functional forms and specifications. Results show that the average cost of CERs decreases with the project scale and duration, scale and duration effects significantly vary across project types, and there is an upward trend in costs. The results also show that the distribution of the projects in the CDM portfolio or a given location does not strictly follow the relative cost structure, nor does the distribution of the CDM projects in different host countries follow the principle of comparative advantage. More than 84% of the CDM portfolio consists of various energy projects with substantially higher costs of CERs than afforestation and reforestation, industrial and landfill gas reduction, and methane avoidance projects, which are only 12% of all projects. While per unit cost of abatement plays an important role in the bottom-up and top-down models to evaluate emission reduction potential and analyze policy alternatives, the findings contradict the presumption of such models that project investors seek out low-cost opportunities. At the aggregate level, the cost of CER by the projects in Asia and Europe is similar but higher than those hosted in Africa, Americas, and Oceania. Yet more than 83% of the projects in the CDM portfolio are located in Asia; more than 69% of the projects are in China and India alone. China appears to have a comparative advantage (i.e., lowest opportunity cost) in energy efficiency projects, while India has a comparative advantage in hydro power projects and Brazil has a comparative advantage in wind power projects. In contrast, energy efficiency category accounts for only 8% of the CDM projects in China, hydro power accounts for 12% of the projects in India, and wind power accounts for 18% of the projects in Brazil. The results provide a basis for evaluating the incentives that the mechanism offers as a cost effective policy instrument that balances greenhouse gas mitigation across sectors and regions, while fulfilling the objective of the convention.

A spot-forward model for electricity prices with regime shifts

- Energy Economics---2015---Florentina Paraschiv, Stein-Erik Fleten, Michael Schürle

We propose a novel regime-switching approach for electricity prices in which simulated and forecasted prices are consistent with currently observed forward prices. Additionally, the model is able to reproduce spikes and negative prices. We distinguish between a base regime as well as upper and lower spike regimes. We derive hourly price forward curves for EEX Phelix, and together with historical hourly spot prices, historical hourly price forward curves are the basis for model calibration. The model can be used for simulation and forecasting of electricity spot prices over short- and medium-term horizons. Tests imply that it shows a better performance than classical time series approaches.

Optimization of the Colombian biodiesel supply chain from oil palm crop based on techno-economical and environmental criteria

- Energy Economics---2015---Luis E. Rincón, Monica J. Valencia, Valentina Hernández, Luis G. Matallana, Carlos A. Cardona

During the last years the worldwide legal framework has stimulated the biofuel development, causing their production and use to be exhaustively studied. Biodiesel has been mostly produced in European countries, but the agronomic potential of the Latin-American countries has led the effort toward the biodiesel production, via regulations. This is the case of Colombia, where the oil palm has been exploited as the major biodiesel feedstock. The acts, laws and regulations indicate the mandatory expansion of biodiesel usage. Nonetheless, the laws do not explain the way in that those expansion targets will be done. In this work, the optimal conditions of the supply chain biodiesel were studied via the techno-economic and environmental analysis. Using logistic restrictions, environmental assessment and cost minimization (all of them were

estimated in this work), the optimal expansion conditions were decided, taking into account the minimal emissions and the effect of the Land Use Change (LUC) for the oil palm crop expansion. The results showed that the Middle Region is the most promising zone for biodiesel expansion, as well as the Eastern Region is the most adequate zone for expansion crops since the LUC impact is lowest. Finally, the results indicated that the biodiesel based industry must be addressed toward other feedstocks.

Fossil fuel producing economies have greater potential for industrial interfuel substitution

- Energy Economics---2015---Jevgenijs Steinkuks, Badri G Narayanan

This study analyzes industrial interfuel substitution in an international context using a large unbalanced panel dataset of 63 countries. We find that compared to other countries fossil fuel producing economies have higher short-term interfuel substitution elasticities. This difference increases further in the long run as fossil fuel producing countries have a considerably longer adjustment of their fuel-using capital stock. These results imply lower economic cost for policies aimed at climate abatement and more efficient utilization of energy resources in energy-intensive economies.

A practical approach to oil wealth management: Application to the case of Kazakhstan

- Energy Economics---2015---Aktoty Aitzhanova, Anastassiya Iskaliyeva, Venkataraman Krishnaswamy, Dmitry Makauskas, Hossein Razavi, Ahmad Reza Sartip, Aida Urazaliyeva

This study presents a practical approach to oil wealth management by bringing together various dimensions (oil production and sustainability of oil reserves, impact on the economy and the balance of trade, and the impact on the fiscal balance, government debt, and the national oil fund) within a long-term planning framework. The study provides a quantitative depiction of the above dimensions to 2050 for the case of Kazakhstan where the country's oil output has grown from

about 0.6million barrels/day (mb/d) in the late 1990s to 1.8 (mb/d) in 2013, and it is expected to reach a peak of 3.5mb/d by 2035. The analysis of this study indicates that within the limits of proven oil reserves, Kazakhstan's oil production capacity would collapse to negligible amounts after the peak period of 2035. This envisaged scenario will have undesirable impacts on the economy, balance of trade and fiscal balance both prior and after 2035. To avoid these erratic impacts, the study examines an alternative "conservative" production scenario that would enable the country to maintain its level of oil production until 2050, and to manage better the transition to a non-oil economy.

Reaping the carbon rent: Abatement and overallocation profits in the European cement industry, insights from an LMDI decomposition analysis

- Energy Economics---2015---Frederic Branger,Philippe Quirion

We analyse variations of carbon emissions in the European cement industry from 1990 to 2012, at the European level (EU 27), and at the national level for six major producers (Germany, France, Spain, the United Kingdom, Italy and Poland). We apply a Log-Mean Divisia Index (LMDI) method, cross-referencing data from three databases: the Getting the Numbers Right (GNR) database developed by the Cement Sustainability Initiative, the European Union Transaction Log (EUTL), and the Eurostat International Trade database.

Refining for export and the convergence of petroleum product prices

- Energy Economics---2015---Armando Zavaleta,W. Walls,Frank W. Rusco

The petroleum refining industry has changed over the past decades from one in which capacity primarily served local and regional markets to one in which trade in refined petroleum products has become more widespread. We investigate the hypothesis of increasing globalization by examining the convergence of prices

for refined products across different markets. Using data on refined products from market centers in the US and Europe, we test for convergence of prices using standard time-series techniques. The data plainly show that markets for refined petroleum products have become more interrelated as Europe exported its gasoline surplus and global demand for petroleum products approached refining capacity. Econometric evidence supports the hypothesis that the US and European markets for oil and refined products are integrated. We find evidence that a structural break during the financial crisis of 2008 changed the long-run equilibrium price relationships and the short-run price dynamics. Refined product markets are likely to experience continued globalization given trends in the United States and Europe and because of key export-oriented refining capacity investments made to take advantage of access to specific crude oil sources.

Real option valuation of power transmission investments by stochastic simulation

- Energy Economics---2015---Rolando Pringles,Fernando Olsina,Francisco Garcés

Network expansions in power markets usually lead to investment decisions subject to substantial irreversibility and uncertainty. Hence, investors need valuing the flexibility to change decisions as uncertainty unfolds progressively. Real option analysis is an advanced valuation technique that enables planners to take advantage of market opportunities while preventing or mitigating losses if future conditions evolve unfavorably. In the past, many approaches for valuing real options have been developed. However, applying these methods to value transmission projects is often inappropriate as revenue cash flows are path-dependent and affected by a myriad of uncertain variables. In this work, a valuation technique based on stochastic simulation and recursive dynamic programming, called Least-Square Monte Carlo, is applied to properly value the deferral option in a transmission investment. The effect of option's maturity, the initial outlay and the capital cost upon the value of the postponement option is investigated. Finally, sensitivity analysis determines

optimal decision regions to execute, postpone or reject the investment projects.

China's electricity market restructuring and technology mandates: Plant-level evidence for changing operational efficiency

- Energy Economics---2015---Chunbo Ma,Xiaoli Zhao

China's electricity sector has experienced substantial efficiency improvement during the last one and a half decades. The recent literature has mostly attributed the efficiency improvement to the 2002 unbundling reform with little attention paid to the large scale retrofitting process introduced by technology mandates. Using a unique panel dataset for hundreds of power plants from 1997 to 2010, we are able to examine the contributions from technology mandates and market restructuring. We confirm the significant contributions from the unbundling reform but more importantly, technology mandates have contributed at least half of the observed efficiency improvement during this period. The results have significant implications for efficiency and demand forecast in the future.

The microstructure of the North American oil market

- Energy Economics---2014---Vincent Kaminski

Recent developments in production of oil and natural gas from the tight sand and shale rock formations (primarily hydraulic fracturing and horizontal drilling) have a profound impact on the North American energy markets. The paper reviews recent crude oil production trends and their impact on the price relationships across different geographical locations in the US and Canada. Price disparity between different market hubs is attributed to the collision between growing volumetric flows of crude oil (as well as changing quality mix of produced crudes) and rigidity of the existing midstream and refining infrastructure. We continue with a discussion of how the North American oil industry adjusts to new disruptive technologies in exploration and production of hydrocarbons.

Understanding recent oil price dynamics: A novel empirical approach

- Energy Economics---2014---D'Ecclesia, Rita L.,Emiliano Magrini,Pierluigi Montalbano,Umberto Triulzi

Crude oil is a major driver of the global economy and its price dynamics are a key indicator for producers, consumers and investors. The increasing volatility of crude oil prices in the last decade has encouraged many researchers to model its dynamics. Recent studies have tried to explain this dynamics by taking into account the role of various market participants many of whom have increasingly used crude oil for portfolio diversification. We propose a modified supply-demand framework which assumes that the real price of crude oil is affected not only by fundamental shocks but also by financial shocks. We assess the role of what we define as the financial shock component when describing the dynamics of the real crude oil price and endeavor to measure a possible equilibrium relationship between standard supply/demand variables and our financial shock component. Using a Dynamic Ordinary Least Squares (DOLS) approach and an ECM framework we are able to empirically assess the significant role of "hedging pressure" on the real price of oil and find evidence that the impact of the "hedging pressure" is not only affecting quick reverting short-term deviations but also the structural long-run equilibrium of the oil price.

Price discovery in crude oil futures

- Energy Economics---2014---John Elder,Hong Miao,Sanjay Ramchander

This study examines price discovery among the two most prominent price benchmarks in the market for crude oil, WTI sweet crude and Brent sweet crude. Using data on the most active futures contracts measured at the one-second frequency, we find that WTI maintains a dominant role in price discovery relative to Brent, with an estimated information share in excess of 80%, over a sample from 2007 to 2012. Our analysis is robust to different decompositions of the sample,

over pit-trading sessions and non-pit trading sessions, segmentation of days associated with major economic news releases, and data measured to the millisecond. We find no evidence that the dominant role of WTI in price discovery is diminished by the price spread between Brent that emerged in 2008.

Crude oil price differentials, product heterogeneity and institutional arrangements

- Energy Economics---2014---Monica Giuliatti,Ana Iregui,Jesus Otero

We adopt time-series and cross-section methods to analyse long-term relationships between pairs of crude oil prices and assess how physical and institutional factors affect their speed of reaction to exogenous shocks. Using a methodological approach which does not require identifying specific crudes as benchmarks, we show that the overwhelming majority of prices have stable long term relationships. We also find that crudes with physical similarity converge quickly after a shock, while prices for oil produced in OPEC countries are relatively slow to revert to equilibrium after a shock.

Are there gains from pooling real-time oil price forecasts?

- Energy Economics---2014---Christiane Baumeister,Lutz Kilian,Thomas K. Lee

The answer depends on the objective. The approach of combining five of the leading forecasting models with equal weights dominates the strategy of selecting one model and using it for all horizons up to two years. Even more accurate forecasts, however, are obtained when allowing the forecast combinations to vary across forecast horizons. While the latter approach is not always more accurate than selecting the single most accurate forecasting model by horizon, its accuracy can be shown to be much more stable over time. The MSPE of real-time pooled forecasts is between 3% and 29% lower than that of the no-change forecast and its directional accuracy as high as 73%. Our results are robust to alternative oil price measures and apply to monthly as well as quarterly forecasts. We illustrate

how forecast pooling may be used to produce real-time forecasts of the real and the nominal price of oil in a format consistent with that employed by the U.S. Energy Information Administration in releasing its short-term oil price forecasts, and we compare these forecasts during key historical episodes.

Forecasting the oil–gasoline price relationship: Do asymmetries help?

- Energy Economics---2014---Andrea Bastianin,Marzio Galeotti,Matteo Manera

According to the Rockets and Feathers Hypothesis (RFH), the transmission mechanism of positive and negative changes in the price of crude oil to the price of gasoline is asymmetric. Although there have been many contributions documenting that downstream prices are more reactive to increases than to decreases in upstream prices, little is known about the forecasting performance of econometric models incorporating asymmetric price transmission from crude oil to gasoline. In this paper we fill this gap by comparing point, sign and probability forecasts from a variety of Asymmetric-ECM (A-ECM) and Threshold Autoregressive ECM (TAR-ECM) specifications against a standard ECM. Forecasts from A-ECM and TAR-ECM subsume the RFH, while the ECM implies symmetric price transmission from crude oil to gasoline. We quantify the forecast accuracy gains due to incorporating the RFH in predictive models for the prices of gasoline and diesel. We show that, as far as point forecasts are involved, the RFH does not lead to significant improvements, while it can be exploited to produce more accurate sign and probability forecasts. Finally, we highlight that the forecasting performance of the estimated models is time-varying.

Energy futures prices and commodity index investment: New evidence from firm-level position data

- Energy Economics---2014---Dwight R. Sanders,Scott Irwin

This study brings fresh data to the highly-charged debate about the price impact of long-only index investment in energy futures markets. We use high frequency daily position data for NYMEX crude oil, heating oil, RBOB gasoline, and natural gas that are available from a representative large commodity index fund (“the Fund”) from February 13, 2007 through May 30, 2012. Simple correlation tests, difference-in-means tests, and Granger causality tests generally fail to reject the null hypothesis that changes in Fund positions are unrelated to subsequent returns in all four energy futures markets. We also fail to find any evidence that Fund positions are related to price movements in the WTI crude oil futures market using Singleton’s (2014) long-horizon regression specification. Our results suggest Singleton’s original finding of significant impacts and high levels of predictability may be simply an artifact of the method used to impute crude oil positions of index investors in a particular sample period. Overall, the empirical tests in this study fail to find compelling evidence of predictive links between commodity index investment and changes in energy futures prices.

Jump processes in natural gas markets

- Energy Economics---2014---Charles Mason,Neil Wilmot

Many analysts believe that natural gas will have an increasingly important role in the next few decades. Accordingly, understanding the underpinnings of natural gas prices is likely to be critical, both to policy analysts and to market participants. At present, it is common to assume that these prices follow a geometric Brownian motion, i.e., that log returns – the inter-temporal differences in the natural log of prices – are normally distributed (possibly allowing for some form of mean-reversion). Increasingly, however, it has been recognized that the arrival of new information can lead to unexpectedly rapid changes – or jumps – in spot prices. The implication is that the presumption of normally distributed log-returns may be suspect. In particular, the prospect for abnormally fat tails becomes important. This article investigates the potential presence of jumps in two key natural gas prices:

the spot price at the Henry Hub in the U. S., and the spot price for natural gas at the National Balancing Point in the U. K. We found compelling empirical evidence for the importance of jumps in both markets, though jumps appear to be more important in the U. K.

The oil curse, institutional quality, and growth in MENA countries: Evidence from time-varying cointegration

- Energy Economics---2014---Nicholas Apergis,James Payne

This study re-examines the impact of oil abundance on economic growth in a number of MENA (Middle East and North African) countries for the period 1990–2013. Given the number of economic and institutional reforms undertaken by these countries in recent years, we incorporate measures of institutional quality to evaluate if oil abundance impacts economic growth differently. The results from time-varying cointegration reveal that better institutional quality reduces the unfavorable effect of oil reserves on the performance of the real economy.

Why market rules matter: Optimizing pumped hydroelectric storage when compensation rules differ

- Energy Economics---2014---Nathan Paine,Frances R. Homans,Melisa Pollak,Jeffrey M. Bielicki,Elizabeth J. Wilson

Policies, markets, and technologies interact to create the modern electrical system. Integrating large amounts of electricity generated by variable renewable resources, such as from wind and sunlight, into electricity systems may require energy storage technologies to synchronize electricity production with electricity demand. Electricity markets compensate the performance of these energy storage technologies for the services they provide, and these markets are often operated by regional independent system operators (ISOs) that specify the market rules for this compensation. To

examine how different ISO rules can affect the operation and profitability an energy storage technology, we develop a dynamic programming model of pumped hydroelectric storage (PHES) facility operation under the market rules from the Midcontinent ISO and ISO-New England. We present how differences in rules between these ISOs produced different operational strategies and profits, and how important they are for PHES profitability.

R&D drivers and obstacles to innovation in the energy industry

- Energy Economics---2014---Maria Costa-Campi,N. Duch-Brown,Jose Garcia-Quevedo,Néstor Duch Brown

The energy industry is facing substantial challenges that require the fostering of innovation. In this paper we analyse the main drivers of R&D investment and obstacles to innovation in this industry. We examine, firstly, whether the stated R&D objectives pursued by firms play a role in their R&D effort. Secondly, we analyse the effects of financial, knowledge and market barriers on the innovation outcomes of the firms. The data is taken from the Technological Innovation Panel (PITEC) for Spanish firms for the period 2004–2010. We use a structural model with three equations corresponding to the decision to carry out R&D or not, the R&D effort, and the production of innovations. The results of the econometric estimations show, first, that R&D intensity is positively related to process innovation. Second, the main barriers that hamper innovation in the energy industry are related to market factors while financial and knowledge obstacles are not significant.

Inefficiency persistence and heterogeneity in Colombian electricity utilities

- Energy Economics---2014---Jorge Galan,Michael Pollitt

The electricity reform in Colombia has exhibited gains in terms of reliability but its effects on firm efficiency and service quality have not been clear. Previous

studies evaluating the performance of distribution companies after the reform have not found evidence of improvements, although large differences in efficiency have been found among firms. This suggests high inefficiency persistence and heterogeneity in the Colombian distribution sector. In this paper, we propose an extension of dynamic stochastic frontier models that accounts for unobserved heterogeneity in the inefficiency persistence and in the technology. The model incorporates total expenses, service quality and energy losses in an efficiency analysis of Colombian distributors over fifteen years after the reform. We identify the presence of high inefficiency persistence in the sector, and important differences between firms. In particular, rural companies and firms with small customers present low persistence and evidence the largest gains in efficiency during the period. However, increases in efficiency are only manifested during the last five years when the main improvements in service quality and energy losses are presented. Overall, inefficiency persistence, customer density and consumption density are found to be important criteria to be considered for regulatory purposes.

A nonparametric method to estimate a technical change effect on marginal abatement costs of U.S. coal power plants

- Energy Economics---2014---Maethee Mekaroonreung,Andrew Johnson

The literature usually assumes that technical change reduces marginal abatement cost; however, recent results suggest that precisely the opposite occurs. This paper proposes a nonparametric method to determine the effect of technical change on marginal abatement cost. The method decomposes NOx marginal abatement cost changes in 2000–2004 and in 2004–2008 for 325 boilers operating in 134 U.S. bituminous coal power plant into technical and non-technical change effects. We find that technical change reduces the NOx marginal cost about 28.3% in 2000–2004 and 26.5% in 2004–2008. However, more stringent regulations enacted the NOx budget program results in lower NOx emission levels as plant operators install more advanced NOx abatement

equipment which in turn causes an overall increase in marginal abatement cost.

Economic growth and the transition from traditional to modern energy in Sweden

- Energy Economics---2014---Astrid Kander,David Stern

We examine the role of substitution from traditional to modern energy carriers and of differential rates of innovation in the use of each of these in economic growth in Sweden from 1850 to 1950. We use a simple growth model with a nested CES production function and exogenous factor-augmenting technological change and carry out a counterfactual simulation based on the econometric results. Even though the rate of technical change was higher for modern energy, innovation in the use of traditional energy carriers contributed more to growth between 1850 and 1890, since the cost share of traditional energy was so much larger than that of modern energy in that period. However, after 1890 we find that modern energy contributed much more to economic growth than traditional energy, but, increasingly, labor-augmenting technological change became the most important single driver of growth.

A new approach to measuring shadow price: Reconciling engineering and economic perspectives

- Energy Economics---2014---Sang-choon Lee,Dong-hyun Oh,Jeong-Dong Lee

Shadow price is one of the most important pieces of information in environmental decision making. Two different approaches—namely, economic and engineering—have been applied to obtain the shadow price of undesirable outputs, while using different methodological backgrounds and perspectives. The current study proposes a new conceptual framework and an economic estimation model to reconcile the shadow price estimates derived via the two approaches. We also suggest a new mapping rule that incorporates the concept of abatement level, which is a basic element in the engineering approach. As a result, the proposed

model generates continuously changing estimates—i.e., comprising a shadow price curve—based on the abatement level. We further investigate the determinant factors of shadow price by using second-step regression. The suggested methodology is used to investigate the shadow price of carbon emissions in South Korean electricity generating plants, thus yielding relevant policy implications.

Free-riding on tax credits for home insulation in France: An econometric assessment using panel data

- Energy Economics---2014---Marie-Laure Nauleau

This econometric study assesses the efficiency of the income tax credit system introduced in France in 2005 on investment decisions for household retrofits, focusing on insulation measures. A logit model with random individual effects is estimated using an unbalanced panel of 23,879 households surveyed over the period 2002–2011. An estimation in difference is performed to identify the impact of the policy. The tax credit is found to have had no significant effect during the first two years, suggesting a latency period related to inertia in households' investment decisions, possibly due to the complexity of the tax credit scheme. The tax credit had an increasing, significant positive effect from 2007 to 2010, before slightly decreasing in 2011. This is in line with changes in the tax credit rates, suggesting a correlation with the level of subsidy. Defined as the situation in which the subsidized household would have invested even in the absence of the subsidy, free-ridership progressively decreased over the period, was lower for insulation of opaque surfaces (roofs, walls, etc.) than for insulation of windows and depended on individual characteristics. The estimated average proportion of free-riders varies between 40% and 85% after 2006. In addition, we assess the potential bias caused by time-varying unobservable variables and conclude that our estimates of the impacts of the policy are conservative.

Informational rents in oil and gas concession auctions in Brazil

- Energy Economics---2014---Eric Universo Rodrigues Brasil,Fernando Antonio Slaibe Postali

This article aims to estimate the informational rents earned by winning bidders in oil and gas exploration and production auctions in Brazil. We estimate the distributions of bids and bidders' private valuations using a nonparametric structural model and assuming independence and asymmetry between participants. Petrobras, the Brazilian state-owned petroleum giant and former oil sector monopolist, was considered a competitor that was distinct from other competitors. Thus, we investigate a database based on information from all auctions held between 1999 and 2008. The results suggest that Petrobras earned significantly higher information rents than other competitors. Such rents ranged from 15% to 63%, depending on the number and type of competitors.

The extent of European power markets

- Energy Economics---2014---Veit Böckers,Ulrich Heimeshoff

There is an ongoing debate on the degree of integration of European wholesale power markets. A major task of the European Union is the creation of a common market in Europe and a common power market is an important part of this goal. The literature analyzing the degree of integration of European energy markets is growing and provides mixed results. We add to this literature by using national holidays as exogenous demand shocks to measure integration of European energy markets. Our main findings indicate that integration of European wholesale energy markets has increased with regard to Germany and Austria as well as Belgium and the Netherlands.

Efficiency assessment of hydroelectric power plants in Canada: A multi criteria decision making approach

- Energy Economics---2014---Bing Wang,Ioan Nistor,Tad Murty,Yi-Ming Wei

Hydropower plays a major role in the Canadian electricity generation industry. Few attempts have been made, however, to assess the efficiency of hydropower generation in Canada. This paper analyzes the overall efficiency of hydropower generation in Canada from comprehensive viewpoints of electricity generating capability, its profitability, as well as environmental benefits and social responsibility using the TOPSIS (the Technique for Order Preference by Similarity to Ideal Solution) method. The factors that influence the efficiency of the hydropower generation are also presented to help to the sustainable hydropower production in Canada. The most important results of this study concern (1) the pivotal roles of energy saving and of the social responsibility in the overall efficiency of hydropower corporates and (2) the lower hydropower generation efficiency of some of the most important economic regions in Canada. Other results reveal that the overall efficiency of hydropower generation in Canada experienced an improvement in 2012, following a downward trend from 2005 to 2011. Amidst these influencing factors, energy saving and social responsibility are key factors in the overall efficiency scores while management (defined herein by the number of employees and hydropower stations of a corporation) has only a slightly negative impact on the overall efficiency score.

What explain the short-term dynamics of the prices of CO2 emissions?

- Energy Economics---2014---Shawkat Ham-moudeh,Duc Khuong Nguyen,Ricardo Sousa

Using a Bayesian Structural VAR (BSVAR), this paper analyzes the short-term dynamics of the prices of CO2 emissions in response to changes in the prices of oil, coal, natural gas and electricity. The results show that: (i) a positive shock to the crude oil prices has an initial positive effect on the CO2 allowance prices, which later becomes negative; (ii) an unexpected increase in the natural gas prices reduces the price of CO2 emissions; (iii) a positive shock to the prices of the fuel of choice, coal, has virtually no significant impact on the CO2 prices; (iv) there is a clear positive effect of the coal prices on the CO2 allowance prices when the electricity

prices are excluded from the BSVAR system; and (v) a positive shock to the electricity prices has a negative impact on the price of the CO₂ allowances. We also find that the energy price shocks have a persistent impact on the CO₂ allowance prices, with the largest effect occurring 6 months after a shock strikes. The effect is particularly strong in the case of the shocks to the natural gas and crude oil prices. Finally, the empirical findings suggest an important degree of substitution between the three primary sources of energy (i.e., crude oil, natural gas and coal), particularly when electricity prices are excluded from the BSVAR system.

Low carbon standard and transmission investment analysis in the new multi-region US power sector model FACETS

- Energy Economics---2014---Evelyn Wright,Amit Kanudia

This paper presents a new US multi-region energy systems model built in the TIMES modeling system: the Framework for Analysis of Climate-Energy-Technology Systems (FACETS). The model is designed to analyze energy technology options and policy scenarios across sectors and regions, including the increasingly important interactions between state, regional, and federal policies. FACETS contains a realistic representation of key infrastructure, while retaining the flexibility to explore deep carbon emission reductions and other large changes from the baseline energy system. It is built using a unique, flexible multi-region approach so that the geographic relationships that drive the costs of energy technology transitions can be captured. Significant enhancements to the Veda-TIMES system and a GIS-results viewer permit the massive data handling needed to represent these relationships and interpret results. An analysis of a federal clean energy standard (CES) and investment in the transmission grid is presented.

Household transitions to energy efficient lighting

- Energy Economics---2014---Bradford Mills,Joachim Schleich

New energy efficient lighting technologies can significantly reduce household electricity consumption, but adoption has been slow. A unique dataset of German households is used in this paper to examine the factors associated with the replacement of old incandescent lamps (ILs) with new energy efficient compact fluorescent lamps (CFLs) and light emitting diodes (LEDs). The ‘rebound’ effect of increased lamp luminosity in the transition to energy efficient bulbs is analyzed jointly with the replacement decision to account for household self-selection in bulb-type choice. Results indicate that the EU ban on ILs accelerated the pace of transition to CFLs and LEDs, while storage of bulbs significantly dampened the speed of the transition. Higher lighting needs and bulb attributes like energy efficiency, environmental friendliness, and durability spur IL replacement with CFLs or LEDs. Electricity gains from new energy efficient lighting are mitigated by 23% and 47% increases in luminosity for CFL and LED replacements, respectively. Model results suggest that taking the replacement bulb from storage and higher levels of education dampen the magnitude of these luminosity rebounds in IL to CFL transitions.

The effects of direct trade within China on regional and national CO₂ emissions

- Energy Economics---2014---Zengkai Zhang,Guo, Ju’e,Geoffrey Hewings

Curbing national carbon emissions and clarifying regional carbon reduction responsibility are two challenges faced by China, both of which are influenced by interregional trade. To exclude the influence of trade balance, this paper proposes a methodology to parcel the pollution haven hypothesis into a multi-regional input–output model, applies it to a longer time gap, which is made up of two representative periods of Chinese economy (1997–2002 and 2002–2007), and clarifies the provincial and sectoral contributions to national emissions. We find that (1) embodied CO₂ emissions first remain relatively stable and then increase sharply for the two periods, and the changing trends are mainly determined by the decreasing carbon intensity and the expanding trade scale, respectively.

(2) With the secondary industry as the main contributor, regional carbon spillover is mainly concentrated in the coastal provinces but it contributes to an increase of CO₂ emissions in the central and western regions. (3) The coastal and inland provinces contribute to the increase of national carbon emissions through inter-regional imports and exports, respectively; but the pollution haven hypothesis is not obvious and is only observed in 2002.

An econometric framework for evaluating the efficiency of a market for transmission congestion contracts

- Energy Economics---2014---Timothy D. Mount, Jaeuk Ju

The goals of this paper are to 1) simulate the ex-ante riskiness of purchasing a TCC, and 2) evaluate the efficiency of the TCC market in New York State to determine if there is evidence of under-pricing. Three VAR models are estimated using only market data available before the auction. This model is then used to simulate the daily payouts of a TCC for the following summer. A Monte Carlo procedure simulates the daily summer temperatures, the levels of quantity demanded and prices over the summer months. The main empirical result is that the market price paid for the most important TCC, in terms of volume, (the Hudson Valley to New York City) is higher than the mean of the simulated payouts even though the actual payout was higher than the market price. The market prices for the other two TCCs are lower than the means of the simulated payouts, and as a result, there is no consistent evidence of under-pricing in this analysis of the market for six-month TCCs in the summer of 2006.

Synergy between pollution and carbon emissions control: Comparing China and the United States

- Energy Economics---2014---Kyung-Min Nam, Caleb J. Waugh, Sergey Paltsev, John Reilly, Valerie Karplus

We estimate the potential synergy between pollution

and climate control in the U.S. and China, summarizing the results as emissions cross-elasticities of control. In both countries, ancillary carbon reductions resulting from SO₂ and NO_x control tend to rise with the increased stringency of control targets, reflecting the eventual need for wholesale change toward non-fossil technologies when large reductions are required. Under stringent pollution targets, the non-target effects tend to be higher in China than in the U.S., due to China's heavy reliance on coal. This result suggests that China may have greater incentives to reduce SO₂ and NO_x with locally apparent pollution benefits, but related efforts would at the same time reduce CO₂ emissions significantly. We also find strong non-target effects of CO₂ abatement in both countries, but the cross effects in this direction depend less on the stringency of control and are stronger in the U.S. than in China.

Air pollution policy in Europe: Quantifying the interaction with greenhouse gases and climate change policies

- Energy Economics---2014---Johannes Bollen, Corjan Brink

This paper uses the computable general equilibrium model WorldScan to analyse interactions between EU's air pollution and climate change policies. Covering the entire world and seven EU countries, WorldScan simulates economic growth in a neo-classical recursive dynamic framework, including emissions and abatement of greenhouse gases (CO₂, N₂O and CH₄) and air pollutants (SO₂, NO_x, NH₃ and PM_{2.5}). Abatement includes the possibility of using end-of-pipe control options that remove pollutants without affecting the emission-producing activity itself. This paper analyses several variants of EU's air pollution policies for the year 2020. Air pollution policy will depend on end-of-pipe controls for not more than two thirds, thus also at least one third of the required emission reduction will come from changes in the use of energy through efficiency improvements, fuel switching and other structural changes in the economy. Greenhouse gas emissions thereby decrease, which renders climate change policies less costly. Our results show that car-

bon prices will fall, and may even drop to zero when the EU agrees on a more stringent air pollution policy.

Crude oil: Commodity or financial asset?

- Energy Economics---2014---Marek Kolodziej,Robert Kaufmann,Nalin Kulatilaka,David Bicchetti,Nicolas Maystre

We examine the relation among daily returns to crude oil prices, equity prices, and commodity markets by modifying previous efforts in two important ways; expanding the model to include the equity price for an oil-producing firm, ConocoPhillips, which ameliorates omitted variable bias and estimating the expanded model using the Kalman Filter, which reduces uncertainty associated with OLS estimates from rolling windows. Consistent with the notion of a commodity price beta for oil industry stocks, there is a positive correlation between returns to the spot price of WTI and ConocoPhillips. This correlation indicates not all price changes in crude oil are expected to persist; indeed, some of the price reductions associated with the Asian Financial crisis and the price increase associated with the 2008 price spike are not included in our estimate for long-run prices. In 2008:Q4, the correlations between daily returns to crude oil and equities flip from negative to positive. We hypothesize that this flip is triggered by a large reduction in interest rates in the fourth quarter of 2008, which is associated with a reduction in convenience yields and a change from backwardation to contango in futures markets. These changes increase the returns to holding crude oil as a financial asset relative to holding oil as a commodity.

Aviation fuel demand development in China

- Energy Economics---2014---Jian Chai,Zhong-Yu Zhang,Shou-Yang Wang,Kin Keung Lai,John Liu

This paper analyzes the core factors and the impact path of aviation fuel demand in China and conducts a structural decomposition analysis of the aviation fuel cost changes and increase of the main aviation enterprises' business profits. Through the establishment of an integrated forecast model for China's aviation fuel

demand, this paper confirms that the significant rise in China's aviation fuel demand because of increasing air services demand is more than offset by higher aviation fuel efficiency. There are few studies which use a predictive method to decompose, estimate and analyze future aviation fuel demand. Based on a structural decomposition with indirect prediction, aviation fuel demand is decomposed into efficiency and total amount (aviation fuel efficiency and air transport total turnover). The core influencing factors for these two indexes are selected using path analysis. Then, univariate and multivariate models (ETS/ARIMA model and Bayesian multivariate regression) are used to analyze and predict both aviation fuel efficiency and air transport total turnover. At last, by integrating results, future aviation fuel demand is forecast. The results show that the aviation fuel efficiency goes up by 0.8% as the passenger load factor increases 1%; the air transport total turnover goes up by 3.8% and 0.4% as the urbanization rate and the per capita GDP increase 1%, respectively. By the end of 2015, China's aviation fuel demand will have increased to 28 million tonnes, and is expected to be 50 million tonnes by 2020. With this in mind, increases in the main aviation enterprises' business profits must be achieved through the further promotion of air transport.

A compressed sensing based AI learning paradigm for crude oil price forecasting

- Energy Economics---2014---Lean Yu,Yang Zhao,Ling Tang

Due to the complexity of crude oil price series, traditional statistics-based forecasting approach cannot produce a good prediction performance. In order to improve the prediction performance, a novel compressed sensing based learning paradigm is proposed through integrating compressed sensing based denoising (CSD) and certain artificial intelligence (AI), i.e., CSD-AI. In the proposed learning paradigm, CSD is first performed as a preprocessor for the original data of international crude oil price to eliminate the noise, and then a certain powerful AI tool is employed to conduct prediction for the cleaned data. In particular, the process of CSD

aims to reduce the level of noise which pollutes the data, and to further enhance the prediction performance of the AI model. For verification purpose, international crude oil price series of West Texas Intermediate (WTI) are taken as sample data. Empirical results demonstrate that the proposed CSD-AI learning paradigm significantly outperforms all other benchmark models including single models without CSD process and hybrid models with other denoising techniques, in terms of level and directional accuracies. Furthermore, in the case of different data samples with different time ranges, the proposed model performs the best, indicating that the proposed CSD-AI learning paradigm is an effective and robust approach in crude oil price prediction.

The influence of energy prices on adoption of clean technologies and recycling: Evidence from European SMEs

- Energy Economics---2014---Angela Triguero,Lourdes Moreno-Mondéjar,María A. Davia

This paper examines the relative influence of energy prices on several environmental practices at firm level among SMEs. To that aim, we explore an EU-wide data-set providing information for 5194 SMEs in 27 European countries. We distinguish between recycling and purchasing and/or development of cleaner technologies and investigate whether the set of external and internal factors to the firm driving the adoption of least-integrated environmental innovation (recycling) differ from those influencing cleaner technologies (either purchased or in-house). The main findings stemming from a multivariate probit model suggest some significant differences among firms performing recycling practices and those purchasing and developing cleaner technologies. In particular, we find that current energy prices only increase the probability to adopt recycling practices while they have no significant effect on the most-integrated environmental innovation (developing cleaner technologies). Our results also indicate that market factors (proxied as expected increases in the demand for green products) are more relevant

drivers of the least-advanced eco-innovation than of developing cleaner technologies. Interestingly, we find that higher technological and managerial capabilities are more effective in driving the adoption of cleaner technologies than in enhancing recycling solutions. A positive impact of cooperation and collaboration with universities and private agencies is found only on developing cleaner technologies in-house. This finding confirms the role of knowledge networks for the most-advanced innovative practice. Finally, neither existing nor future environmental regulations have significant impact on environmentally-friendly innovative practices while subsidies only increase the probability of purchasing cleaner technologies.

Electricity load level detail in computational general equilibrium – Part I – Data and calibration

- Energy Economics---2014---Renato Rodrigues,Pedro Linares

The growing importance of the electricity sector in many economies, and of energy and environmental policies, requires a detailed consideration of these sectors and policies in computable general equilibrium (CGE) models, including both technological and temporal aspects. This paper presents the first attempt to our knowledge at building temporal disaggregation into a CGE model, while keeping technological detail. This contribution is coupled with some methodological improvements over existing technology-rich CGE models. The model is able to account for the indirect effects characteristic of CGE models while also mimicking the detailed behavior of the electricity operation and investment present before only in bottom-up detailed models. The present paper is the first of two parts and focuses on the bottom-up top-down calibration methodology needed to build such a model. Part II will present the CGE model applied to the evaluation of an energy policy with temporal consequences.

Capital investment requirements for greenhouse gas emissions mitigation in power generation on near term to century time scales and global to regional spatial scales

- Energy Economics---2014---Vaibhav Chaturvedi,Leon Clarke,James Edmonds,Katherine Calvin,Page Kyle

Our paper explores the implication of climate mitigation policy and electricity generation technology performance for capital investment demands by the electric power sector on near term to century time scales. We find that stabilizing GHG emissions will require additional investment in the electricity generation sector over and above investments that would be needed in the absence of climate policy, in the range of 15 to 29 trillion US\$ (48–94%) depending on the stringency of climate policy during the period 2015 to 2095 under default technology assumptions. This increase reflects the higher capital intensity of power systems that control emissions as well as increased electrification of the global economy. Limits on the penetration of nuclear and carbon capture and storage technology could increase costs substantially. Energy efficiency improvements can reduce the investment requirement by 18 to 24 trillion US\$ (compared to default technology climate policy assumptions), depending on climate policy scenario. We also highlight the implications of different technology evolution scenarios for different regions. Under default technology set, the heaviest investments across scenarios in power generation were observed in China, India, SE Asia and Africa regions with the latter three regions dominating in the second half of the 21st century.

Climate policy and induced R&D: How great is the effect?

- Energy Economics---2014---Leslie Shiell,Nikita Lyssenko

Carbon taxes or tradable permit systems to address climate change may induce research and development in energy-related technologies. We construct a single-knowledge-stock model of R&D, growth and climate to

assess the importance of this effect. The contribution of induced R&D is shown to be very sensitive to (i) the duplication externality, (ii) the feasibility of dedicated research subsidies to internalize inter-firm knowledge spillovers, (iii) the opportunity cost of R&D, (iv) the initial level of research expenditure, and (v) the elasticity of substitution between energy and other factors of production. In contrast, the direction and scale of the inter-temporal research spillover are of secondary importance. We find strong support for Rezai's (2011) argument that, when the business-as-usual scenario (no policy) is modeled appropriately (all externalities treated as external), sacrifices for early generations associated with optimal climate policy are minor or non-existent. Employing our preferred selections for the parameters, we find that adding an induced R&D component to the model increases the welfare impact of the first-best policy (optimally chosen carbon tax and research subsidies) by an average value of more than 400%, and of the second-best policy (carbon tax alone) by approximately 22%.

Environmental assessment for corporate sustainability by resource utilization and technology innovation: DEA radial measurement on Japanese industrial sectors

- Energy Economics---2014---Toshiyuki Sueyoshi,Mika Goto

This study proposes a new use of DEA (Data Envelopment Analysis) radial approach to examine the corporate sustainability of Japanese industrial sectors. The concept of corporate sustainability is measured by its subcomponent measures, including UEN (Unified Efficiency under Natural Disposability), UEM (Unified Efficiency under Managerial Disposability), UENM (Unified Efficiency under Natural and Managerial Disposability), UEI (Unified Efficiency for Intermediate measurement) and UENM(DC) (Unified Efficiency under Natural and Managerial Disposability with Desirable Congestion). Among the five measures, the UEI examines a degree of how each firm can efficiently utilize its resources. The UENM(DC) examines a degree of how the firm can reduce an amount of undesir-

able outputs by technology innovation and/or managerial change. Such a combined use between UEI and UENM(DC) has been never explored in DEA environmental assessment. The empirical results obtained from the proposed approach have identified two important implications. One of the two implications is that the Japanese energy industry has been long under governmental regulation so that energy firms do not have corporate governance capabilities at the level of other industrial sectors which are competing in a global market. In particular, the implication is applicable to Japanese electric power firms. It is necessary for them to change their corporate governances (e.g., by adding new executive board members who have international experience and/or woman executives, as widely found in American and European energy industries) so that they can pay attention to consumers, not regulatory agencies of the Japanese government. The other implication is that technology innovation can more effectively improve the performance of the energy sector. Employing high efficiency and low carbon generation technologies to achieve desirable fuel mix is essential for improving the corporate sustainability of the Japanese energy sector.

Long-run carbon emission implications of energy-intensive infrastructure investments with a retrofit option

- Energy Economics---2014---Jon Strand, Sebastian Miller, Sauleh Siddiqui

Investments in long-lived, fossil-fuel intensive infrastructure can have large effects on carbon emissions over a long future period. We simulate a 2-period model of infrastructure investment with subsequent retrofit to purge its carbon emissions, under uncertainty about climate and retrofit costs. The energy intensity chosen upon investment depends on current and expected future energy and environmental costs, and on future retrofit cost. Simulations of a simplified but realistic model indicate that energy consumption and carbon emissions can be highly excessive when future energy and climate costs are not considered at the time infrastructure investments are made, and charged at globally

suboptimal rates when operated; often by more than 50% when energy costs are undervalued at this rate both ex ante and ex post. Good anticipated retrofit options reduce ex post energy costs, but lead to ex ante choice of more energy-intensive infrastructure, which could more than fully offset the energy-reducing effect of the retrofit. These results are of particular importance for emerging economies with large current and anticipated energy-related investments, where long-term climate policy goals may be seriously jeopardized by policy makers facing too low energy prices, now and in the future.

Time-varying long range dependence in energy futures markets

- Energy Economics---2014---Ahmet Sensoy, Erk Hacihasanoglu

This study aims to investigate the presence of long-range dependence in energy futures markets. Using a daily dataset covering from 1990 to 2013 (which includes crucial events for energy markets such as invasion of Iraq and global financial crisis of 2008), we estimate time-varying generalized Hurst exponents of several energy futures contracts with different times to maturity using a rolling window approach. Results reveal that efficiency of energy futures markets is clearly time-varying and changes drastically over the sample period. For futures contracts with 1–4 months to maturities, crude oil and gasoline are found to be more efficient compared to others. On the other hand, for contracts with 5–9 months to maturities, crude oil and natural gas futures are more efficient. For almost every different month to maturity, heating oil and gas oil futures are found to be the least efficient markets. Moreover in general, the efficiency of energy futures markets is found to be decreasing dramatically when time to maturity is increasing. Several implications are discussed.

The relationship between oil prices and the Nigerian stock market. An analysis based on fractional integration and cointegration

- Energy Economics---2014---Luis Gil-Alana, Olaoluwa Yaya

We examine the relationship between oil prices and the stock market in Nigeria. We focus on the degree of persistence of the series, and based on the similarities observed between the two series, a fractionally cointegrated framework is proposed. The results indicate that the two series display a similar order of integration, which is close to, although above 1. Testing for cointegration, this is decisively rejected since the order of integration in the equilibrium relationship was similar to that of the individual series. However, testing for long memory with oil prices acting as a weakly exogenous regressor, we obtained significant evidence of a positive relationship between the two variables though with a short memory effect, this relation being significant only during the following three months.

Time-varying Long-run Income and Output Elasticities of Electricity Demand with an Application to Korea

- Energy Economics---2014---Yoosoon Chang, Chang Sik Kim, J. Miller, Joon Y. Park, Sungkeun Park

It is widely accepted that long-run elasticities of demand for electricity are not stable over time. We model long-run sectoral electricity demand using a time-varying cointegrating vector. Specifically, the coefficient on income (residential sector) or output (commercial and industrial sectors) is allowed to follow a smooth semiparametric function of time, providing a flexible specification that allows more accurate out-of-sample forecasts than either fixed or discretely changing regression coefficients. We fit the model to Korean data over 1995:01-2012:12 for the residential sector and 1985:01-2012:12 for the commercial and industrial sectors. The rapid development of Korea over this period provides a very clear case for allowing the

coefficient on income/output to vary over time, but the essential modeling strategy is widely applicable.

Energy conservation and CO2 emission reduction in China's 11th Five-Year Plan: A performance evaluation

- Energy Economics---2014---Jin-Hua Xu, Ying Fan, Song-Min Yu

In the 11th Five-Year Plan (FYP) (2005–2010), the Chinese Government initiated a series of energy-saving and emission reduction policies in many key fields in response to environmental pollution and climate change. This paper quantitatively evaluates the performance of energy conservation and CO₂ emission reduction in this period, the impact of these policies and potentials, by integrating the contributions of energy conversion efficiency and energy utilization efficiency improvement, industrial restructuring, fuel mix shift and renewable energy development in a unified framework, as a first attempt to introduce energy conversion efficiency improvement into a decomposition approach. Comprehensive and specific policies are summarized as a policy list to be investigated. The results show that energy intensity and conversion efficiency effects were mainly responsible for driving down energy consumption, by 637.4Mtce and 85.4Mtce respectively, and they reduced CO₂ emissions by 1345.3Mt and 243.8Mt respectively due to a significant improvement in the 11th FYP period. Most of the contributions made by the conversion efficiency effect (94%) come from thermal power generation, and the emission coefficient effect reduced CO₂ emissions by 17.4Mt through developing renewable energy. Economic growth is still the biggest driver of energy consumption and increasing emissions, while industrial restructuring and fuel mix shift effects contributed relatively little. Developing renewable energy and promoting economic restructuring to limit the increase of energy-intensive sectors are still the main challenges and the next policy focus to achieve the targets for energy saving and carbon emission reduction in the 12th Five-Year Plan.

Sustainability development for supply chain management in U.S. petroleum industry by DEA environmental assessment

- Energy Economics---2014---Toshiyuki Sueyoshi,Derek Wang

Environmental assessment and protection are important concerns in modern business. Consumers are interested in environmental protection. They avoid purchasing products from dirt-imaged companies even if their prices are much less than the ones produced by green-imaged companies. The green image is very important for business survivability in our global market. A business concern associated with the green image is how to attain corporate sustainability where companies can attain both economic success and pollution prevention in their operations. There is tradeoff between economic prosperity and environmental concern. To attain a high level of corporate sustainability, companies need to measure the current performance in terms of their operational and environmental achievements. This study proposes a use of Data Envelopment Analysis (DEA) for such assessment. The proposed DEA assessment provides corporate leaders and managers with not only the measure of corporate sustainability but also information regarding how to invest for technology innovation for abatement of undesirable outputs (e.g., CO₂). As an application, this study utilizes the proposed approach to measure the corporate sustainability of petroleum firms in the United States. The petroleum industry is functionally separated into integrated and independent companies. The integrated companies, referred to as “Major”, have their large supply chains for both “upstream” (e.g., exploration, development and production of crude oil or natural gas) and “downstream” (e.g., oil tankers, refineries, storages and retails). Meanwhile, the independent companies focus upon the upstream function, but not the downstream, in their business operations. The empirical comparison between the two groups of petroleum firms identifies that the integrated companies outperform the independent companies because a large supply chain incorporated into the former group provides them with both a scale merit in their opera-

tions and an opportunity to obtain consumer’s opinions on their business operations. Thus, the large supply chain system, covering business functions for upstream and downstream, enhances corporate sustainability in the U.S. petroleum industry. It is easily envisioned that the empirical findings discussed in this study are useful in preparing business strategy and industrial policy for the petroleum industry of not only the United States but also other nations involved in oil and gas production.

Fuzzy interval programming for energy and environmental systems management under constraint-violation and energy-substitution effects: A case study for the City of Beijing

- Energy Economics---2014---Cong Dong,Guohe Huang,Yanpeng Cai,Wei Li,Guanhui Cheng

In this research, a fuzzy interval-parameter approach considering constraint-violation and energy-substitution effects (FIP-CVESE) was developed for planning municipal energy systems, which was an integration of interval linear programming (ILP) and fuzzy linear programming (FLP), as well as methods of constraint-violation and energy-substitution analyses. The proposed method was then applied to a real-world case for supporting the planning of the energy system in Beijing. The developed FIP-CVESE method could not only tackle uncertainties expressed as both interval numbers and fuzzy sets, but also allow several given levels of tolerable violations of system objective and constraints to expand the model’s decision space, facilitating the improvement in solution robustness. The obtained results could provide a series of desired decision alternatives at preferred satisfaction degrees, including schemes related to energy resources allocation, technology adoption, facility capacity expansion, transportation device identification, and environmental pollution mitigation. Also the substitution solutions among multiple energy resources can be generated by combining energy substitution effects with the violation levels of resources demands constrains through the introduction of violation variables. The acquired solutions could also help decision makers gain insights

of trade-offs between the economy and environment, as well as support decision-making for the planning of the energy system in Beijing.

An empirical comparison of alternative schemes for combining electricity spot price forecasts

- Energy Economics---2014---Jakub Nowotarski,Eran Raviv,Stefan Trück,Rafał Weron,Stefan Trueck

In this comprehensive empirical study we critically evaluate the use of forecast averaging in the context of electricity prices. We apply seven averaging and one selection scheme and perform a backtesting analysis on day-ahead electricity prices in three major European and US markets. Our findings support the additional benefit of combining forecasts of individual methods for deriving more accurate predictions, however, the performance is not uniform across the considered markets and periods. In particular, equally weighted pooling of forecasts emerges as a simple, yet powerful technique compared with other schemes that rely on estimated combination weights, but only when there is no individual predictor that consistently outperforms its competitors. Constrained least squares regression (CLS) offers a balance between robustness against such well performing individual methods and relatively accurate forecasts, on average better than those of the individual predictors. Finally, some popular forecast averaging schemes – like ordinary least squares regression (OLS) and Bayesian Model Averaging (BMA) – turn out to be unsuitable for predicting day-ahead electricity prices.

Macro determinants of volatility and volatility spillover in energy markets

- Energy Economics---2014---Berna Karali,Octavio Ramirez

We analyze the time-varying volatility and spillover effects in crude oil, heating oil, and natural gas futures markets by incorporating changes in important macroeconomic variables and major political and weather-related events into the conditional variance equations. We allow asymmetric responses to random disturbances

in each market as well as to good and bad economic news related to the overall economy. Results show the presence of asymmetric effects in both random disturbances and macroeconomic variables. A bidirectional volatility spillover effect is found between natural gas and crude oil and between the natural gas and heating oil markets. Crude oil volatility is found to increase following major political, financial, and natural events. Seasonality and day-of-the-week effects are found in the crude oil and heating oil markets.

Tail risk in energy portfolios

- Energy Economics---2014---Carlos González-Pedraz,Manuel Moreno,Juan Ignacio Peña

This article analyzes the tail behavior of energy price risk using a multivariate approach, in which the exposure to energy markets is given by a portfolio of oil, gas, coal, and electricity. To accommodate various dependence and tail decay patterns, this study models energy returns using different generalized hyperbolic conditional distributions and time-varying conditional mean and covariance. Employing daily energy futures data from August 2005 to March 2012, the authors recursively estimate the models and evaluate tail risk measures for the portfolio's profit-and-loss distribution for long and short positions at various horizons and confidence levels. Both in-sample and out-of-sample analyses applied to different energy portfolios show the importance of heavy tails and positive asymmetry in the distribution of energy risk factors. Thus, tail risk measures for energy portfolios based on standard methods (e.g. normality, constant covariance matrix) and on models with exponential tail decay underestimate actual tail risk, especially for short positions and short time horizons.

Impacts of energy shocks on US agricultural productivity growth and commodity prices—A structural VAR analysis

- Energy Economics---2014---Sun Ling Wang,Lihong McPhail

We examine the impacts of energy price shocks on U.S.

agricultural productivity growth and commodity prices' volatility by developing a structural VAR model. We use historical annual data of real U.S. gasoline prices, agricultural total factor productivity (TFP), real GDP, real agricultural exports, and real agricultural commodity price from 1948 to 2011 to estimate the model. Our results indicate that an energy price shock has a negative impact on productivity growth in the short run (1year). An energy price shock and an agricultural productivity shock each account for about 10% of U.S. agricultural commodity price volatility with the productivity shock's contribution slightly higher. However, the impact from energy prices outweighs the contribution of agricultural productivity in the medium term (3years). With more persistent impacts, energy shocks contribute to most (about 15%) of commodity price's variation in the long run.

Electric utilities, fuel use, and responsiveness to fuel prices

- Energy Economics---2014---Daniel C. Matsoff, Douglas Noonan, Jinshu Cui

This research tests the impact of changes in fuel price to explain fuel use by electric utilities. We employ a three-stage least squares model that explains changes in fuel use as a function of changes in three fuel prices. This model is repeated across sub-samples of data aggregated at the plant level and operating holding company level. We expect that plants and holding companies reduce fuel use when fuel prices rise. Several fuel substitution effects within and across plants and holding companies are demonstrated, as well as several frictions. At the plant level, higher prices of natural gas lead to less natural gas consumption, less coal consumption, and more fuel oil consumption. At the operating holding company level, results demonstrate the inelasticity of coal use and the increases of natural gas in response to higher coal prices. Subsamples demonstrate heterogeneity of results across different plants. Results emphasize that technological, market, and regulatory frictions may hinder the performance of energy policies.

Heterogeneous price dynamics in U.S. regional electricity markets

- Energy Economics---2014---José G. Dias, Sofia Ramos

The U.S. electricity wholesale market is organized in several deregulated regional markets. This paper compares price dynamics of electricity in the U.S. wholesale markets and shows that electricity prices from the West and East coasts have different regime dynamics. Our methodology suggests that electricity prices are better parameterized by four regimes with different levels of volatility. Additionally, West and East coast markets differ in the time spent in each regime. The extremely high volatility regime describes West coast prices during the California electricity crisis, but East coast prices are also frequent in that regime. We find evidence of synchronization of price dynamics in the mean-reverting and highest volatility regimes, i.e., prices from the East and West coasts tend to be in the same regimes at the same time.

Comparative statics of a monopolistic firm facing price-cap and command-and-control environmental regulations

- Energy Economics---2014---Michael Caputo

An exhaustive comparative statics analysis of a model of a monopolistic firm facing price-cap regulation and a variety of commonly implemented command-and-control environmental regulations is carried out. The comparative statics are intrinsic to each of the models and thus form their basic, empirically testable properties. Several unanticipated results emerge from the analysis. In particular, it is shown that a subset of the intrinsic comparative statics are qualitatively invariant to all of the commonly employed command-and-control environmental regulations that a price-cap regulated profit-maximizing monopoly might face, while others are specific to the type of command-and-control environmental regulation in place.

Hedging crude oil using refined product: A regime switching asymmetric DCC approach

- Energy Economics---2014---Zhiyuan Pan,Yudong Wang,Li Yang

In this paper, we explore the strategy on hedging crude oil using refined product. We develop a regime switching asymmetric DCC (RS-ADCC) model by taking into account both of regime switching and asymmetry in correlations. Our out-of-sample findings indicate that RS-ADCC displays greater hedging effectiveness than some conventional multivariate GARCH. Heating oil can better hedge crude oil than gasoline.

Effect of inventory announcements on crude oil price volatility

- Energy Economics---2014---Hui Bu

This paper examines the behavior of crude oil futures price volatility and investigates how the EIA weekly crude oil inventory reports announcements, especially information shocks, impact crude oil price movement and volatility. This study focuses on inventory information shocks using a new measure rather than on inventory changes themselves. The empirical results reveal that inventory information shocks rather than actual inventory changes negatively affect crude oil returns on the day the EIA releases the inventory information, although inventory shocks have no effect on daily conditional variance, which mainly follows a GARCH(1,1) process. To test the robustness of our model, we re-estimate the models for three subsamples. According to all results, we find that the effect of inventory shocks is weakened in rapid growth periods and disappears in steep fall markets.

Climate change adaptation and water resource management: A review of the literature

- Energy Economics---2014---Sheila M. Olmstead

This paper considers the extent and usefulness of the existing empirical literature on water supply, demand, and adaptation to climate change for incorporation into integrated assessment modeling efforts. We review

the existing literature on the likely economic impacts of climate change, acting through water supply and demand effects in specific river basins, and the ability of adaptation to mitigate those impacts. Since adaptive responses will be implemented largely by local, regional, and national water management institutions, we also review what is known about the responses of water users to water prices, non-price water conservation policies, water trading, investment in and operations of storage and conveyance infrastructure, and trans-boundary water allocation mechanisms — the set of policy levers typically available to water managers at various geographic scales. Remaining gaps in the empirical economic literature on these topics are identified. The paper also describes the potential contributions of linking existing and new empirical research on water resource adaptation with IAMs. The importance of further empirical economic and political-economic research on the role of water management institutions in adaptation, or maladaptation, to climate change emerges as an important theme.

Climate–water interactions—Challenges for improved representation in integrated assessment models

- Energy Economics---2014---Andrew Bell,Tingju Zhu,Hua Xie,Claudia Ringler

Water plays a major role in the climate system and in mediating impacts of climate variability and change on all sectors of the economy. The incorporation of water resources modeling into integrated assessment models (IAMs) to study climate–hydrology processes, related water impacts and adaptation options is thus an area of interest, yet it poses a number of methodological challenges. In particular, models of economic activity, climate, water availability and use, and adaptation are developed at differing temporal and spatial scales and with different goals. This makes their integration highly complex and computationally demanding. In this review we highlight a set of modeling challenges in water resource systems, describe the state of the art of approaches to integrating water resources modeling with IAMs and economic modeling, and identify

constraints and opportunities moving forward in the development of water resources modeling within the IAM frameworks.

Measuring climatic impacts on energy consumption: A review of the empirical literature

- Energy Economics---2014---Maximilian Auffhammer, Erin Mansur

This paper reviews the literature on the relationship between climate and the energy sector. In particular, we primarily discuss empirical papers published in peer-reviewed economics journals focusing on how climate affects energy expenditures and consumption. Climate will affect energy consumption by changing how consumers respond to short run weather shocks (the intensive margin) as well as how people will adapt in the long run (the extensive margin). Along the intensive margin, further research that uses household and firm-level panel data of energy consumption may help identify how energy consumers around the world respond to weather shocks. Research on technology adoption, e.g. air conditioners, will further our understanding of the extensive margin adjustments and their costs. We also note that most of the literature focuses on the residential sector. Similar studies are urgently needed for the industrial and commercial sectors.

Integrated assessment of climate impacts and adaptation in the energy sector

- Energy Economics---2014---Juan-Carlos Ciscar, Paul Dowling

From an engineering perspective, climate change can affect the energy sector in a number of ways, such as changes in the efficiency of power plants and increases in peak demand due to higher cooling demand in hotter summers. This article reviews how integrated assessment models have estimated the impacts of climate in the energy sector, including the modelling of adaptation. While most of the literature has considered changes in space heating and cooling demand, few models have studied the impacts on the supply side of the energy sector. The article also reviews

the main findings of the related literature. A number of knowledge gaps and possible research priorities are identified. Modelling possible adaptation measures and assessing the effects of climate extremes on the energy infrastructure are topics that require further attention.

Migration and household adaptation to climate: A review of empirical research

- Energy Economics---2014---Henry Klaiber

This paper reviews empirical research on migration and land use impacts associated with climate change. Household migration arises due to changes in economic opportunities and climate amenities resulting from climate change. Throughout the paper, efforts are made to highlight key empirical findings as well as areas in need of additional research. The existing literature is discussed through the lens of reduced form and structural approaches paying particular attention to preference heterogeneity and the often complex interconnections between economic sectors in determining household migration. Areas in need of additional research include improving our understanding of the coupling between human and natural systems, accounting for endogenous attributes and payoffs, and incorporating richer characterizations of the tradeoffs driving migration across multiple economic sectors.

Integrated assessment modeling of climate change adaptation in forestry and pasture land use: A review

- Energy Economics---2014---Steven K. Rose

Climate change is likely to affect commercial forest and pasture land use and production activities. As such, behavioral responses that adapt to the new and evolving climatic conditions are also likely. Integrated Assessment Models (IAMs) have an important role to play. IAMs are a unique class of models that integrate global biophysical and economic systems in order to explore issues with potentially significant interactions and feedbacks between the two systems, such as potential future impacts from climate change. Climate risks to forestry, pasture, and livestock are potential risks

that need to be understood and weighed. Those risks are defined by both the nature of climate change as well as society's adaptive capacity. This paper reviews and characterizes climate change adaptation modeling of forestry and pasture land use by IAMs, as well as economic modeling. The paper discusses what needs to be modeled or considered, what we have learned from the literature available, and issues and opportunities for future research. The literature is sparse, and in an early stage, but has already yielded insights regarding adaptation's potential for reducing risks, and possibly generating societal benefits. Empirical modeling will be important going forward to identify adaptation options and provide an observation based grounding for IAM modeling. Relevant empirical modeling to date is limited but highlights that there are many potential facets to adaptation related to these sectors that need to be considered by IAMs in some form. Data deficiencies will also need to be overcome and IAM model development advanced. This paper is part of a research initiative, and special issue of this journal, to improve adaptation modeling in climate impacts research.

Empirical studies on agricultural impacts and adaptation

- Energy Economics---2014---Maximilian Auffhammer, Wolfram Schlenker

Agricultural production is heavily dependent on weather outcomes, and hence climate change has the potential to significantly alter the sector's productivity. Both reduced form studies as well as integrated assessment models have found that the agricultural sector might experience significant impacts. We discuss the advantages of empirical reduced-form studies and their link and potential usefulness to integrated assessment models. We further discuss challenges facing empirical studies and recent research that looks at the longer term changes in climate and attempts to measure adaptation.

Agricultural adaptation to climate change in rich and poor countries: Current modeling practice and potential for empirical contributions

- Energy Economics---2014---Thomas Hertel, David B. Lobell

In this paper we discuss the scope of the adaptation challenge facing world agriculture in the coming decades. Due to rising temperatures throughout the tropics, pressures for adaptation will be greatest in some of the poorest parts of the world where the adaptive capacity is least abundant. We discuss both autonomous (market driven) and planned adaptations, distinguishing: (a) those that can be undertaken with existing technology, (b) those that involve development of new technologies, and (c) those that involve institutional/market and policy reforms. The paper then proceeds to identify which of these adaptations are currently modeled in integrated assessment studies and related analyses at global scale. This, in turn, gives rise to recommendations about how these models should be modified in order to more effectively capture climate change adaptation in the farm and food sector. In general, we find that existing integrated assessment models are better suited to analyzing adaptation by relatively well-endowed producers operating in market-integrated, developed countries. They likely understate climate impacts on agriculture in developing countries, while overstating the potential adaptations. This is troubling, since the need for adaptation will be greatest amongst the lower income producers in the poorest tropical countries. This is also where policies and public investments are likely to have the highest payoff. We conclude with a discussion of opportunities for improving the empirical foundations of integrated assessment modeling with an emphasis on the poorest countries.

Informing climate adaptation: A review of the economic costs of natural disasters

- Energy Economics---2014---Carolyn Kousky

This paper reviews the empirical literature on the economic impacts of natural disasters to inform both the

modeling of potential future climate damages and climate adaptation policy related to extreme events. It covers papers that estimate the short- and/or long-run economic impacts of weather-related extreme events as well as studies identifying the determinants of the magnitude of those damages (including fatalities). The paper also reviews the small number of empirical papers on the potential extent of adaptation in response to changing extreme events.

Climate change, sea level rise, and coastal disasters. A review of modeling practices

- Energy Economics---2014---Francesco Bosello, Enrica De Cian

The climate change impacts on sea level rise and coastal disasters, and the possible adaptation responses have been studied using very different approaches, such as very detailed site-specific engineering studies and global macroeconomic assessments of coastal zone vulnerability. This paper reviews the methodologies and the modeling practices used by the sea level rise literature. It points at the strengths and weaknesses of each approach, motivating differences in results and in policy implications. Based on the studies surveyed, this paper also identifies potential directions for future research.

Temperature, human health, and adaptation: A review of the empirical literature

- Energy Economics---2014---Olivier Deschenes

This paper presents a survey of the empirical literature studying the relationship between health outcomes, temperature, and adaptation to temperature extremes. The objectives of the paper are to highlight the many remaining gaps in the empirical literature and to provide guidelines for improving the current Integrated Assessment Model (IAM) literature that seeks to incorporate human health and adaptation in its framework. I begin by presenting the conceptual and methodological issues associated with the measurement of the effect of temperature extremes on health, and the role of adaptation in possibly muting these effects. The main conclusion that emerges from the literature is

that despite the wide variety of data sets and settings most studies find that temperature extremes lead to significant reductions in health, generally measured with excess mortality. Regarding the role of adaptation in mitigating the effects of extreme temperature on health, the available knowledge is limited, in part due to the few real-world data sets on adaptation behaviors. Finally, the paper discusses the implications of the currently available evidence for assessments of potential human health impacts of global climate change.

Leverage effect in energy futures

- Energy Economics---2014---Ladislav Krištoufek

We propose a comprehensive treatment of the leverage effect, i.e. the relationship between returns and volatility of a specific asset, focusing on energy commodities futures, namely Brent and WTI crude oils, natural gas and heating oil. After estimating the volatility process without assuming any specific form of its behavior, we find the volatility to be long-term dependent with the Hurst exponent on a verge of stationarity and non-stationarity. To overcome such complication, we utilize the detrended cross-correlation and the detrending moving-average cross-correlation coefficients and we find the standard leverage effect for both crude oils and heating oil. For natural gas, we find the inverse leverage effect. Additionally, we report that the strength of the leverage effects is scale-dependent. Finally, we also show that none of the effects between returns and volatility is detected as the long-term cross-correlated one. These findings can be further utilized to enhance forecasting models and mainly in the risk management and portfolio diversification.

Dynamic modeling of uncertainty in the planned values of investments in petrochemical and refining projects

- Energy Economics---2014---Juliano Melquiades Vianello, Leticia Costa, José Paulo Teixeira

There is a large gap between the planned value of investment in a project and its financial implementation. This fact creates a mismatch between the planned and

effectively achieved net present value (NPV) of the project. Considering the project portfolio of a company, this could even threaten your solvency in the future.

Risk factors and value at risk in publicly traded companies of the nonrenewable energy sector

- Energy Economics---2014---Marcelo Bianconi,Joe Yoshino

We analyze a sample of 64 oil and gas companies of the nonrenewable energy sector from 24 countries using daily observations on return on stock from July 15, 2003 to August 14, 2012.

Dynamic effects of rising oil prices on consumer energy prices in Canada and the United States: Evidence from the last half a century

- Energy Economics---2014---Abbas Valadkhani

This paper examines the dynamic relationship between the price of crude oil and the CPI energy price sub-index in Canada and the U.S. using a Markov-regime switching model and the Bai–Perron sequential method. Since these two series are cointegrated during the sample period (January 1961–June 2013), a short-run dynamic model is thus estimated for each country in which all coefficients and the error-variance terms can freely switch over time between two values prevailing in Regimes 0 and 1. Previous studies indicate that the price of crude oil does not currently affect the aggregate CPI as much as it did in the 1970s. This finding is not disputed in this paper. However, the sequentially-determined break date as well as the time-varying regime-switching probabilities point to two new findings. First, the marginal effects of changes in oil price on consumer energy prices (not the aggregate CPI) have consistently increased and become more instantaneous for both countries after the Western U.S. Energy Crisis of 2000. Second, the speed of adjustment (proxied by different error-correction coefficients) has also risen, particularly for the U.S. Therefore, oil prices exert far more positive and immediate impacts on energy costs in the post- rather than pre-1999 periods.

Emissions embodied in Chinese exports taking into account the special export structure of China

- Energy Economics---2014---Matthias Weitzel,Tao Ma

Quantification of CO₂ emissions embodied in China's trade is important for an informed debate on whom to blame for the recent rise in Chinese emissions or the calculation of border carbon adjustments. Applying input–output (IO) techniques, we calculate these emissions in (1) a standard model, (2) a regionally disaggregated model, taking into account that export production is concentrated in more advanced and more emission efficient provinces and (3) in a model with export processing, taking into account that almost half of the Chinese exports rely on a large share of imported intermediates and little domestic value and emissions added. We compare year 2007 emissions embodied in Chinese exports in a unified framework. We also report emissions embodied in Chinese imports used for intermediate production of exports by combining calculations for China with data from global IO models.

CO₂ emission standards and investment in carbon capture

- Energy Economics---2014---Jan Eide,Fernando J. de Sisternes,Howard J. Herzog,Mort D. Webster

Policy makers in a number of countries have proposed or are considering proposing CO₂ emission standards for new fossil fuel-fired power plants. The proposed standards require coal-fired power plants to have approximately the same carbon emissions as an uncontrolled natural gas-fired power plant, effectively mandating the adoption of carbon capture and sequestration (CCS) technologies for new coal plants. However, given the uncertainty in the capital and operating costs of a commercial scale coal plant with CCS, the impact of such a standard is not apparent a priori. We apply a stochastic generation expansion model to determine the impact of CO₂ emission standards on generation investment decisions, and in particular for coal plants with CCS. Moreover, we demonstrate how the incentive

to invest in coal-CCS from emission standards depends on the natural gas price, the CO₂ price, and the enhanced oil recovery price, as well as on the level of the emission standard. This analysis is the first to consider the entire power system and at the same time allow the capture percentage for CCS plants to be chosen from a continuous range to meet the given standard at minimum cost. Previous system level studies have assumed that CCS plants capture 90% of the carbon, while studies of individual units have demonstrated the costs of carbon capture over a continuous range. We show that 1) currently proposed levels of emission standards are more likely to shift fossil fuel generation from coal to natural gas rather than to incentivize investment in CCS; 2) tighter standards that require some carbon reductions from natural gas-fired power plants are more likely than proposed standards to incentivize investments in CCS, especially on natural gas plants, but also on coal plants at high gas prices; and 3) imposing a less strict emission standard (emission rates higher than natural gas but lower than coal; e.g., 1500lbs/MWh) is more likely than current proposals to incentivize investment in coal CCS technology, but only at high gas prices and to a lesser extent than a stringent standard (e.g., 300lbs/MWh).

On the effects of world stock market and oil price shocks on food prices: An empirical investigation based on TVP-VAR models with stochastic volatility

- Energy Economics---2014---Ikram Je- babli, Mohamed Arouri, Frédéric Teulon

Transmission of price shocks from one market to another one has long been investigated in the economic literature. However, studies have namely dealt with the relationship between financial and energy markets. With the recent changes in market conditions, investors, policy-makers and interest groups are giving special attention to food market. This paper aims at analyzing shock transmission between international food, energy and financial markets and to provide some insights into the volatility behavior during the past years and discuss its implications for portfolio man-

agement. To do this, we present a new time varying parameter VAR (TVP-VAR) model with stochastic volatility approach which provides extreme flexibility with a parsimonious specification. We resort also to a generalized vector autoregressive framework in which forecast-error variance decompositions are invariant to the variable ordering for the assessment of total and directional volatility spillovers. Our main findings suggest that volatility spillovers increase considerably during crisis and, namely after mid-2008, when stock markets become net transmitter of volatility shocks while crude oil becomes a net receiver. Shocks to crude oil or MSCI markets have immediate and short-term impacts on food markets which are emphasized during the financial crisis period. Moreover, we show that augmenting a diversified portfolio of food commodities with crude oil or stocks significantly increases its risk-adjusted performance.

Optimal path for controlling CO₂ emissions in China: A perspective of efficiency analysis

- Energy Economics---2014---P. Zhou, Z.R. Sun, D.Q. Zhou, Peng Zhou

This paper examines the optimal control of CO₂ emissions from a perspective of efficiency analysis. Several centralized data envelopment analysis (DEA) models are introduced to study the optimal allocation of CO₂ emissions under spatial, temporal and spatial-temporal allocation strategies, respectively. The models have been used to determine the optimal paths for controlling CO₂ emissions at provincial and regional levels in China. A sensitivity analysis of the optimal path on the emission control coefficient under spatial-temporal allocation strategy is further carried out. Our empirical results show that more developed regions should take emission reduction responsibility earlier than less developed regions in China. Of the three allocation strategies, spatial-temporal allocation strategy seems to be a better choice for achieving the optimal control of CO₂ emissions at country level since it is more encompassing by allowing both timing and spatial substitutions. It is also found that there exists an inverted U-shape relationship between the aggregate optimal

GDP and the emission control coefficient, which shows that modest emission reduction policy might be more appropriate for China in order to achieve the joint goals of economic development and CO₂ emission reduction.

Design of experiments applied to environmental variables analysis in electricity utilities efficiency: The Brazilian case

- Energy Economics---2014---Rafael C. Leme,Anderson P. Paiva,Paulo E. Steele Santos,Pedro P. Balestrassi,Leandro de Lima Galvão

Benchmarking plays a central role in the regulatory scene. Regulators set tariffs according to a performance standard and, if the companies can outperform such a standard, they can retain the gains observed by such outperformance. Efficiency performance is usually assessed by comparison (or a benchmark) against either other companies or the company's own historical performance. This paper discusses the impact of environmental variables on the efficiency performance of electricity distribution companies. Indeed, such variables, which are argued to be unmanageable, may affect the electricity utilities' performance. Thus, this paper proposes a simulation methodology based on design of experiment philosophy for statistically testing environmental variables and the interactions among them, enabling regulators to build the best suited semi-parametric two-stage model of electricity utility benchmarking analysis. To demonstrate the power of the proposed approach, experimental simulations are carried out using real data published by Brazil's regulator. The results show that environmental variables may impact efficiency performance linearly and nonlinearly.

Wavelet dynamics for oil-stock world interactions

- Energy Economics---2014---Mara Madaleno,Carlos Pinho

A previous research ignores the distinction between short term and long term, and by decomposing financial variables (world general and stock market indexes) and the macroeconomic variable (oil prices) at various

time scales, we study the relationship among series on a daily scale by scale basis. Continuous time wavelets help to circumvent the problems associated to basic linear regressions and given that stock-oil relationships are usually described as complicated we extend previous findings by providing more generalized and convincing results, in analyzing contagion and interdependence issues as well as lead and lag effects for both world general and sector stock levels between December 1992 and October 2012. The relationship between oil prices and sector stock returns is ambiguous, because results seem to show that there are both phase and anti-phase relationships, where mostly it is oil that is the lagging variable, independently of the sector under analysis. There is higher coherence among series for higher scales thus supporting the interdependence hypothesis, showing that long run market dynamics are more uncertain. Empirical results indicate a bidirectional relationship between both series for large time horizons, which can be associated to fundamentalist traders, especially fund managers and institutional investors, and which depend on the historical period under analysis.

The demand for E85: Geographical location and retail capacity constraints

- Energy Economics---2014---Sebastien Pouliot,Bruce Babcock

Consumption of high-ethanol gasoline blends must increase if United States renewable biofuel mandates are to rise above current levels as envisioned by the Renewable Fuel Standard. One such blend is E85 which contains no more than 85% ethanol and no less than 15% gasoline. We derive the demand for E85 based on a model of motorists' preferences for motor fuel blends and calibrate the demand for E85 using data on the location of flex vehicles and fuel stations that sell E85 in the United States. We also show how limits on the capacity of fuel stations to sell E85 affect demand and explore the potential future demand for E85 by increasing the number of fuel stations offering E85 and the number of flex vehicles. We show that the existing fleet of flex vehicles is sufficient to accommodate more than 15billiongallons of ethanol without a large price

discount on E85 only if the number of stations that sell E85 increases substantially. Provided with fast enough installation of new E85 pumps, this level of consumption would be sufficient to meet the mandates envisioned for conventional ethanol by 2015.

Implications of small modular reactors for climate change mitigation

- Energy Economics---2014---Gokul Iyer,Nathan Hultman,Steve Fetter,Son H. Kim

Achieving climate policy targets will require large-scale deployment of low-carbon energy technologies, including nuclear power. The small modular reactor (SMR) is viewed as a possible solution to the problems of energy security as well as climate change. In this paper, we use an integrated assessment model (IAM) to investigate the evolution of a global energy portfolio with SMRs under a stringent climate policy. Technology selection in the model is based on costs; we use results from previous expert elicitation studies of SMR costs. We find that the costs of achieving a 2°C target are lower with SMRs than without. The costs are higher when large reactors do not compete for market share compared to a world in which they can compete freely. When both SMRs and large reactors compete for market share, reduction in mitigation cost is achieved only under advanced assumptions about SMR technology costs and future cost improvements. While the availability of SMRs could lower mitigation costs by a moderate amount, actual realization of these benefits would depend on the rapid up-scaling of SMRs in the near term. Such rapid deployment could be limited by several social, institutional and behavioral obstacles.

A real options model to evaluate the effect of environmental policies on the oil sands rate of expansion

- Energy Economics---2014---L. Kobari,S. Jaimungal,Y. Lawryshyn

Canadian oil sands hold the third largest recognized oil deposit in the world. While the rapidly expanding oil sands industry in western Canada has driven

economic growth, the extraction of the oil comes at a significant environmental cost. It is believed that the government policies have failed to keep up with the rapid oil sands expansion, creating serious challenges in managing the environmental impacts. This paper presents a practical, yet financially sound, real options model to evaluate the rate of oil sands expansion, under different environmental cost scenarios resulting from governmental policies, while accounting for oil price uncertainty and managerial flexibilities. Our model considers a multi-plant/multi-agent setting, in which labor costs increase for all agents and impact their optimal strategies, as new plants come online. Our results show that a stricter environmental cost scenario delays investment, but leads to a higher rate of expansion once investment begins. Once constructed, a plant is highly unlikely to shut down. Our model can be used by government policy makers, to gauge the impact of policy strategies on the oil sands expansion rate, and by oil companies, to evaluate expansion strategies based on assumptions regarding market and taxation costs.

Estimating base temperatures in econometric models that include degree days

- Energy Economics---2014---James Woods,Cody Fuller

Heating and cooling degree days are in common use in conditional demand models, billing analysis, and large-scale energy forecasts. The implications of either choosing an ex-ante base temperature, or scanning over the base temperatures, as suggested in Fels (1986) and recommended by some evaluation protocols, are infrequently considered. These procedures result in biased estimates of weather-driven loads because of correlated errors-in-variables, and impart a downward bias to the variance of those estimates by a factor of two. A non-linear estimation procedure that corrects for these biases and an ex-ante correction factor for evaluating prior evaluations are offered.

On the use of the moment-matching technique for pricing and hedging multi-asset spread options

- Energy Economics---2014---Tommaso Pellegrino,Piergiacomo Sabino

The aim of this paper is to show the benefit of applying a moment matching technique to the short leg component in order to price and hedge multi-asset spread options: in particular, we approximate the real dynamics of the short leg component by taking a log-normal proxy, whose equivalent volatility can be computed by performing a two-moment matching approximation. The pricing of the option is then performed once the equivalent correlation parameter between the long leg underlying and the proxy short leg component has been calculated. The main advantage associated with the moment matching approach proposed in this paper is a reduction of the dimension of the pricing problem: we can, indeed, continue using all the option formulas available in the literature for two-legged spread options, i.e. spread options written on two underlyings. Besides it, the combined use of an option formula for two-legged spread options and the moment matching technique applied to the short leg component provides a good approximation to the Monte Carlo simulation. It is well-known that the Monte Carlo price and Greeks can be considered as the benchmark since no exact formula is available for the pricing and hedging of multi-asset spread options. The accuracy of our approach is even comparable to the one provided by using closed form approximation formulas based on three underlyings, where each underlying entering into the short leg component is treated separately.

Long-term effects of income specialization in oil and gas extraction: The U.S. West, 1980–2011

- Energy Economics---2014---Julia Haggerty,Patricia H. Gude,Mark Delorey,Ray Rasker

The purpose of the study is to evaluate the relationships between oil and natural gas specialization and socioeconomic well-being during the period 1980 to

2011 in a large sample of counties within the six major oil- and gas-producing states in the interior U.S. West: Colorado, Montana, New Mexico, North Dakota, Utah, and Wyoming. The effects of participation in the early 1980s oil and gas boom and long-term specialization were considered as possible drivers of socioeconomic outcomes. Generalized estimating equations were used to regress 11 measures of economic growth and quality of life on oil and gas specialization while accounting for various confounding factors including degree of access to markets, initial socioeconomic conditions in 1980, and dependence on other economic sectors. Long-term oil and gas specialization is observed to have negative effects on change in per capita income, crime rate, and education rate. Participation in the early 1980s boom was positively associated with change in per capita income; however the positive effect decreases the longer counties remain specialized in oil and gas. Our findings contribute to a broader public dialogue about the consequences of resource specialization involving oil and natural gas and call into question the assumption that long-term oil and gas development confers economic advantages upon host communities.

A Fuzzy Goal Programming model for solving aggregate production-planning problems under uncertainty: A case study in a Brazilian sugar mill

- Energy Economics---2014---Aneirson Francisco da Silva,Fernando Augusto Silva Marins

This paper proposes a Fuzzy Goal Programming model (FGP) for a real aggregate production-planning problem. To do so, an application was made in a Brazilian Sugar and Ethanol Milling Company. The FGP Model depicts the comprehensive production process of sugar, ethanol, molasses and derivatives, and considers the uncertainties involved in ethanol and sugar production. Decision-makings, related to the agricultural and logistics phases, were considered on a weekly-basis planning horizon to include the whole harvesting season and the periods between harvests. The research has provided interesting results about decisions in the agricultural stages of cutting, loading and transportation to sug-

arcane suppliers and, especially, in milling decisions, whose choice of production process includes storage and logistics distribution.

Output-based incentive regulation in electricity distribution: Evidence from Italy

- Energy Economics---2014---Carlo Cam-
bini,Annalisa Croce,Elena Fumagalli

Incentive regulation in electricity distribution is expected to enlarge its scope, from an input-oriented instrument to one that includes additional, output-based incentives. This creates a potential conflict with more traditional concerns for productive efficiency. In the case of Italy, together with input-oriented instruments, output-based incentives have been applied to indicators of quality for over a decade. Using micro-data from the largest Italian distribution company, we conduct an assessment of the effects of this regulatory framework. The aim of this work is threefold. First, we measure performance in terms of cost-efficiency and find that similar cost-reducing efforts were exercised in all distribution units. Second, we measure performance with respect to the overall regulatory framework. Using quality-related rewards and penalties, we find that more cost-efficient areas were also more successful in earning rewards/avoiding penalties: favorable external conditions have similar, positive effects on both cost and quality performance. Using the cost of the energy not supplied, we find no evidence of a conflict between cost efficiency and social cost efficiency. Results indicate, however, that it is preferable to use social costs when measuring a single unit's performance. From these results we derive specific policy indications.

Are the macroeconomic effects of oil price shock symmetric?: A Factor-Augmented Vector Autoregressive approach

- Energy Economics---2014---Lian An,Xiaoze Jin,Xiaomei Ren

This paper aims to examine the asymmetric effect of oil price shocks on real economic activity in the U.S. within the context of a nonlinear Factor-Augmented

Vector Autoregressive (FAVAR) model. By employing simulation methods, we trace the effects of positive and negative oil price shocks on the macroeconomic variables through the Impulse Response Function (IRF). It is found that the negative impacts of higher oil prices are larger than the positive effects of lower oil prices. And the asymmetric effects are more evident when the oil price shocks are larger. The results are robust to different lag specification and choice of factors.

Price discovery in energy markets

- Energy Economics---2014---Keshab Shrestha

In this study, we empirically analyze the price discovery process in the futures and spot markets for crude oil, heating oil and natural gas using daily closing prices. We use two different information share measures that are based on the methods proposed by Gonzalo and Granger (1995) and Lien and Shrestha (2014). Both measures indicate that almost all the price discovery takes place in the futures markets for the heating oil and natural gas. However, for the crude oil, the price discovery takes place both in the futures and spot markets. As a whole, our study indicates that futures markets play an important role in the price discovery process.

Reducing household electricity demand through smart metering: The role of improved information about energy saving

- Energy Economics---2014---James Carroll,Sean Lyons,Eleanor Denny

The international roll out of residential smart meters has increased considerably in recent years. The improved consumption feedback provided, and in particular, the installation of in-house displays, has been shown to significantly reduce residential electricity demand in some international trials. This paper attempts to uncover the underlying drivers of such information-led reductions by exploring two research questions. First, does feedback improve a household's stock of information about potential energy reducing behaviours? And second, do improvements in such information

help explain the demand reductions associated with the introduction of smart metering and time-of-use tariffs? Data is from a randomised controlled smart metering trial (Ireland) which also collected extensive information on household attitudes towards energy conservation and self-reported stocks of information related to energy saving. As with previous results in Ireland, we find that participation in a smart metering programme with time-of-use tariffs significantly reduces demand. Although treated households also increased their self-reported energy-reducing information, such improvements are not correlated with demand reductions in the short-run. Given this result, it is possible that feedback and other information provided in the context of smart metering are mainly effective in reducing and shifting demand because they act as a reminder and motivator.

Modeling gasoline demand in the United States: A flexible semiparametric approach

- Energy Economics---2014---Weiwei Liu

The focus of this paper is on the modeling and estimation of quarterly state-level gasoline demand in the United States. The existing literature may not appropriately evaluate the price elasticity and income elasticity of gasoline demand. Most studies fail to address the possible heterogeneity in gasoline demand elasticities that may arise from a variety of sources. The endogeneity issue of gasoline price has remained redundant throughout the literature. I address these challenges using a flexible demand model and a recently developed estimation technique. The econometric approach allows for functional coefficients to accommodate the heterogeneity in demand elasticities. Several instrumental variables are used to investigate the endogeneity of gasoline price. The estimation results provide strong evidence of heterogeneous gasoline demand elasticities across states and over time. Some state-level attributes along with income and macroeconomic shocks are the potential sources of heterogeneity.

DEA environmental assessment on U.S.

Industrial sectors: Investment for improvement in operational and environmental performance to attain corporate sustainability

- Energy Economics---2014---Derek Wang,Shanling Li,Toshiyuki Sueyoshi

Environmental assessment has recently become an important business concern because consumers are interested in environmental protection. They try to avoid purchasing products from dirt-imaged companies, which do not pay attention to environmental protection, even if their prices are much less than the ones produced by green-imaged companies. Thus, a green image is very important for corporate survivability in a global market. This study considers “corporate sustainability”, indicating that companies need to consider both economic prosperity and pollution prevention in their operations. To discuss the issue from corporate strategy for modern business, this study discusses a use of Data Envelopment Analysis (DEA) for environmental assessment by focusing upon Research and Development (R&D) strategy as well as technology innovation and selection for reduction of undesirable outputs (e.g., CO₂ emission). This type of research has never been explored in previous studies. It is easily envisioned that the proposed DEA environmental assessment will guide corporate leaders in identifying how to invest for technology innovation to reduce an amount of undesirable outputs. To discuss the practicality, this study applies the proposed approach to 153 observations on S&P 500 corporations in 2012 and 2013. The empirical investigation confirms that investors pay more serious attention to company’s green image and the reality for a long run sustainability than profitability in a short run concern. Furthermore, the energy sector is the best investment target among seven industrial sectors examined in this study. The measurement of corporate sustainability can serve as an empirical basis in selecting what type of technology is fitted for a specific industry.

Oil price shocks in a data-rich environment

- Energy Economics---2014---Knut Are Aastveit

This paper examines the impact of different types of oil price shocks on the U.S. economy, using a factor-augmented VAR (FAVAR) approach. The results indicate that when examining the effects of oil price shocks, it is important to account for the interaction between the oil market and the macroeconomy. I find that oil demand shocks are more important than oil supply shocks in driving several macroeconomic variables, and that the origin of demand shocks matters. Specifically, the U.S. economy and monetary policy respond differently to global demand shocks that have the effect of raising the price of oil and to oil-specific demand shocks.

Valuing smart meters

- Energy Economics---2014---Guido Pepermans

This paper assesses to what extent consumers are willing to make use of the features and capabilities offered by smart meters. Via a choice experiment households are offered the choice between a set of smart meters, described by six attributes: impact on the comfort and privacy level, functionality, visibility, cost savings, and investment outlay.

The high-frequency response of energy prices to U.S. monetary policy: Understanding the empirical evidence

- Energy Economics---2014---Carlo Rosa

This paper examines the impact of conventional and unconventional monetary policy on energy prices using an event study with intraday data. Three measures for monetary policy surprises are used: 1) the surprise change to the current federal funds target rate, 2) the surprise component to the future path of policy, and 3) the unanticipated announcement of future large-scale asset purchases (LSAP). Estimation results show that monetary policy surprises have economically important and highly significant effects on the level and volatility of energy futures prices and their trading volumes. I

find that, on average, a hypothetical unanticipated 100-basis-point hike in the federal funds target rate is associated with roughly a 3% decrease in West Texas Intermediate crude oil prices. I also document that, in a narrow window around the FOMC meeting, the Federal Reserve's LSAP1 and LSAP2 programs have a cumulative financial market impact on crude oil equivalent to an unanticipated cut in the federal funds target rate of 156 basis points.

Optimally differentiated carbon prices for unilateral climate policy

- Energy Economics---2014---Stefan Boeters

Economic thought on climate policy as an instance of environmental regulation is strongly influenced by the principle of a uniform carbon price. Economists acknowledge that this principle breaks down in a "second-best" world with other distortions, such as taxes and market power in domestic and international markets. However, systematic analysis of this point in the economic climate policy literature is scarce. In the present paper, a computable general equilibrium (CGE) set-up is chosen in order to examine what pattern of differentiated carbon prices emerges as optimal in a second-best world.

How do oil price shocks affect consumer prices?

- Energy Economics---2014---Liping Gao,Hyeonwoo Kim,Richard Saba

This paper evaluates the degree of pass-through from oil price shocks to disaggregate U.S. consumer prices. We find significantly positive effects of the oil price shock only on energy-intensive CPIs, which imply that significantly positive, though quantitatively small, response of the total CPI is mainly driven by substantial increases in prices of energy-related commodities. Unexpected changes in the oil price may result in decreases in the budget for non-energy commodities, if the demand for energy is inelastic (Edelstein and Kilian, 2009). Decreases in the demand for non-energy commodities will then result in limited influences on

prices of those goods, which is consistent with our empirical findings.

Price discrimination and limits to arbitrage: An analysis of global LNG markets

- Energy Economics---2014---Robert Ritz

Gas prices around the world vary widely despite being connected by international trade of liquefied natural gas (LNG). Some industry observers argue that major exporters have acted irrationally by not arbitraging prices. This is also difficult to reconcile with a competitive model in which regional price differences exist solely because of transport costs. We show that a model which incorporates market power can rationalize observed prices and trade flows. We highlight how different features of the LNG market limit the ability and/or incentive of other players to engage in arbitrage, including constraints in LNG shipping. We also present some rough estimates of market power in short-term sales by Qatar (to Japan and the UK), and discuss the potential impact of US LNG exports.

Electrification and productivity growth in Korean manufacturing plants

- Energy Economics---2014---Yonghun Jung,Seong-Hoon Lee

This paper presents a theoretical model of firm-specific productivity growth that incorporates technological knowledge by electrification and tests the model empirically. Our theoretical explanations suggest that the energy-transformation from fossil fuel to electricity by electrification could cause a decrease in the short-term level of productivity but an increase in the long-term rate of productivity growth in firms. Our empirical evidence from a large panel of Korean manufacturing plants is generally consistent with the theoretical predictions on the relatedness of technological knowledge by the electrification to the level and rate effects of the firm's productivity. The electrification measured by the share of electricity results in lowering the short-term productivity level but in raising the long-term rate of productivity growth of firms.

Uncovering the asymmetric linkage between financial derivatives and firm value — The case of oil and gas exploration and production companies

- Energy Economics---2014---Dinh Phan,Hoa Nguyen,Robert Faff

We investigate the role of derivatives in enhancing firm value of US oil and gas exploration and production companies over the period of 1998–2009, using both cross-sectional and time-series tests. Initially focusing on Tobin's Q, we document a 'hedging discount' in periods of increasing oil and gas prices, while there is some evidence that hedging leads to an increase in firm value in periods of decreasing prices. In the companion time-series tests our core finding indicates that hedger portfolios underperform compared to non-hedger portfolios i.e. confirming a hedging discount. We extend these time series tests to provide a range of conditional analyses exploring the circumstances in which this discount manifests. Here we find that the hedging discount is specifically related to periods of elevating oil and gas prices, especially if the price is high.

Economic analysis of the profitability of existing wind parks in Portugal

- Energy Economics---2014---Ivonne Peña,Inês Lima Azevedo,Luís António Fialho Marcelino Ferreira

Discussions on the appropriate policy design and level of incentive to promote renewable energy adoption and meet the 20/20/20 goals have spurred recently in the European Union. These discussions are also ongoing in Portugal, namely in what concerns the level and duration of feed-in tariffs that should be provided to independent power producers. This, in turn, raises the question of whether the past feed-in tariff levels were well designed to achieve the goals of a larger penetration of renewables in the Portuguese grid. The policies to induce wind adoption have led to a growth in wind installed capacity and share of electricity generated by wind in Portugal, but questions arise on their cost-effectiveness and whether alternative

policy designs would have led to the same goal. In this work, we estimate profits made by wind independent power producers for wind parks that were connected in Portugal between 1992 and 2010, and conclude that the feed-in tariffs have overcompensated some wind power producers. We also discuss the recent changes in feed-in tariff legislation published in February 2013 and estimate the expected costs of the introduced changes.

Iranian-Oil-Free Zone and international oil prices

- Energy Economics---2014---Mohammad Reza Farzanegan, Mozhgan Raeisian Parvari

One of the main elements of economic sanctions against Iran due to its nuclear and military programs is crude oil exportation restrictions in addition to investment in Iranian energy related projects. Senders of such sanction are interested in understanding the impacts of such embargos on international oil prices. We apply unrestricted vector autoregressive (VAR) model, using impulse response functions (IRF) and variance decomposition analysis (VDA) tools with annual data from 1965 to 2012 to analyze the dynamic response of international oil prices to Iranian oil export sanction. Controlling for the supply of non-Iranian oil, the world GDP per capita, and post-Islamic revolution exogenous dummy variables, we show that international oil prices respond negatively and statistically significant to increasing shock in absolute negative changes of the Iranian oil exports – our proxy of Iran oil sanctions – following the first 2 years after shock. The main reason is the positive response of the non-Iranian oil supply to negative shocks in Iranian oil exports, filling the missing supply of Iranian oil in international markets.

Implementing a load duration curve of electricity demand in a general equilibrium model

- Energy Economics---2014---Anthony Wiskich

Top-down computable general equilibrium models of energy–economy interactions have a limited representation of the electricity sector, typically using constant elasticities of substitution between generation types. Detailed bottom-up electricity models generally have

embedded load duration curves with the electricity price determined by the marginal cost of generation. This study incorporates a simple representation of electricity generation with these bottom-up features directly into the GTAP general equilibrium model.

Spill or leak? Carbon leakage with international technology spillovers: A CGE analysis

- Energy Economics---2014---Reyer Gerlagh, Onno Kuik

This paper studies the effect of endogenous technical change and international technology spillovers on carbon leakage. It is well known that a unilateral CO₂ abatement policy in one region may cause CO₂ emissions to increase in non-abating regions because of the relocation of CO₂-intensive firms and because of energy market effects. If, however, the CO₂ mitigation policy induces energy-saving technological innovation in the home region and this innovation can freely spill-over to energy users abroad, carbon leakage may be offset by induced efficiency gains in foreign firms. In this paper we develop a simple mathematical model of carbon leakage and technological spillovers and perform numerical simulations with an adjusted CGE model to illustrate the potential importance of international technology spillovers. We show that carbon leakage can become negative at moderate levels of technology spillover.

Factorial decomposition of CO2 emissions: A generalized Divisia index approach

- Energy Economics---2014---Alexander Vaninsky

This paper introduces a novel approach to estimating the impact of the major factors driving CO₂ emissions: GDP, energy consumption, population, their carbon intensities, and other related indicators that may be chosen arbitrarily. The suggested approach is based on the generalization of the Divisia index to interconnected factors. The approach also extends the Kaya identity by explicitly including Gross Domestic Product and energy consumption. A computer program in R language aimed at automating the calculations is

supplied. Factorial analysis of the United States' and China's CO₂ emissions is provided as an example of application.

Explaining the contract terms of energy performance contracting in China: The importance of effective financing

- Energy Economics---2014---Yan Li, Yueming Qiu, Yi David Wang

Energy service company (“ESCO”) uses Energy Performance Contracting (“EPC”) to provide energy-saving services to its clients. Under an EPC, both ESCO and the client invest in the energy efficiency measures, according to a negotiated share of investment. Within the length of the contract, the ESCO and its client divide up the saved energy bill according to a negotiated share. Once the contract expires, the client claims all of the saved energy bills if the energy efficiency measures still last. Different EPC projects have different contract terms, including total investment, share of investment and length of contract. These contract terms directly determine the resulted energy savings. Thus it is essential and important to look at how these contract terms are formed and what are the major influencing factors. This paper first builds a theoretical bargain model between ESCO and its client to find out the structural relationship among these contract terms. Then, using the information of about 140 EPC contracts in China in 2010 and 2011, the paper empirically estimates the impacts of various factors on the contract terms and the resulted energy savings. We find that cost of capitals for ESCOs and the clients, especially for ESCOs, is a major factor influencing contract terms and the resulted energy savings. Thus providing effective financing is critical for the development of EPC in China.

The impact of ownership unbundling on cost efficiency: Empirical evidence from the New Zealand electricity distribution sector

- Energy Economics---2014---Massimo Filippini, Heike Wetzel

Several countries around the world have introduced reforms to the electric power sector. One important element of these reforms is the introduction of an unbundling process, i.e., the separation of the competitive activities of supply and production from the monopoly activity of transmission and distribution of electricity. There are several forms of unbundling: functional, legal and ownership. New Zealand, for instance, adopted an ownership unbundling in 1998. As discussed in the literature, ownership unbundling produces benefits and costs. One of the benefits may be an improvement in the level of the productive efficiency of the companies due to the use of the inputs in just one activity and a greater level of transparency for the regulator. This paper analyzes the cost efficiency of 28 electricity distribution companies in New Zealand for the period between 1996 and 2011. Using a stochastic frontier panel data model, a total cost function and a variable cost function are estimated in order to evaluate the impact of ownership unbundling on the level of cost efficiency. The results indicate that ownership separation of electricity generation and retail operations from the distribution network has a positive effect on the cost efficiency of distribution companies in New Zealand. The estimated effect of ownership separation suggests a positive average one-off shift in the level of cost efficiency by 0.242 in the short-run and 0.144 in the long-run.

Can agent-based models forecast spot prices in electricity markets? Evidence from the New Zealand electricity market

- Energy Economics---2014---David Young, Stephen Poletti, Oliver Browne

Modelling price formation in electricity markets is a notoriously difficult process, due to physical constraints on electricity generation and transmission, and the potential for market power. This difficulty has inspired the recent development of bottom-up agent-based algorithmic learning models of electricity markets. While these have proven quite successful in small models, few authors have attempted any validation of their model against real-world data in a more realistic model. In

this paper we develop the SWEM model, where we take one of the most promising algorithms from the literature, a modified version of the Roth and Erev algorithm, and apply it to a 19-node simplification of the New Zealand electricity market. Once key variables such as water storage are accounted for, we show that our model can closely mimic short-run (weekly) electricity prices at these 19 nodes, given fundamental inputs such as fuel costs, network data, and demand. We show that agents in SWEM are able to manipulate market power when a line outage makes them an effective monopolist in the market. SWEM has already been applied to a wide variety of policy applications in the New Zealand market.²² This research was partly funded by a University of Auckland FDRF Grant #9554/3627082. The authors would like thank Andy Philpott, Golbon Zakeri, Anthony Downward, an anonymous referee, and participants at the EPOC Winter Workshop 2010 for their helpful comments.

Accounting for asymmetric price responses and underlying energy demand trends in OECD industrial energy demand

- Energy Economics---2014---Olutomi Adeyemi, Lester Hunt

This paper explores the way technical progress and improvements in energy efficiency are captured when modelling OECD industrial energy demand. The industrial sectors of the developed world involve a number of different practices and processes utilising a range of different technologies. Consequently, given the derived demand nature of energy, it is vital when modelling industrial energy demand that the impact of technical progress is appropriately captured. However, the energy economics literature does not give a clear guide on how this can be achieved; one strand suggests that technical progress is ‘endogenous’ via asymmetric price responses whereas another strand suggests that it is ‘exogenous’. More recently, it has been suggested that potentially there is a role for both ‘endogenous’ technical progress and ‘exogenous’ technical progress and consequently the general model should be specified accordingly.

A comparison of regular price cycles in gasoline and liquefied petroleum gas

- Energy Economics---2014---Sean Isakower, Zhongmin Wang

Regular and asymmetric gasoline price cycles are observed in a number of countries. While most studies found that such price cycles are well characterized by the theoretical Edgeworth price cycle, some studies suggest alternative explanations. This paper contributes to this literature by being the first to compare regular price cycles in a nongasoline product—liquefied petroleum gas (LPG)—with gasoline price cycles. Our main finding is that LPG price cycles in the Perth area of Western Australia are much longer and more asymmetric than gasoline price cycles in the same market. This finding is consistent with Noel’s (2008) prediction that Edgeworth cycles are longer and more asymmetric when aggregate demand is more elastic—the aggregate demand for LPG is presumably more elastic than the demand for gasoline.

Exploring the impacts of a carbon tax on the Chinese economy using a CGE model with a detailed disaggregation of energy sectors

- Energy Economics---2014---Zhengquan Guo, Xingping Zhang, Yuhua Zheng, Rao Rao

This paper applies a computable general equilibrium model to investigate the impacts of a carbon tax on China’s economy and carbon emissions based on China’s 2010 Input–Output Table. To obtain robust simulation results, we further disaggregate the energy sectors into eight departments according to energy use characteristics. The empirical results indicate that a moderate carbon tax would significantly reduce carbon emissions and fossil fuel energy consumption and slightly reduce the pace of economic growth. However, a large carbon tax has a significantly negative impact on China’s economy and social welfare. Moreover, a large carbon tax would entail marked price changes in China. Of the fossil fuels in use, reducing coal consumption would have the greatest impact on reducing carbon emissions, and the ad valorem duty rate for coal would

be the highest after levying a carbon tax because it has the highest carbon emission coefficient. Therefore, China should strive to promote clean coal technology, which may be crucial to reducing carbon emissions. Moreover, levying a carbon tax would improve the use of clean energy, which would be an effective means of reducing carbon emissions. Therefore, the Chinese government should formulate the regulations for and pass a carbon tax as early as possible to achieve its carbon emission abatement target and further contribute to mitigating climate change.

Optimal strategic oil stockpiling and import tariffs: The case of China

- Energy Economics---2014---Xiao-Bing Zhang

As two of the most important instruments for dealing with the issues of energy supply security, strategic petroleum reserves (SPRs) and oil import tariffs have been proven effective in developed countries. While China is currently building up its strategic oil reserves to ensure energy security, it is of great importance to investigate China's optimal oil stockpiling policies while taking into account the possibility of imposing an import tariff or quota, which can also be used for alleviating the energy insecurity of an oil-importing country. Employing a dynamic programming framework, this paper examines the optimal SPR policies and oil import tariffs or quotas for China and the interactions between the two instruments under different scenarios for the world oil market. The results show that the combination of optimal tariffs and SPR policies can substantially reduce the expected oil insecurity cost for China; the effect is larger when the probability that a disruption will continue is higher.

The forecasting accuracy of implied volatility from ECX carbon options

- Energy Economics---2014---Svetlana Viteva,Yulia Veld-Merkoulova,Kevin Campbell

This study analyzes the forecasting accuracy of the implied volatility of options on futures contracts for

the delivery of CO₂ emission allowances (carbon options) traded on the European Climate Exchange. We demonstrate that option implied volatility is highly informative about the variance of returns realized over the remaining life of the options. It is also directionally accurate in predicting future volatility changes. However, we also find that implied volatility of carbon options is biased, especially for periods of time which do not coincide with the remaining life of the option. This suggests that the market has yet to fully mature.

Dutch disease effect of oil rents on agriculture value added in Middle East and North African (MENA) countries

- Energy Economics---2014---Nicholas Apergis,Ghassen El-Montasser,Emmanuel Sekyere,Ahdi Noomen Ajmi,Rangan Gupta,Ghassen El Montasser

This paper investigates the effect of oil rents on agriculture value added in oil producing Middle East and North African (MENA) countries. Annual data from 1970 to 2011, panel cointegration tests by Pedroni (1999), long ran panel causality tests by Canning and Pedroni (2008), and two-step System GMM by Blundell and Bond (1998) are used in this study. We find a negative relationship between oil rents and agriculture value added in the long run, with a rather slow rate of short run adjustment of agriculture value added back to equilibrium after a boom in oil rents. These results indicate that an oil sector boom is associated with a contraction in the agriculture sectors of the countries in the panel in the long run. This is probably attributable to a resource movement effect from other economic sectors to the booming oil sector in these countries. This serves as evidence of a Dutch disease effect of an oil sector boom on agriculture in the MENA countries in this study.

Estimation of productivity in Korean electric power plants: A semiparametric smooth coefficient model

- Energy Economics---2014---Almas Heshmati,Subal Kumbhakar,Kai Sun

This paper analyzes the impact of load factor, facility and generator types on the productivity of Korean electric power plants. In order to capture important differences in the effect of load policy on power output, we use a semiparametric smooth coefficient (SPSC) model that allows us to model heterogeneous performances across power plants and over time by allowing underlying technologies to be heterogeneous. The SPSC model accommodates both continuous and discrete covariates. Various specification tests are conducted to assess the performance of the SPSC model. Using a unique generator level panel dataset spanning the period 1995–2006, we find that the impact of load factor, generator and facility types on power generation varies substantially in terms of magnitude and significance across different plant characteristics. The results have strong implications for generation policy in Korea as outlined in this study.

Capital–energy substitution: Evidence from a panel of Irish manufacturing firms

- Energy Economics---2014---Stefanie Haller,Marie Hyland

We use a translog cost function to model production in the Irish manufacturing sector over the period from 1991 to 2009. We estimate both own- and cross-price elasticities and Morishima elasticities of substitution between capital, labour, materials and energy. We find that capital and energy are substitutes in the production process. Across all firms we find that a 1% rise in the price of energy is associated with an increase of 0.04% in the demand for capital. The Morishima elasticities, which reflect the technological substitution potential, indicate that a 1% increase in the price of energy causes the capital/energy input ratio to increase by 1.5%. The demand for capital in energy-intensive firms is more responsive to increases in energy prices, while it is less responsive in foreign-owned firms. We also observe a sharp decline in firms' responsiveness in the first half of the sample period.

Persistence and cycles in historical oil price data

- Energy Economics---2014---Luis Gil-Alana,Rangan Gupta

This paper deals with the analysis of two observed features in historical oil price data; in particular, persistence and cyclicity. Using monthly data from September 1859 to October 2013, we observe that the series presents two peaks in the spectrum, one occurring at the long run or zero frequency and the other at a cyclical frequency. These features can be well described in terms of a long memory model that incorporates both peaks in the spectrum. It is found that the order of integration at the zero frequency is about 0.6, and the one at the cyclical frequency is substantially smaller (of about 0.3) with the length of the cycles being approximately of about 74 periods (months), which is consistent with the length suggested by the business cycle theory.

What drives natural gas prices? — A structural VAR approach

- Energy Economics---2014---Sebastian Nick,Stefan Thoenes

In this study, we develop a structural vector autoregressive model (VAR) for the German natural gas market. Our setup allows us to analyze the determinants of the natural gas price in a comprehensive framework. In particular, we illustrate the usefulness of our approach by disentangling the effects of different fundamental influences on gas prices during three recent supply interruptions: the Russian–Ukrainian gas dispute of January 2009, the Libyan civil war in 2011 and the withheld Russian exports in February 2012. Our results show that the natural gas price is affected by temperature, storage and supply shortfalls in the short term, while the long-term development is closely tied to both crude oil and coal prices, capturing the economic climate and the substitution relationship between the different energy commodities.

Are oil and gas stocks from the Australian market riskier than coal and uranium stocks?

Dependence risk analysis and portfolio optimization

- Energy Economics---2014---Jose Arreola Hernandez

This article models the dependence risk and resource allocation characteristics of two 20-stock coal–uranium and oil–gas sector portfolios from the Australian market in the context of the global financial crisis of 2008–2009. The modeling framework implemented consists of pair vine copulas and, linear and nonlinear portfolio optimization methods with respect to five risk measures. The paper’s objectives are to find out if the oil and gas stocks are riskier than the coal and uranium stocks, to identify the optimization method and risk measure that produce the best risk-return trade-off, to recognize the stocks in which the optimal weight allocations converge on average, and to acknowledge the vine copula model that best accounts for the overall dependence of the energy portfolios. The research findings indicate that the oil stocks have higher dependence risk than the coal, uranium and gas stocks in financial crisis periods. The higher risk of the oil stocks is confirmed by the larger concentration of symmetric and asymmetric dependence they have in the negative tail. The canonical vine (c-vine) copula model is observed to better capture the overall dependence of the energy portfolios. The combination of a pair c-vine copula and nonlinear portfolio optimization produces the highest return relative to risk. The optimal weight allocations converge on average in some stocks.

Radial and non-radial approaches for environmental assessment by Data Envelopment Analysis: Corporate sustainability and effective investment for technology innovation

- Energy Economics---2014---Toshiyuki Sueyoshi, Derek Wang

Environmental assessment and protection are important concerns in modern business. Consumers are

interested in corporate effort and investment for environmental protection. It can be easily imagined that they avoid purchasing products from dirty-imaged companies even if their prices are much less than the ones produced by green-imaged companies. A green image is recently a very important concern for corporate survivability in a competitive global market. By extending previous works on environment assessment and corporate sustainability, where companies need to consider both economic prosperity and pollution prevention in their operations, this study discusses a new use of Data Envelopment Analysis (DEA) for environmental assessment by utilizing its radial and non-radial measurements. The proposed radial and non-radial approaches may guide corporate leaders, managers and policy makers by providing not only quantitative assessment on their efforts for environmental protection but also information regarding how to invest for technology innovation on abatement of undesirable outputs. The empirical investigation identifies that the green investment in U.S. energy industry is useful for improving its unified (operational and environmental) performance if operational performance is measured by ROA (Return on Assets) and an amount of CO₂ emission reduction because the industry is the largest emitter among seven industry sectors examined in this study. The green investment makes it possible that firms can increase their net incomes by a good corporate image. However, if the financial measure is replaced by a corporate value (i.e., Tobin’s q ratio, mainly measured by stock price), the energy industry does not exhibit the best investment opportunity because the effect of green investment is limited on enhancing its corporate value. The energy industry is a very large process industry so that the green investment does not immediately increase its corporate value as found in the other industrial sectors such as information technology industry.

How do oil producers respond to oil demand shocks?

- Energy Economics---2014---Jochen Güntner

This paper analyzes the response of international oil producers to demand-induced changes in the price of

crude oil during 1975–2011, focusing on potential differences between OPEC and non-OPEC countries. The goal is to derive consistent estimates of the short-run price elasticity of crude oil supply at the country level. I find that oil producers hardly respond to demand shocks within the same month, and that the corresponding impact price elasticities of supply are statistically indistinguishable from zero. While there is little evidence of differences in the dynamic responses to a typical flow demand shock, on average over the sample period, OPEC members seem to curtail production in response to a speculative demand shock, whereas non-OPEC production expands significantly. Flow and speculative demand shocks account for a nontrivial fraction of the total variability in country-level crude oil supply.

Energy consumption and economic growth in the next 11 countries: The bootstrapped autoregressive metric causality approach

- Energy Economics---2014---Ertugrul Yildirim, Deniz Sukruoglu, Alper Aslan

Departing from previous literature, using bootstrapped autoregressive metric causality approach which is more robust against non-stationarity and break problems than lag augmented tests, this study analyzes causal relation between economic growth and energy consumption in the Next 11 countries. Estimating a trivariate model consisting of GDP per capita, energy consumption per capita and gross capital formation, it was found that the neutrality hypothesis is valid for all of the countries except for Turkey. These findings imply that energy conservation-oriented policies should be implemented in Bangladesh, Egypt, Indonesia, Iran, Korea, Mexico, Pakistan and Philippines. In the case of Turkey, a unidirectional causal nexus was found from energy consumption to economic growth. Since the growth hypothesis is valid, energy conservation policy poses an obstacle for economic growth in Turkey.

Oil price shocks and agricultural commodity prices

- Energy Economics---2014---Yudong Wang, Chongfeng Wu, Li Yang

While the impacts of oil price changes on agricultural commodity markets are of great interest to economists, previous studies do not differentiate oil-specific shocks from aggregate demand shocks. In this paper, we address this issue using a structural VAR analysis. Our findings indicate that the responses of agricultural commodity prices to oil price changes depend greatly on whether they are caused oil supply shocks, aggregate demand shocks or other oil-specific shocks mainly driven by precautionary demand. Oil shocks can explain a minor friction of agricultural commodity price variations before the food crisis in 2006–2008, whereas in post-crisis period their explanatory abilities become much higher. After crisis, the contributions of oil-specific factors to variations in agricultural commodity prices are greater than those of aggregate demand shocks. The results from an alternative SVAR confirm the robustness of our main findings.

Responsive feed-in tariff adjustment to dynamic technology development

- Energy Economics---2014---Thilo Grau

This paper reviews the adjustments of the feed-in tariffs for new solar photovoltaic (PV) installations in Germany. As PV system prices declined rapidly since 2009, the German government implemented automatic mechanisms to adjust the remuneration level for new installations in response to deployment volumes. This paper develops an analytic model to simulate weekly installations of PV systems of up to 30kW based on project profitability and project duration. The model accurately replicates observed market developments and is used to assess different adjustment mechanisms against multiple scenarios for PV system price developments. The analysis shows that responsive feed-in tariff schemes with frequent tariff adjustments and short qualifying periods reach deployment targets most effectively.

Bounds testing approach to analysis of the environment Kuznets curve hypothesis

- Energy Economics---2014---Olugbenga On-afowora,Oluwole Owoye

This paper examines the long-run and the dynamic temporal relationships between economic growth, energy consumption, population density, trade openness, and carbon dioxide (CO₂) emissions in Brazil, China, Egypt, Japan, Mexico, Nigeria, South Korea, and South Africa based on the environment Kuznets curve (EKC) hypothesis. We employ the ARDL Bounds test to cointegration and CUSUM and CUSUMSQ tests to ensure cointegration and parameter stability. The estimated results show that the inverted U-shaped EKC hypothesis holds in Japan and South Korea. In the other six countries, the long-run relationship between economic growth and CO₂ emissions follows an N-shaped trajectory and the estimated turning points are much higher than the sample mean. In addition, the results indicate that energy consumption Granger-causes both CO₂ emissions and economic growth in all the countries. Our results are consistent with previous studies that show that there is no unique relationship between energy consumption, population density, economic growth, trade openness, and the environment across countries.

Energy tariffs in a small open economy

- Energy Economics---2014---Henry Thompson

Tariffs on imported energy alter production and redistribute income. The present paper examines a small open economy producing two traded goods with capital, labor, and imported energy. A tariff reduces import and domestic factor income but payment to one domestic factor rises. Energy intensive output falls but the other output may rise in the general equilibrium. Political opinions on the tariff would differ. Revenue is concave in the tariff suggesting that the government might set the tariff to maximize revenue. A simulation illustrates these general equilibrium properties across a range of tariffs.

On the economic determinants of oil production

- Energy Economics---2014---Alessandro Cologni,Matteo Manera

In this paper, decisions regarding production in oil exporting countries are studied by means of theoretical analysis and empirical investigation. In particular, we aim at describing the relationship between oil production levels and changes in the world oil demand and prices.

The effect of biodiesel policies on world biodiesel and oilseed prices

- Energy Economics---2014---Dusan Drabik,Harry de Gorter,Govinda Timilsina

A theoretical and empirical model is developed to analyze the effect of a biodiesel mandate, a tax exemption (tax credit) and an exogenous diesel price shock on world soybean and canola markets. The jointness in crushing oil and meal from the oilseed reduces the size of the link between biodiesel and oilseed prices. A diesel price shock with a mandate results in a smaller change in oilseed prices compared with a tax exemption. Higher diesel prices increase biodiesel prices under a tax exemption but lower them with a blend mandate. When both canola and soybeans are used to produce biodiesel, an increase in the diesel price leads to higher canola prices, but the effect on soybean prices is ambiguous and depends on relative elasticities of meal demand and canola supply because canola produces more oil than soybeans.

‘Green’ productivity growth in China’s industrial economy

- Energy Economics---2014---Shiyi Chen,Jane Golley

This paper uses a Directional Distance Function (DDF) and the Malmquist–Luenberger Productivity Index to estimate the changing patterns of ‘green’ total factor productivity (GTFP) growth of 38 Chinese industrial sectors during the period 1980–2010. Unlike the measures of traditional total factor productivity (TFP)

growth, the DDF incorporates carbon dioxide emissions as an undesirable output directly into the production technology, which credit sectors for simultaneously reducing their emissions and increasing their output. Our estimates of aggregate and sector-level GTFP growth reveal that Chinese industry is not yet on the path towards sustainable, low-carbon growth. A dynamic panel data analysis of the determinants of GTFP across sectors is used to identify factors that might rectify this situation, including state owned enterprise (SOE) reform, the growth of small private enterprises, continued openness to foreign investment and higher spending on R&D, particularly in emission-intensive sectors.

Decision-support tool for assessing future nuclear reactor generation portfolios

- Energy Economics---2014---Shashi Jain,Ferry Roelofs,Cornelis W. Oosterlee

Capital costs, fuel, operation and maintenance (O&M) costs, and electricity prices play a key role in the economics of nuclear power plants. Often standardized reactor designs are required to be locally adapted, which often impacts the project plans and the supply chain. It then becomes difficult to ascertain how these changes will eventually reflect in costs, which makes the capital costs component of nuclear power plants uncertain. Different nuclear reactor types compete economically by having either lower and less uncertain construction costs, increased efficiencies, lower and less uncertain fuel cycles and O&M costs etc. The decision making process related to nuclear power plants requires a holistic approach that takes into account the key economic factors and their uncertainties. We here present a decision-support tool that satisfactorily takes into account the major uncertainties in the cost elements of a nuclear power plant, to provide an optimal portfolio of nuclear reactors. The portfolio so obtained, under our model assumptions and the constraints considered, maximizes the combined returns for a given level of risk or uncertainty. These decisions are made using a combination of real option theory and mean-variance portfolio optimization.

The differential effects of oil demand and supply shocks on the global economy

- Energy Economics---2014---Paul Cashin,Kamiar Mohaddes,Maziar Raissi,Mehdi Raissi

We employ a set of sign restrictions on the impulse responses of a Global VAR model, estimated for 38 countries/regions over the period 1979Q2–2011Q2, as well as bounds on impact price elasticities of oil supply and oil demand to discriminate between supply-driven and demand-driven oil-price shocks, and to study the time profile of their macroeconomic effects across a wide range of countries and real/financial variables. We show that the above identification scheme can greatly benefit from the cross-sectional dimension of the GVAR—by providing a large number of additional cross-country sign restrictions and hence reducing the set of admissible models. The results indicate that the economic consequences of a supply-driven oil-price shock are very different from those of an oil-demand shock driven by global economic activity, and vary for oil-importing countries compared to energy exporters. While oil importers typically face a long-lived fall in economic activity in response to a supply-driven surge in oil prices, the impact is positive for energy-exporting countries that possess large proven oil/gas reserves. However, in response to an oil-demand disturbance, almost all countries in our sample experience long-run inflationary pressures, an increase in real output, a rise in interest rates, and a fall in equity prices.

Forecasting energy markets using support vector machines

- Energy Economics---2014---Theophilos Papadimitriou,Periklis Gogas,Efthymios Stathakis

In this paper we investigate the efficiency of a support vector machine (SVM)-based forecasting model for the next-day directional change of electricity prices. We first adjust the best autoregressive SVM model and then we enhance it with various related variables. The system is tested on the daily Phelix index of the German and Austrian control area of the European Energy Exchange (EEX) wholesale electricity market.

The forecast accuracy we achieved is 76.12% over a 200day period.

Component estimation for electricity prices: Procedures and comparisons

- Energy Economics---2014---Francesco Lisi,Fany Nan

Electricity price time series usually exhibit some form of nonstationarity, corresponding to long-term behavior, one or more periodic components as well as dependence on calendar effects. As a result, modeling electricity prices requires accounting for both long-term and periodic components. In the literature, several filtering procedures have been proposed but a standard has not yet been found. Furthermore, since different procedures are applied in contexts that are not homogeneous with respect to data, periods and final goals, a fair comparison is difficult. This work considers several methods for component estimation in a homogeneous framework and compares them according to specific criteria. The final purpose is to find an estimation procedure that performs well, independently of the intended market and that can be proposed as a reference for electricity price time series filtering.

An ethanol blend wall shift is prone to increase petroleum gasoline demand

- Energy Economics---2014---Cheng Qiu,Gregory Colson,Michael Wetzstein

In 2010, the U.S. Environmental Protection Agency announced a waiver allowing an increase in the fuel-ethanol blend limit (the “blend wall”) from 10% (E10) to 15% (E15). Justifications for the waiver are reduced vehicle-fuel prices and less consumption of petroleum gasoline, leading to greater energy security. Empirical investigations of this waiver using Monte Carlo simulations reveal an anomaly where a relaxation of this blend wall elicits a demand response. Under a wide range of elasticities, this demand response can actually increase the consumption of petroleum gasoline and thus lead to greater energy insecurity. The

economics supporting this result and associated policy implications are developed and discussed.

Accounting for uncertainty in willingness to pay for environmental benefits

- Energy Economics---2014---Ricardo Daziano,Martin Achtnicht

Previous literature on the distribution of willingness to pay has focused on its heterogeneity distribution without addressing exact interval estimation. In this paper we derive and analyze Bayesian confidence sets for quantifying uncertainty in the determination of willingness to pay for carbon dioxide abatement. We use two empirical case studies: household decisions of energy-efficient heating versus insulation, and purchase decisions of ultra-low-emission vehicles. We first show that deriving credible sets using the posterior distribution of the willingness to pay is straightforward in the case of deterministic consumer heterogeneity. However, when using individual estimates, which is the case for the random parameters of the mixed logit model, it is complex to define the distribution of interest for the interval estimation problem. This latter problem is actually more involved than determining the moments of the heterogeneity distribution of the willingness to pay using frequentist econometrics. A solution that we propose is to derive and then summarize the distribution of point estimates of the individual willingness to pay under different loss functions.

Revisiting the relationship between spot and futures prices in the Nord Pool electricity market

- Energy Economics---2014---Rafał Weron,Michał Zator

This work discusses potential pitfalls of applying linear regression models for explaining the relationship between spot and futures prices in electricity markets, in particular, the bias coming from the simultaneity problem, the effect of correlated measurement errors and the impact of seasonality on the regression results. Studying a 13-year long (1998–2010) price series of spot and futures prices at Nord Pool and employing

regression models with GARCH residuals, we show that the impact of the water reservoir level on the risk premium is positive, which is to be expected, but contradicts the results of Botterud et al. (2010). We also show that after taking into account the seasonality of the water level, the storage cost theory proposed by Botterud et al. (2010) to explain the behavior of convenience yield has only limited support in the data.

Household demand and willingness to pay for hybrid vehicles

- Energy Economics---2014---Yizao Liu

This paper quantitatively evaluates consumers' willingness to pay for hybrid vehicles by estimating the demand of hybrid vehicles in the U.S. market. Using micro-level data on consumer purchases of hybrid and non-hybrid vehicles from National Household Travel Survey 2009, this paper formulates a mixed logit model of consumers' vehicle choices. Parameter estimates are then used to evaluate consumers' willingness to pay for hybrids. Results suggest that households' willingness to pay for hybrids ranges from \$963 to \$1718 for different income groups, which is significantly lower than the average price premium (over \$5000) of hybrid vehicles, even when taking the fuel costs savings of hybrid vehicles into consideration. The differences reveal that although the market has shown increasing interest in hybrid vehicles, consumers' valuation of the hybrid feature is still not high enough to compensate for the price premium when they make new purchases. Policy simulations are conducted to examine the effects of raising federal tax incentives on the purchase of hybrid vehicles.

Strategic Eurasian natural gas market model for energy security and policy analysis: Formulation and application to South Stream

- Energy Economics---2014---Chi Kong Chyong, Benjamin Hobbs

The mathematical formulation of a strategic Eurasian natural gas market model is presented. The model represents horizontal oligopolistic relationships among

producers, bilateral market power between producer (Russia) and transit (Ukraine) countries, detailed transport constraints, and operation decisions over a 20-year time horizon. To demonstrate the model's capabilities, a financial and market analysis of the proposed South Stream gas pipeline from Russia via the Black Sea to South Europe is summarized. Insights obtained include the following. First, expectations of high demand growth in Europe and/or transit risks do not justify the construction of the South Stream pipeline because under all demand and Ukraine transit interruption scenarios, the net benefits to the South Stream participants are negative (the NPV ranges from \$1.9 billion (bn) to \$7.4 bn). Second, Ukraine's perception of high transit market power vis-à-vis Russia may trigger the construction of the otherwise unprofitable South Stream project. Thus, under Ukraine's high transit market power scenario, the NPV of South Stream ranges between \$2.4 bn and \$24.5 bn. Third, we find that the South Stream investment increases the efficiency of the European gas market under the following conditions: (i) when gas demand in Europe grows 2% per year up to 2030, (ii) when Ukraine poses high transit market power, or (iii) under a combination of severe transit risks through Ukraine and low demand scenarios in Europe. It should be noted that the value of South Stream to both its project sponsors and the market as a whole is much higher when Ukraine exercises transit market power than under the high demand scenario. Therefore, whether Ukraine is likely to wield market power is crucial to the success of the South Stream project because that is the only scenario in which the project yields both a positive expected NPV to its sponsors and the highest value to the market as a whole.

What do market-calibrated stochastic processes indicate about the long-term price of crude oil?

- Energy Economics---2014---Warren J. Hahn, James A. DiLellio, James S. Dyer

Stochastic process models of commodity prices are important inputs in energy investment evaluation and planning problems. In this paper, we focus on mod-

eling and forecasting the long-term price level, since it is the dominant factor in many such applications. To provide a foundation for our modeling approach we first evaluate the empirical characteristics of crude oil price data from 1990 to 2013 using unit root and variance ratio tests. Statistical evidence from these tests shows only weak support for the applicability of stationary mean-reverting type processes up through 2004, with non-stationary Brownian motion type processes becoming more plausible when the data from 2005 to 2013 is added. We then apply a Kalman filtering method with maximum likelihood approach to estimate the model parameters for both a single-factor Geometric Brownian motion (GBM) process as well as the two-factor Schwartz and Smith (2000) process. The latter process decomposes the spot price into unobservable factors for the long-term equilibrium level and short-term deviation, and it accommodates aspects of both a GBM process and a mean-reverting process. Both empirical and simulated data are analyzed with these models, and we quantify the increases in both the drift rate and volatility of these processes that result from developments in the crude oil markets since the middle of the last decade. We conclude by comparing and contrasting both historical accuracy and forecasts from the parameterized models, and show that when the emphasis is on the long-term expectations, a single factor GBM forecast may be sufficient.

Crude oil moments and PNG stock returns

- Energy Economics---2014---Arjun Chatrath,Hong Miao,Sanjay Ramchander

We examine the risk-neutral moments of crude oil and their relationship to stock returns in the Petroleum and Natural Gas (PNG) industry. We find substantial overlaps in the association between returns and S&P 500- and crude oil higher moments. Net of these overlaps, PNG stocks share a significant negative relationship with crude volatility and positive relationships with crude skewness and kurtosis. Large cap stocks and those with a history of hedging exhibit negative loadings on crude volatility. However, after controlling for S&P 500- and crude oil returns and their risk-neutral

moments, there is little evidence that PNG stocks systematically and significantly price either S&P 500- or crude oil volatility. We document a weak pricing of crude skewness, but find no evidence for the pricing of the implied higher moments of market returns.

The impact of the household decision environment on fuel choice behavior

- Energy Economics---2014---Bianca van der Kroon,Roy Brouwer,Pieter J.H. van Beukering

Consumer preferences for fuels and alternative cook-stove technologies in Kenya are examined, focusing on household internal and external determinants driving choice behavior in a choice experiment. The potential for a transition towards cleaner and more efficient fuels and technologies is assessed by zooming in on three fuel-stove combinations. We find substantial demand and positive willingness to pay for the fuel-stove combinations in three locations representing different decision environments. Demand is significantly higher in the peri-urban and the resource abundant rural location than in the resource scarce rural location. The presence of better developed consumer markets for fuels in these locations functions as an important driver for cook-stove adoption. Although charcoal and ethanol stoves are preferred over improved firewood stoves, continued firewood usage is expected. Energy switching behavior cannot be substantiated. Instead, energy stacking is more likely, where charcoal and ethanol add to and extend a household's energy portfolio.

The impact of oil price shocks on U.S. bond market returns

- Energy Economics---2014---Wensheng Kang,Ronald Ratti,Kyung Hwan Yoon

This paper examines the effect of the demand and supply shocks driving the global crude oil market on aggregate U.S. bond index real returns. A positive oil market-specific demand shock is associated with significant decreases in aggregate bond index real returns for 8 months following the shock. A positive innovation in aggregate demand has a negative effect on real

bond return that is statistically significant and becomes more adverse over 24 months. Structural shocks driving the global oil market jointly account for 27.1% of the variation in real bond returns at 24 month horizon. A spillover index from rolling SVAR models is used to identify the interdependence between the oil market and bond returns. The mean for this spillover index is 0.381 over 2001:01–2011:12 and 0.476 over September through December 2008 during the height of the global financial crisis.

Asymmetries in the dynamic interrelationship between energy consumption and economic growth: Evidence from Turkey

- Energy Economics---2014---Ayşen Araç,Mübariz Hasanov

In this study we examine possible nonlinearities in dynamic interrelationship between energy consumption and economic growth in Turkey for the 1960–2010 period by using a smooth transition vector autoregressive model. In order to trace the effects of one variable on another, we calculate Generalized Impulse Response Functions (GIRFs). The computed impulse response functions demonstrate asymmetric effects of positive versus negative and small versus large energy consumption shocks on output growth and vice versa. Specifically, we find that negative energy shocks have a greater effect on output growth than positive energy shocks, and that big negative energy shocks affect output much more than small negative energy shocks. Similarly, we find that positive output shock has a greater effect on energy consumption whereas negative shocks have almost no effect on energy consumption. The results of this study have clear and important implications for energy economists and policymakers in Turkey.

The impact of wind power generation on the electricity price in Germany

- Energy Economics---2014---Janina Ketterer

This paper investigates the relationship between intermittent wind power generation and electricity price

behaviour in Germany. Using a GARCH model, I evaluate the effect of wind electricity generation on the level and the volatility of the electricity price in an integrated approach. The results show that variable wind power reduces the price level but increases its volatility. This paper's results also indicate that regulatory change has stabilised the wholesale price. The electricity price volatility has decreased in Germany after a modification of the marketing mechanism of renewable electricity. This gives confidence that further adjustments to regulation and policy may foster a better integration of renewables into the power system.

Economic evaluation of the conversion of industrial paper sludge to ethanol

- Energy Economics---2014---Hui Chen,Richard Venditti,Ronalds Gonzalez,Richard Phillips,Hasan Jameel,Sunkyu Park

The conversion of industrial paper sludge to ethanol was simulated using engineering process simulation software loaded with laboratory generated conversion data and financially analyzed. In one scenario, sludge is fractionated to remove ash, generating a higher concentration carbohydrate stream for separate hydrolysis and fermentation (SHF). In a second scenario, non-fractionated sludge is processed with only pH adjustment. Four primary sludges from mills producing either virgin or recycled paper were analyzed and the experimental conversion results used to inform the simulations. Financial analysis was conducted assuming ethanol wholesale price of US\$ 0.608 per liter. The most profitable case was fractionated virgin sludge (from a virgin paper mill) to ethanol (F-VK1) with a net present value (NPV) of US\$ 11.4 million, internal rate of return (IRR) of 28%, payback period of 4.4 years and minimum ethanol revenue (MER) of US\$ 0.32 per liter. Risk analysis showed that the F-VK1 case obtained a near 100% probability of business success with both central and bearish (pessimistic) assumptions.

The role of energy conservation and natural gas prices in the costs of achieving California's renewable energy goals

- Energy Economics---2014---Timothy Conside,Edward Manderson

This paper develops an econometric forecasting system of energy demand coupled with engineering-economic models of energy supply. The framework is used to quantify the energy and environmental impacts of renewable and natural gas based electricity power generation in California, considering the role of on-going energy conservation efforts and incorporating different natural gas price scenarios over the forecast horizon (2011–2035). The results indicate that, relative to a business-as-usual scenario of continuing to rely on imported electricity to meet future demand, California's renewable portfolio standard (RPS) of 33% renewables by 2020 will increase electricity rates by over 10%. However, the RPS will also provide substantial annual savings in carbon dioxide emissions, equal to 40million-metrictons in 2020. Continuing non-price induced energy conservation at the historical rate will only result in a marginal reduction in electricity rates, although lower electricity use means that substantial savings are nonetheless achieved in electricity expenditures. In addition, continuing trend energy conservation leads to substantial savings in carbon dioxide emissions. Like the RPS, developing domestic natural gas generation also leads to rate increases and reductions in carbon dioxide emissions (relative to the baseline). However, these impacts are minor compared to the RPS scenario.

The merit order effect of wind and photovoltaic electricity generation in Germany 2008–2016: Estimation and distributional implications

- Energy Economics---2014---Johanna Cludius,Hauke Hermann,Felix Chr. Matthes,Verena Graichen

Generation from renewable energy sources in Germany has experienced a considerable uptake in recent years. Mainly responsible for this development is the German Renewable Energy Sources Act (Erneuerbare Energien

Gesetz, EEG). This paper considers redistributive implications of the EEG for different electricity consumers. Using time-series regression analysis, we show that electricity generation by wind and PV has reduced spot market prices considerably by 6€/MWh in 2010 rising to 10€/MWh in 2012. We use these results to build a near-term forecasting tool for merit order effects, projected to reach 14-16€/MWh in 2016. On the other hand, the costs of the EEG are passed forward to consumers in the form of a surcharge. Our findings highlight significant redistributive transfers under the current design of the EEG. In particular, some energy-intensive industries are benefiting from lower wholesale electricity prices whilst being largely exempted from contributing to the costs of the scheme. We also highlight implications of our results for other areas for reform of the EEG, such as adequate remuneration mechanisms that ensure efficient operation and investment decisions are made under the scheme. More generally, these findings suggest that policy makers need to integrate distributional assessments into policy design and implementation.

Energy-growth conundrum in energy exporting and importing countries: Evidence from heterogeneous panel methods robust to cross-sectional dependence

- Energy Economics---2014---Abdul Jalil

This article uses the panel methods for energy exporting and importing countries that discuss the heterogeneity and cross sectional dependence in investigating the linkages between energy consumption and economic growth. The findings of the study suggest that the energy consumption is an important input not only in the energy importing but also in energy exporting countries. Furthermore, the results of the present paper suggest that the policy options should be different for the different countries in the back drop of heterogeneous slope coefficients.

Electricity consumption and economic growth in transition countries: A revisit using bootstrap panel Granger causality analysis

- Energy Economics---2014---Yemane Wolde-Rufael

The purpose of this paper is to revisit the Granger causal relationship between electricity consumption and economic growth for 15 transition economies for the period 1975–2010 using a bootstrap panel causality approach that allows for both cross-sectional dependency and for heterogeneity across countries. Applying this approach, we found a unidirectional causality running from electricity consumption to economic growth only in Belarus and Bulgaria; from economic growth to electricity consumption in the Czech Republic, Latvia, Lithuania and the Russian Federation; bidirectional causality only in Ukraine while no Granger causality in any direction in Albania, Macedonia, Moldova, Poland, Romania, Serbia, Slovak Republic and Slovenia. These results show that there is a limited support for the electricity-led growth hypothesis. Nevertheless these different findings provide important implications for energy strategies and policies for transition countries.

Interdependence of oil prices and stock market indices: A copula approach

- Energy Economics---2014---Kunlath Sukcharoen,Tatevik Zohrabyan,David Leatham,Ximing Wu

In this paper we study the relationship between the oil price and stock market index of various countries between 1982 and 2007. We exclude oil and gas stock companies from the stock indices to remove the obvious direct linkage. Oil price series are converted into local currency to account for possible exchange rate effects. The method of copula is used to model the general dependence between stock returns and oil price returns. Our findings suggest a weak dependence between oil prices and stock indices for most cases, which are consistent with the results from previous studies. Exceptions are for the stock index returns of large oil consuming and producing countries (United States and Canada), which are shown to have a relatively strong

dependence with the oil price series. The introduction of Euro in 1999 altered considerably dependence between oil prices and stock returns.

Is environmental efficiency trade inducing or trade hindering?

- Energy Economics---2014---Seda Meyveci Doganay,Selin Sayek,Fatma Taskin

Global efforts to identify strategies for sustainable economic growth and development underline the need for understanding important links between environmental policies and international trade. In this paper, by constructing an environmental efficiency index for 111 countries from 1980 to 2009, we are able to empirically test for one such link. An improvement in the environmental efficiency index in terms of carbon dioxide emissions reflects a decrease in the cost of efforts to mitigate the environmental costs associated with growth. Countries that improve their environmental efficiency are found to experience strong international trade effects, both through increased exports and increased imports. While the positive link between efficiency improvements and exports is supportive of the Porter hypothesis, the positive link between efficiency improvements and imports is supportive of strong positive income effects on account of environmental efforts. These results, which are robust to alternative estimation strategies, lend strong support to global efforts to improve countries' environmental efficiencies.

Renewable and non-renewable energy consumption and economic activities: Further evidence from OECD countries

- Energy Economics---2014---Ruhul Salim,Kamrul Hassan,Sahar Shafiei

This article examines the dynamic relationship between renewable and non-renewable energy consumption and industrial output and GDP growth in OECD countries using data over the period of 1980–2011. The panel cointegration technique allowing structural breaks is used for empirical investigation. The results show that there is a long-term equilibrium relationship among

non-renewable and renewable energy sources, industrial output and economic growth. The panel causality analyses show bidirectional causality between industrial output and both renewable and non-renewable energy consumption in the short and long run. However, there is evidence of bidirectional short-run relationship between GDP growth and non-renewable energy consumption while unidirectional causality between GDP growth and renewable energy consumption. These results indicate that OECD economies still remain energy-dependent for their industrial output as well as overall economic growth. However, expansion of renewable energy sources is a viable solution for addressing energy security and climate change issues, and gradually substituting renewable to non-renewable energy sources could enhance a sustainable energy economy.

Biofuel subsidies versus the gas tax: The carrot or the stick?

- Energy Economics---2014---Diya B. Mazumder

This paper provides an analytical framework to examine the relative efficiencies of a revenue-neutral biofuel subsidy and a gas tax in the presence of pre-existing distortions and growing substitutability between fuels. Both policies are set to achieve a targeted reduction in gasoline use at the state level. The model is then calibrated for a small open economy such as Illinois which is one of the largest producers of biofuels such as ethanol in the U.S. The main result of the paper shows that raising the biofuel subsidy use reduces overall welfare by more than a higher gas tax, both aimed to achieve a targeted reduction in pure gasoline. The relative efficiency of the higher gas tax is primarily due to it exacerbating the pre-existing distortion in the biofuel market by less than the subsidy. Moreover, for current parameter estimates welfare improving policy combinations for achieving a targeted amount of energy security are higher gas taxes combined with lower biofuel subsidies and a lower tax on income. However, the preference for a gasoline-labor tax swap shrinks as the elasticity of substitution between the two fuels rises.

Multilevel index decomposition analysis: Approaches and application

- Energy Economics---2014---X.Y. Xu,B.W. Ang

With the growing interest in using the technique of index decomposition analysis (IDA) in energy and energy-related emission studies, such as to analyze the impacts of activity structure change or to track economy-wide energy efficiency trends, the conventional single-level IDA may not be able to meet certain needs in policy analysis. In this paper, some limitations of single-level IDA studies which can be addressed through applying multilevel decomposition analysis are discussed. We then introduce and compare two multilevel decomposition procedures, which are referred to as the multilevel-parallel (M-P) model and the multilevel-hierarchical (M-H) model. The former uses a similar decomposition procedure as in the single-level IDA, while the latter uses a stepwise decomposition procedure. Since the stepwise decomposition procedure is new in the IDA literature, the applicability of the popular IDA methods in the M-H model is discussed and cases where modifications are needed are explained. Numerical examples and application studies using the energy consumption data of the US and China are presented.

Industry location in Chinese provinces: Does energy abundance matter?

- Energy Economics---2014---Jean-Marie Grether,Irina Hotz,Nicole Mathys

We identify the driving factors of manufacturing activity across Chinese provinces with a particular focus on energy endowments. A model of production location is estimated, including both comparative advantage and economic geography determinants. The data set used consists of a panel of 28 Chinese provinces and 12 manufacturing industries over the period 1999–2009. Results confirm the relative importance of energy endowments. We find that larger energy endowments are significantly correlated with larger production of energy-intensive sectors. Disaggregation across energy carriers shows that coal exhibits the strongest impact. These results are robust across alternatives.

Futures pricing in electricity markets based on stable CARMA spot models

- Energy Economics---2014---Fred Espen Benth, Claudia Klüppelberg, Gernot Müller, Linda Vos

We present a new model for the electricity spot price dynamics, which is able to capture seasonality, low-frequency dynamics and extreme spikes in the market. Instead of the usual purely deterministic trend we introduce a non-stationary independent increment process for the low-frequency dynamics, and model the large fluctuations by a non-Gaussian stable CARMA process. The model allows for analytic futures prices, and we apply these to model and estimate the whole market consistently. Besides standard parameter estimation, an estimation procedure is suggested, where we fit the non-stationary trend using futures data with long time until delivery, and a robust L1-filter to find the states of the CARMA process. The procedure also involves the empirical and theoretical risk premia which – as a by-product – are also estimated. We apply this procedure to data from the German electricity exchange EEX, where we split the empirical analysis into base load and peak load prices. We find an overall negative risk premium for the base load futures contracts, except for contracts close to delivery, where a small positive risk premium is detected. Peak load contracts, on the other hand, show a clear positive risk premium, when they are close to delivery, while contracts in the longer end also have a negative premium.

Crude oil prices and exchange rates: Causality, variance decomposition and impulse response

- Energy Economics---2014---Tantatape Brahmasrene, Jui-Chi Huang, Yaya Sissoko

This paper examines the short-run and long-run dynamic relationship between the U.S. imported crude oil prices and exchange rates. The monthly data of the U.S. crude oil imports from five source countries during January 1996 and December 2009 are examined. Empirical results indicate that the exchange rates Granger-caused crude oil prices in the short run

while the crude oil prices Granger-caused the exchange rates in the long run. Furthermore, oil prices were affected by the exchange rate changes at a minimal level. However, in the medium run and the long run, oil price shocks had a significant impact on exchange rate changes. Exchange rate shock has a significant negative impact on crude oil prices while the impulse response of the exchange rate variable to a crude oil price shock was statistically insignificant. Finally, the impact of extreme price volatility in June 2008 on exchange rates was significant. When world oil prices are stabilized, currency fluctuations and uncertainty can be minimized.

The windy city: Property value impacts of wind turbines in an urban setting

- Energy Economics---2014---Corey Lang, James J. Opaluch, George Sfinarolakis

This paper examines the impact of wind turbines on house values in Rhode Island. In contrast to wind farms surrounded by sparse development, in Rhode Island single turbines have been built in relatively high population dense areas. As a result, we observe 48,554 single-family, owner-occupied transactions within five miles of a turbine site, including 3254 within one mile, which is far more than most related studies. We estimate hedonic difference-in-differences models that allow for impacts of wind turbines by proximity, viewshed, and contrast with surrounding development. Across a wide variety of specifications, the results suggest that wind turbines have no statistically significant negative impacts on house prices, in either the post public announcement phase or post construction phase. Further, the lower bound of statistically possible impacts is still outweighed by the positive externalities generated from CO2 mitigation.

Dynamic Granger-causal networks of electricity spot prices: A novel approach to market integration

- Energy Economics---2014---G. Castagneto-Gissey, M. Chavez, F. De Vico Fallani, Giorgio Castagneto Gissey

This study uses network theory to analyze the interactions of a representative sample of 13 European (EU) electricity spot prices during the period 2007–2012. We construct 7651 dynamic multivariate networks, where the nodes correspond to different EU countries and the links weight the Granger-causality between the variations of the respective electricity prices. Global connectivity is then characterized by the system's density, or the total quantity of causal interactivity sustained by the network system, which informs about the occurrence of abnormal changes in connectivity. We report a considerably large peak lasting from October 2011 to April 2012, where the graph's density over-basal jump reached a magnitude of 2.4 times, suggesting an improved degree of connectivity of electricity markets during this period. By applying the Markov regime-switching model on the network density we find that this change coincides with the implementation of the European Commission's Third Energy Package. At the local level, the in-strength values quantifying the dependence of the electricity price variation of an EU country on other countries, validate the reliability of our technique by verifying historical events such as the occurrence of interconnectors commissioning and market coupling. On the path to full market integration, market networks should be periodically monitored. Our model, which is able to create a time-varying network describing the evolving influences between the European electricity prices, is able to detect important changes in market integration and can be considered a suitable and promising approach for this task.

Dynamic spillovers of oil price shocks and economic policy uncertainty

- Energy Economics---2014---Nikolaos Antonakakis, Ioannis Chatziantoniou, George Filis

This study examines the dynamic relationship between changes in oil prices and the economic policy uncertainty index for a sample of both net oil-exporting and net oil-importing countries over the period 1997:01–2013:06. To achieve that, an extension of the Diebold and Yilmaz (2009, 2012) dynamic spillover index based on structural decomposition is

employed. The results reveal that economic policy uncertainty (oil price shocks) responds negatively to aggregate demand oil price shocks (economic policy uncertainty shocks). Furthermore, during the Great Recession of 2007–2009, total spillovers increase considerably, reaching unprecedented heights. Moreover, in net terms, economic policy uncertainty becomes the dominant transmitter of shocks between 1997 and 2009, while in the post-2009 period there is a significant role for supply-side and oil specific demand shocks, as net transmitters of spillover effects. These results are important for policy makers, as well as, investors interested in the oil market.

Mitigating climate change: Decomposing the relative roles of energy conservation, technological change, and structural shift

- Energy Economics---2014---Gouri Shankar Mishra, Saleh Zakerinia, Sonia Yeh, Jacob Teter, Geoff Morrison

We decompose the contribution of five drivers of energy use and CO₂ emissions reductions in achieving climate change goals over 2005–2100 for various climate policy scenarios. This study contributes to the decomposition literature in three ways. First, it disaggregates drivers of energy demand into technological progress and demand for energy services, represented in terms of useful energy, allowing us to estimate their contributions independently — an improvement over other economy-wide decomposition studies. Secondly, this approach reduces the ambiguity present in many previous measures of structural change. We delineate structural shifts into two separate measures: changes in fuel mix within a given resource or service pathway; and changes in mix among distinct energy resources or end-use services. Finally, this study applies decomposition methods to energy and emission trajectories from two mutually informing perspectives: (i) primary energy resources — crude oil, natural gas, coal, nuclear, and renewables; and (ii) end-uses of energy services — residential and commercial buildings, industry, and transportation. Our results show that technological improvements and energy conservation are important in meeting climate

goals in the first half of the coming century; and that nuclear and renewable energy and CCS technology are crucial in meeting more stringent goals in the second half of the century. We examine the relative roles of the drivers in reducing CO₂ emissions separately for developed and developing regions. Although the majority of energy and emission growth – and by extension the greatest opportunities for mitigation – will occur in developing countries, the decomposition shows that the relative roles of the five drivers are broadly consistent between these two regions.

On the relationship between the prices of oil and the precious metals: Revisiting with a multivariate regime-switching decision tree

- Energy Economics---2014---Philippe Charlot,Vélayoudom Marimoutou

This study examines the volatility and correlation and their relationships among the euro/US dollar exchange rates, the S&P500 equity indices, and the prices of WTI crude oil and the precious metals (gold, silver, and platinum) over the period 2005 to 2012. Our model links the univariate volatilities with the correlations via a hidden stochastic decision tree. The ensuing Hidden Markov Decision Tree (HMDT) model is in fact an extension of the Hidden Markov Model (HMM) introduced by Jordan et al. (1997). The architecture of this model is the opposite that of the classical deterministic approach based on a binary decision tree and, it allows a probabilistic vision of the relationship between univariate volatility and correlation. Our results are categorized into three groups, namely (1) exchange rates and oil, (2) S&P500 indices, and (3) precious metals. A switching dynamics is seen to characterize the volatilities, while, in the case of the correlations, the series switch from one regime to another, this movement touching a peak during the period of the Subprime crisis in the US, and again during the days following the Tohoku earthquake in Japan. Our findings show that the relationships between volatility and correlation are dependent upon the nature of the series considered, sometimes corresponding to those found in econometric studies, according to which correlation increases in

bear markets, at other times differing from them.

Carbon auctions, energy markets & market power: An experimental analysis

- Energy Economics---2014---Noah Dormady

This paper provides an experimental analysis of a simultaneous energy-emissions market under conditions of market power. The experimental design employs real-world institutional features; including stochastic demand, permit banking, inter-temporal (multi-round) dynamics, a tightening cap, and resale. The results suggest that dominant firms can utilize energy-emissions market linkages to simultaneously inflate the price of energy and suppress the price of emissions allowances. Whereas under prior market designs, regulators were concerned with dominant firms exercising their market power over the emissions market to exclude rivals and manipulate the permit market by hoarding permits; the results of this paper suggest that this strategy is less profitable to dominant firms in contemporary auction-based markets than strategic capacity withholding in the energy market and associated demand reduction in the emissions market.

Does money talk? — The effect of a monetary attribute on the marginal values in a choice experiment

- Energy Economics---2014---Claudia Aravena,Peter Martinsson,Riccardo Scarpa

When designing choice experiments for nonmarket valuation the role of the price attribute is of major importance. In the energy sector the uncertainty of future direction of changes in prices makes it difficult to include an adequate price vector in the design. We separately investigate the implication of using price vectors with increases and decreases in tariffs from current levels, on marginal value estimate from choice experiment data developed using prospect theory. In addition, we also analyse the effect of excluding the price vector on these marginal values. By and large, our results support the neoclassical theory as we find that the means of the conditional estimates of the marginal values of

attributes are unaffected by the direction of the price change and from exclusion of the price attribute. However, the distributions show a larger spread of values when the choice experiment implies a tariff decrease, which may have policy implications.

Modeling the daily electricity price volatility with realized measures

- Energy Economics---2014---Michael Frömmel,Xing Han,Stepan Kratochvil

We propose using Realized GARCH-type models to estimate the daily price volatility in the EPEX power markets. The model specifications extract the volatility-related information from realized measures, which improves the in-sample fit of the data. More importantly, evidence on the out-of-sample predictability reinforces the value of the specifications, as the forecast quality is improved over the benchmark EGARCH model under eight conventional criteria. In particular, we show that the benefit of including intraday range as a realized measure is more substantial than realized variance. All the key findings are robust under rolling-window and recursive estimation schemes, Gaussian and skewed t-distribution assumptions on the innovation process, and alternative specifications on the predictable price component.

An energy factor proportions model of the US economy

- Energy Economics---2014---Henry Thompson

A factor proportions model examines the effects of falling energy input and its rising price in the US economy based on a novel production function motivated by the definition of physical work. This physical production function specifies separate interaction of energy and labor with capital, estimated with annual data from 1951 to 2008. Energy has a large output elasticity and inelastic own input demand. A rising energy price lowers the return to capital in the general equilibrium even though capital is a moderate substitute for energy. Energy has robust comparative static elasticities linked to manufacturing in the general equilibrium.

On the income–nuclear energy–CO2 emissions nexus revisited

- Energy Economics---2014---Jungho Baek,Dominique Pride

This paper seeks to contribute to the debate over the income–nuclear energy–CO2 emissions nexus by taking specific account of the possible endogeneity of income, which has been largely ignored by early studies. A multivariate cointegrated vector autoregression (CVAR) is applied to top six nuclear generating countries. We find that nuclear energy tends to reduce CO2 emission for all countries. It is also found that income has a beneficial effect on the environment only in some countries. Finally, we find that CO2 emissions and income are indeed determined simultaneously, while nuclear energy acts exogenously, indicating that nuclear energy is the driving variable, which significantly influences the long-run movements of CO2 emissions and income, but is not affected by CO2 emissions and income in the model.

Symmetric transmission of prices in the retail gasoline market in Brazil

- Energy Economics---2014---André Suriane da Silva,Cláudio Roberto Fóffano Vasconcelos,Silvinha Pinto Vasconcelos,Rogério Silva de Mattos

This study aimed to analyze the existence of asymmetric transmission of prices in the Brazilian gasoline market following a regional approach, using a disaggregated data set for the period between May 2004 and February 2011. The main result finds evidence of symmetric price transmission in retail gasoline market due to price shocks arising from the distributors. It is important to highlight that the disaggregation of the data allowed the study to show that the asymmetry is not a national problem, but specific to each city and different for each of the regions in Brazil.

Evaluating sub-national building-energy efficiency policy options under uncertainty: Efficient sensitivity testing of alternative climate, technological, and socioeconomic futures in a regional integrated-assessment model

- Energy Economics---2014---Michael J. Scott,Don S. Daly,Yuyu Zhou,Jennie S. Rice,Pralit L. Patel,Haewon C. McJeon,G. Page Kyle,Son H. Kim,Jiyong Eom,Leon E. Clarke

Improving the energy efficiency of building stock, commercial equipment, and household appliances can have a major positive impact on energy use, carbon emissions, and building services. Sub-national regions such as the U.S. states wish to increase energy efficiency, reduce carbon emissions, or adapt to climate change. Evaluating sub-national policies to reduce energy use and emissions is difficult because of the large uncertainties in socioeconomic factors, technology performance and cost, and energy and climate policies. Climate change itself may undercut such policies. However, assessing all of the uncertainties of large-scale energy and climate models by performing thousands of model runs can be a significant modeling effort with its accompanying computational burden. By applying fractional-factorial methods to the GCAM-USA 50-state integrated-assessment model in the context of a particular policy question, this paper demonstrates how a decision-focused sensitivity analysis strategy can greatly reduce computational burden in the presence of uncertainty and reveal the important drivers for decisions and more detailed uncertainty analysis.

A strong argument for using non-commodities to generate electricity

- Energy Economics---2014---Katarina Tatiana Marques Santiago,Fernando Menezes Campello de Souza,Diogo Bezerra

An optimal control approach towards generating electricity is used to analyze the trade-off between using of primary sources which are regarded as commodities, such as fossil fuels, biomass and water to generate electricity, and exploiting these sources for their other eco-

nomic uses (for example, in the petrochemical industry, in the production of fuels, in agriculture, in steelmaking, and so forth). In order to do so, a dynamic model is presented which establishes relationships between economic growth, the fossil fuel, water and biomass sectors, and energy policies, based on the application of the Pontryagin Maximum Principle. Among other results, the analysis establishes that, under the optimal path, the price of commodities for non-energy uses should be twice the price of the energy assets. This indicates that sources which are not commodities such as solar energy, wind energy, and geothermal energy, should be used to generate electricity.

Oil price uncertainty and manufacturing production

- Energy Economics---2014---Goodness C. Aye,Vincent Dadam,Rangan Gupta,Bonginkosi Mamba

Given the rapid rise and volatility of oil prices, the paper investigates the effect of oil price uncertainty on the South African manufacturing production using monthly observations covering the period 1974:02 to 2012:12. In addition, we quantify the responses of manufacturing production to positive and negative oil price shocks. We examine the dynamic relationship using a bivariate GARCH-in-mean VAR simultaneously estimated with a full information maximum likelihood technique. The conditional standard deviation of the forecast of the growth of US crude oil imported acquisition cost by refiners is used as a measure of oil price uncertainty. Our results show that oil price uncertainty negatively and significantly impacts on South Africa's manufacturing production. We also find that the responses of manufacturing production to positive and negative shocks are asymmetric.

The switching relationship between natural gas and crude oil prices

- Energy Economics---2014---Matthew Brigida

In this analysis we more accurately capture the cointegrating relationship between natural gas and crude

oil prices by endogenously incorporating shifts in the cointegrating vector into the estimation of the cointegrating equation. Specifically, we allow the cointegrating equation to switch between m states, according to a first-order Markov process. First, we find evidence that regime-switching exists in the relative pricing relationship, and that two is the optimal number of states. Once we control for shifts in the cointegrating vector, we find that natural gas and crude oil prices are cointegrated, and an error correction model (ECM) of their long-term equilibrium relationship is properly specified. This finding broadens the ECM model of their relationship to longer and more varied sample periods. Also, in a direct comparison of the two and one state cointegrating equations, we found evidence of the potential superiority of the two-state equation, in that it may be robust to shifts in the cointegrating vector which are missed by standard tests for a unit root. Further, our analysis finds evidence that natural gas and crude oil prices did not permanently ‘decouple’ in the early 2000s, but rather experienced a temporary shift in regimes. We find that forecasts of the relative pricing of natural gas and crude oil should be conditioned on state probability.

Pricing Contracts Under Uncertainty in a Carbon Capture and Storage Framework

- Energy Economics---2014---W. Cai,D.I. Singh, E.M. Craparo, J.A. White

Carbon capture and storage (CCS) has been demonstrated as a viable option for reducing carbon emissions to the atmosphere. We consider a situation where a tax on emissions is imposed on carbon dioxide (CO₂) producers to encourage their participation in CCS. Operators of CO₂ transportation pipelines and storage sites enter into individual contracts with emissions producers to store CO₂. We study the problem of selecting the optimal price and volume of these contracts under both cost and emissions uncertainty to optimize the storage operator’s expected profit.

The impact of heat waves on electricity spot markets

- Energy Economics---2014---Anna Pechan, Klaus Eisenack

Thermoelectric power plants depend on cooling water drawn from water bodies. Low river run-off and/or high water temperatures limit a plant’s production capacity. This problem may intensify with climate change. Our study quantifies the impact of forced capacity reductions on market prices, production costs, consumer and producer surplus, as well as emissions by means of a bottom-up power generation system model. First, we simulate the German electricity spot market during the heat wave of 2006. Then we conduct a sensitivity study that accounts for future climatic and technological conditions.

Modeling volatility and correlations between emerging market stock prices and the prices of copper, oil and wheat

- Energy Economics---2014---Perry Sadorsky

Increased financial integration between countries and the financialization of commodity markets are providing investors with new ways to diversify their investment portfolios. This paper uses VARMA-AGARCH and DCC-AGARCH models to model volatilities and conditional correlations between emerging market stock prices, copper prices, oil prices and wheat prices. The dynamic conditional correlation model is found to fit the data the best and used to generate dynamic conditional correlations, hedge ratios and optimal portfolio weights. Emerging market stock prices and oil prices display leverage effects where negative residuals tend to increase the variance (conditional volatility) more than positive ones. Correlations between these assets increased considerably after 2008, and have yet to return to their pre 2008 values. On average, oil provides the cheapest hedge for emerging market stock prices while copper is the most expensive but given the variability in the hedge ratios, one should probably not put too much emphasis on average hedge ratios.

Daily seasonality in crude oil returns and volatilities

- Energy Economics---2014---Benjamin R. Auer

In this article, we test for the existence of daily seasonality in returns and volatilities of crude oil. Using a dummy-augmented GARCH specification for the period from May 1987 to October 2013, our key findings are as follows: (i) Volatilities on Mondays are significantly higher than on all other weekdays, providing the important insight that seasonal effects should be considered when forecasting crude oil volatility. (ii) Returns on the other hand tend to be lower on Mondays than on other weekdays, suggesting profitable investment strategies based on this seasonal pattern. In fact, the analysis of a simple long-short trading rule based on the Monday effect provides some evidence that it can outperform a passive buy-and-hold approach. However, it cannot do so to an extent that is statistically significant. (iii) Our seasonality results are fairly robust to the choice of other frequently used GARCH model variants, like GARCH-M, TGARCH and CGARCH.

A network game analysis of strategic interactions in the international trade of Russian natural gas through Ukraine and Belarus

- Energy Economics---2014---Daisuke Nagayama, Masahide Horita

Natural gas is an important source of relatively low-emission, low-cost, non-nuclear and abundant energy; however, the difficulty of storage and transportation adds geopolitical and geostrategic complexity to its international trade. Much of the global natural gas trade occurs through natural gas pipelines, which as an infrastructure is strictly specific to the transportation of natural gas. Therefore, the very structure of natural gas pipeline networks can dictate the strategic relationship among countries involved in its trade. This paper applies a Network Game Model where these pipeline networks are modeled as graphs and respective value functions, and employs the Link-based Flexible Network Allocation Rule developed by Jackson (2005)

as a solution concept to measure the relative power structure among these natural gas trading countries. The paper analyzes the case of trade between Russia, Ukraine, Belarus and Western Europe, and compares the results to existing analyses that employ a Cooperative Game Model in Characteristic Function Form and the Shapley Value as the solution concept. Whereas the results of the analysis conducted in the previous literature indicate that Russia's relative power was significantly stronger than other players both before and after the construction of the Nord Stream pipeline, the results provided in this paper draw a different conclusion. Ukraine's relative power was already equal to that of Russia before the Nord Stream. This may be understood as one of the underlying causes for the prolonged conflicts that occurred repeatedly in this region concerning natural gas trade.

Comparing energy use structures: An input-output decomposition analysis of large economies

- Energy Economics---2014---Amir Borges Ferreira Neto, Fernando Perobelli, Suzana Bastos

In this paper, we aim to assess how the changes in aspects of demand impact the use of energy in the developing economies of Brazil, China, and India and the developed economies of Germany, the United Kingdom, and the United States. To achieve this objective, we use input-output matrices for the years 1995 and 2005 by applying a structural decomposition analysis. We find the following: Brazil is the only country where technology has a positive impact on energy. Germany and the United Kingdom decrease their use of energy over the sample period. China and the United Kingdom are the only countries where the use of renewable inputs decreases; and, in Brazil, China, and the United States, the use of coal increases. When we change the focus of our analysis from aggregated to disaggregated results, these countries can be lined up differently in terms of development in relation to their wealth and energy use.

Do producers apply a capacity cutting strategy to increase prices? The case of the England and Wales electricity market

- Energy Economics---2014---Lubomir Lizal,Sherzod Tashpulatov

Promoting competition among electricity producers is primarily targeted at ensuring fair electricity prices for consumers. Producers could, however, withhold part of production facilities (i.e., apply a capacity cutting strategy) and thereby push more expensive production facilities to satisfy demand for electricity. This behavior could lead to a higher price determined through a uniform price auction. Using the case of the England and Wales wholesale electricity market we empirically analyze whether producers indeed did apply a capacity cutting strategy. For this purpose we examine the bidding behavior of producers during high- and low-demand trading periods within a trading day. We find statistical evidence for the presence of capacity cutting by several producers, which is consistent with the regulatory authority's reports.

The causal relationship between renewable electricity generation and GDP growth: A study of energy sources

- Energy Economics---2014---Adrienne Ohler,Ian Fetters

This paper examines the causal relationship between economic growth and electricity generation from renewable sources (biomass, geothermal, hydroelectric, solar, waste, and wind) across 20 OECD countries over 1990 to 2008. The results from a commonly used panel error correction model find (a) a bidirectional relationship between aggregate renewable generation and real GDP, (b) biomass, hydroelectricity, waste, and wind energy exhibit a positive long-run relationship with GDP, (c) hydroelectricity and waste generation exhibit a short-run positive bidirectional relationship with GDP growth, and (d) biomass, hydroelectric, and waste electricity generation have the largest impact on real GDP in the long-run. We extend the analysis to

consider the possibility of structural breaks and cross-sectional dependence. Accounting for cross-sectional dependence, we find that in the short-run, increases in biomass and waste generation negatively affect GDP, while aggregate renewable and hydroelectricity increase GDP. Energy conservation policies will positively impact GDP, if the policies cause decreases in biomass or waste energy but increase hydroelectricity and wind energy.

A parsimonious model of tax avoidance and distortions in petroleum exploration and development

- Energy Economics---2014---James Smith

We present a simple model of petroleum exploration and development that can be applied to study the performance of alternative tax systems and identify potential distortions. Although the model is highly simplified, it incorporates many factors and some of the key tradeoffs that would influence an investor's investment behavior. The model recognizes the role of enhanced oil recovery and treats the impact of taxation on exploration and development in an integrated manner consistent with an investor's joint optimization of investments at both stages of the process. The model is simple and user-friendly, which facilitates application to a broad range of problems.

What makes carbon traders cluster their orders?

- Energy Economics---2014---Fernando Palao,Ángel Pardo

The ability to trade large amounts of assets at low costs could be hindered when the size of the orders is concentrated at specific trade sizes. This paper documents evidence of size clustering behavior in the European Carbon Futures Market and analyzes the circumstances under which it happens. Our findings show that carbon trades are concentrated in sizes of one to five contracts and in multiples of five. We have also demonstrated that more clustered prices have more clustered sizes, suggesting that price and size resolution in the European Carbon Market are complementary

and that carbon traders round both the price and the size of their orders. Finally, the analysis of the key determinants of the size clustering reveals that traders use a reduced number of different trade sizes when uncertainty is high, market liquidity is poor, and the desire to open new positions and cancel old ones is very strong.

The impact of carbon capture and storage on a decarbonized German power market

- Energy Economics---2014---S. Spiecker,V. Eichholt,C. Weber

The European energy policy is substantially driven by the target to reduce the CO₂-emissions significantly and to mitigate climate change. Nevertheless European power generation is still widely based on fossil fuels. The carbon capture and storage technology (CCS) could be part of an approach to achieve ambitious CO₂ reduction targets without large scale transformations of the existing energy system. In this context the paper investigates on how far the CCS-technology could play a role in the European and most notably in the German electricity generation sector. To account for all the interdependencies with the European neighboring countries, the embedding of the German electricity system is modeled using a stochastic European electricity market model (E2M2s). After modeling the European side constraints, the German electricity system is considered in detail with the stochastic German Electricity market model (GEM2s). The focus is thereby on the location of CCS plant sites, the structure of the CO₂-pipeline network and the regional distribution of storage sites. Results for three different European energy market scenarios are presented up to the year 2050. Additionally, the use of CCS with use of onshore and offshore sites is investigated.

Building and household X-factors and energy consumption at the residential sector

- Energy Economics---2014---Hossein Estiri

Energy use in residential buildings is one of the major sources of greenhouse gas emission production from

cities. Using microdata from the 2009 Residential Energy Consumption Survey (RECS), this study applies structural equation modeling to analyze the direct, indirect, and total impacts of household and building characteristics on residential energy consumption. Results demonstrate that the direct impact of household characteristics on residential energy consumption is significantly smaller than the corresponding impact from the buildings. However, accounting for the indirect impact of household characteristics on energy consumption, through choice of the housing unit characteristics, the total impact of households on energy consumption is just slightly smaller than that of buildings. Outcomes of this paper call for smart policies to incorporate housing choice processes in managing residential energy consumption.

Impact of the regulatory framework for transmission investments on the cost of renewable energy in the EU

- Energy Economics---2014---Marcelo Saguan,Leonardo Meeus

Under the current regulatory frame in the EU, transmission planning is done at the national level to maximize national welfare, rather than European welfare. In this paper, we develop a competitive equilibrium model that calculates the impact of this imperfect regulatory framework on the cost of renewable energy. We apply the model to a power system with two interconnected zones, and find that the impact is case specific, but significant. We also find that the negative impact of national transmission planning on the cost of renewable energy is more significant in a state of the world in which Member States trade renewable energy, but that this negative effect is much smaller than the positive effect of renewable energy trade between Member States. We conclude that the imperfect regulatory framework for transmission investment is a significant cost for renewable energy in the EU, but that it should not stop Member States from trading renewable energy.

Tail events: A new approach to understanding extreme energy commodity prices

- Energy Economics---2014---Nicolas Koch

This paper shows that extreme energy price changes, located in the 10% tails of the distribution, cluster across energy futures markets during the boom–bust cycle of 2006 to 2012. Using multinomial logit regressions, we find that the coincidence of such tail events cannot be explained solely by common supply and demand fundamentals. Instead, we provide evidence that the transmission of extreme price changes occurs through a financial demand channel. Specifically, changes in the net long position of hedge funds are associated with a significant increase in the probability of coincident large positive and negative returns across energy markets. Evidence that index investments drive tail events is limited. Further, we identify adverse shocks to speculator funding liquidity as determinant of synchronized price drops across energy markets. The likelihood of extreme negative returns in more than one market significantly increases when the TED spread rises.

The relationship between spot and futures oil prices: Do structural breaks matter?

- Energy Economics---2014---Pei-Fen Chen,Chien-Chiang Lee,Jhih-Hong Zeng

This paper examines the effect of structural breaks on the spot–futures oil prices relationship. We explore the impact of structural breaks on four critical issues, including cointegrating relationships, market efficiency under the expectation hypothesis and the no arbitrage rule, causalities, and forecasting performance of futures oil volatility. As far as our empirical results exhibit, the structural break we detect endogenously causes some influences on these issues, which is in sharp contrast to the conclusions of existing studies. Our findings offer some implications and suggestions to researchers, investors, and policymakers.

Benchmarking in the European Union Emissions Trading System: Abatement incentives

- Energy Economics---2014---Lars Zetterberg

This paper investigates abatement incentives for allowance allocation based on output and sector specific benchmarks, here called output based allocation or benchmarking. Special attention is given to updated allocation and we assume that allowances can be traded with other sectors (open cap). We confirm earlier studies that output based allocation based on ex-ante data provide the same abatement incentives as auction or grandfathering and also confirm that output based allocation with updated output and ex-ante benchmarks provides as high abatement incentives as auction, but constitutes a production subsidy. However, we also find that benchmarking with updated output and updated benchmarks reduces abatement incentives somewhat, but less so than updated grandfathering. An allocation rule where the sector cap is prescribed ex-ante, for instance based on historic emissions, and distributed to installations in proportion to their updated production preserves full abatement incentives and avoids some of the costs associated with the determination of benchmarks. However, this rule also constitutes a production subsidy, which decreases with industry concentration. If a sector is split into smaller groups each with one benchmark per sub-sector, benchmarking evolves toward grandfathering. Since benchmarking is conditioned on production, this allocation method protects production from leakage, i.e. migrating to areas where firms face no emissions cost. This may actually be the most compelling reason for choosing benchmarking.

Dynamic spillovers among major energy and cereal commodity prices

- Energy Economics---2014---Walid Mensi,Shawkat Hammoudeh,Duc Khuong Nguyen,Seong-Min Yoon

Over the past decade, the sharp increases in the prices of oil and agricultural commodities have raised serious concerns about the heightened volatility of these markets and the possible negative interactions between them. This article deals with the dynamic return and volatility spillovers across international energy and cereal commodity markets. It also examines the impacts

of three types of OPEC news announcements on the volatility spillovers and persistence in these markets. For this purpose, we make use of the VAR-BEKK-GARCH and VAR-DCC-GARCH models for the daily spot prices of eight major commodities including WTI oil, Europe Brent oil, gasoline, heating oil, barley, corn, sorghum, and wheat. Our results provide evidence of significant linkages between these energy and cereal markets. Moreover, the OPEC news announcements are found to exert influence on the oil markets as well as on the oil–cereal relationships. Finally, we show that the persistence of volatility decreases (increases) for the crude oil and heating oil (gasoline) returns after accounting for the OPEC announcements in these multivariate GARCH models. However, the results are more mixed for the cereal markets. Overall, our results can be used to improve the risk-adjusted performance by having more diversified portfolios and also serve to hedge the oil risk more effectively.

Assessment of initial emission allowance allocation methods in the Korean electricity market

- Energy Economics---2014---Jaekyun Ahn

Korea will introduce an emission trading policy from 2015. The rules for the initial allocation of emission allowances have not been decided yet. This paper assesses the effect of various initial emission allowance allocation methods of the Korean electricity market. This study employs the mixed complementarity problem, which is able to incorporate operation, investment, and emission trade decisions in the deregulated electricity market in order to provide more realistic results. In particular, the allocation rules to existing plants and new entrants are modeled separately in this study. The model quantifies the impacts of different allocation rules on emissions, capacity mix, emission allowance prices, electricity prices, and social welfare. We examine typical allocation rules such as auction to all power plants, best available technology (BAT) benchmark to all power plants, fuel-specific benchmark to existing power plants along with BAT benchmark to new entrants, and fuel-specific benchmark to all power

plants. We find that giving free allocations to new power plants prompts more new investment and this raises overall social welfare even though the direct cost of achieving the emission reduction target rises. While the auction is the most powerful policy to reduce emissions in the electricity sector, giving away permits to all power plants based on a fuel-specific benchmark encourages investment, increases output, and leads to a greater level of welfare from an imperfectly competitive industry.

Market design and supply security in imperfect power markets

- Energy Economics---2014---Sebastian Schwenen

Supply security in imperfect power markets is modelled under different market designs. In a uniform price auction for electricity with two firms, strategic behaviour may leave firms offering too few capacities and unable to supply all realized demand. Market design that relies on capacity markets increases available generation capacities for sufficiently high capacity prices and consequently decreases energy prices. However, equilibrium capacity prices are non-competitive. Capacity markets can increase security of supply, but cannot mitigate market power, which is exercised in the capacity market instead of the energy market.

Energy markets volatility modelling using GARCH

- Energy Economics---2014---Olga Efimova, Apostolos Serletis

This paper investigates the empirical properties of oil, natural gas, and electricity price volatilities using a range of univariate and multivariate GARCH models and daily data from wholesale markets in the United States for the period from 2001 to 2013. The key contribution to the literature is the estimation of trivariate BEKK and DCC models that allow us to observe spillovers and interactions among energy markets. We evaluate and compare the performance of univariate and multivariate models with a range of diagnostic

and forecast performance tests, and assess forecasting performance and conditional correlation dynamics.

The economic significance of gasoline wholesale price volatility to retailers

- Energy Economics---2014---Jedidiah Brewer,David M. Nelson,George Overstreet

We show that gasoline retailer profits heavily depend on the direction of wholesale cost movements. Using a unique, firm-level, proprietary sample of 121 U.S. gasoline retailers collectively operating over 4500 stores, we find that it tends to be only in months when wholesale prices are declining that retailers make meaningfully positive profits, and that in spite of the low profits earned when wholesale prices are increasing, over the entire wholesale price cycle, volatility is preferred by retailers to relatively stable wholesale prices. We are the first to our knowledge to link asymmetric price responses directly to firm profits and characterize the economic significance of asymmetric pricing in the retail gasoline industry. Our findings may have important implications for the scores of other industries where asymmetric retail-to-wholesale price responses are found.

Modelling the general dependence between commodity forward curves

- Energy Economics---2014---Mikhail Zolotko,Ostap Okhrin

This study proposes a novel framework for the joint modelling of commodity forward curves. Its key contribution is twofold. First, we introduce a family of dynamic conditional correlation models based on hierarchical Archimedean copulae (HAC-DCC), which are flexible but parsimonious instruments that capture a wide range of dynamic dependencies. Second, we apply these models in the context of commodity forward curves as part of the framework. An extensive Value-at-Risk analysis shows that certain HAC-DCC models consistently outperform other introduced benchmarks in terms of the preciseness of their out-of-sample distribution forecasts of the returns of various commodity

futures portfolios. This shows that the proposed modelling framework, as one of its possible applications, can be a useful and convenient risk management tool.

The relationship between energy and equity markets: Evidence from volatility impulse response functions

- Energy Economics---2014---Eric Olson,Andrew J. Vivian,Mark Wohar

This paper examines the relationship between the energy and equity markets by estimating volatility impulse response functions from a multivariate BEKK model of the Goldman Sach's Energy Index and the S&P 500; in addition, we also calculate the time varying conditional correlations and time varying dynamic hedge ratios. From volatility impulse response functions, we find that low S&P 500 returns cause substantial increases in the volatility of the energy index; however, we find only a weak response from S&P 500 volatility to energy price shocks. Moreover, our dynamic hedge ratio analysis suggests that the energy index is generally a poor hedging instrument.

The incentive to invest in thermal plants in the presence of wind generation

- Energy Economics---2014---Valeria Di Cosmo,Laura Malaguzzi Valeri

In a deregulated market, the decision to add generation rests with private investors. This paper evaluates how generator profits are affected by increasing wind generation. Using hourly historical data for the Irish Single Electricity Market, we simulate new series of electricity prices, representative plant bids and wind generation. We calibrate the model based on the negative correlation between electricity prices and wind generation. This allows us to determine that increasing wind generation induces lower profits for all baseload plants. Additionally, it decreases profits for baseload natural gas plants more than for less flexible coal-fuelled plants, which might encourage investment in less flexible plants.

The demand for road diesel in Canada

- Energy Economics---2014---Philippe Barla,Mathieu Gilbert-Gonthier,Jean-René Tagne Kuelah

In this paper, we estimate the demand for road diesel in Canada using aggregate annual data for the period 1986–2008. Using a partial adjustment model (PAM), we find short and long run price elasticities of -0.43 and -0.8 respectively. However, using cointegration techniques, we obtain price elasticities that are 30 to 50% lower. The short run elasticity with respect to GDP per capita is evaluated at 0.5 with the PAM and 1.55 with cointegration. In the long run, both estimation techniques indicate an income elasticity around 0.9. Our results underline the importance of controlling for the expansion of the primary sector which has been characterizing the Canadian economy in the 2000s.

Ethanol and trade: An analysis of price transmission in the US market

- Energy Economics---2014---Dengjun Zhang, Frank Asche,Atle Oglend

This paper examines the price transmission mechanisms between domestic ethanol and imported ethanol in the US market using a multivariate Johansen approach. The data and model support one cointegrating relationship between the prices of domestically produced ethanol, imported ethanol, and other relevant products (gasoline, crude oil, and corn). The rejection of weak exogeneity of the imported ethanol price and corn price implies that these two prices would adjust to changes in the price linkage. Those empirical findings indicate that the impact of eliminating trade barriers on the imported ethanol price would spillover to the domestic ethanol price and subsequently to corn price.

A multi-fuel, multi-sector and multi-region approach to index decomposition: An application to China's energy consumption 1995–2010

- Energy Economics---2014---Chunbo Ma

Index Decomposition Analysis (IDA) has been extensively applied in studies of energy consumption and energy-related emissions. Most have focused on the impacts of industrial structural change and technology progress and a few have also looked at inter-fuel substitution. There has been no study examining spatial aspects within an IDA setting. This paper first describes an analytical framework analyzing driving forces behind a country's changing energy consumption with special highlights on the spatial dimension and then develops an IDA model to operationalize the analytical framework. The model is applied to a panel of 29 Chinese provinces over the period of 1995–2010. It is shown that the model not only captures the impact of changes of economic and human geography but also provides valuable insights and richer information on spatial variations of other contributing factors than conventional country-level analysis.

Analyzing public preferences and increasing acceptability for the Renewable Portfolio Standard in Korea

- Energy Economics---2014---Jungwoo Shin,JongRoul Woo,Sung-Yoon Huh,Jongsu Lee,Gicheol Jeong

In order to respond to the challenge of climate change, similar to other countries, Korea has announced various policies to vitalize the development and uptake of renewable energy. The Renewable Portfolio Standard (RPS) is the most striking example of a policy in this area. This study employs a conjoint survey and Bayesian mixed logit model to analyze consumer preferences for specific attributes of the RPS policy. It analyzes households' marginal willingness to pay (MWTP) for the RPS with specific attributes and simulates the degree of household acceptability of the policy through a scenario analysis. Comparison between costs and benefits of implementing the policy is also attempted by analyzing the households' MWTP with the actual transition expense of RPS implementation incurred by electricity supply companies. The simulation results provide implications for improving RPS policy implementation; households consider the creation of new

jobs as the most important policy attribute, followed by increase in electricity prices, damage to forests, reduction in CO₂ emissions, and length of power outages. Moreover, the Korean household is willing to accept an increase of up to 1.39% in its electricity prices (relative to 2012), and the median MWTP of each household for RPS implementation is KRW 734.99/month (USD 0.67/month).

Environmental taxes and economic growth: Evidence from panel causality tests

- Energy Economics---2014---Sabah Abdullah,Bruce Morley

The aim of this study is to determine the causal relationship between environmental taxes and economic growth, using different measures of environmental taxes with GDP as well as adjusted net savings. A panel of European countries and a separate panel of OECD countries are used from 1995 to 2006 and the standard Granger non-causality approach is applied. The results suggest some evidence of long-run causality running from economic growth to increased revenue from the environmental taxes, with also some evidence of short-run causality in the reverse direction. The inclusion of population and a proxy for economic subsidies had little effect on the long-run relationship, although the proxy for subsidies did have some short-run effect on growth.

How effective are policies to reduce gasoline consumption? Evaluating a set of measures in Spain

- Energy Economics---2014---Javier Asensio,Andres Gomez-Lobo,Anna Matas

Using a panel of 48 provinces for four years we empirically analyze a series of temporary and permanent policies aimed at curbing fuel consumption implemented in Spain between March and June 2011. The first policy was a reduction in the speed limit in highways. The second policy was an increase in the biofuel content of fuels used in the transport sector. The third measure was a decrease of 5% in commuting and regional train

fares that resulted in two major metropolitan areas reducing their overall fare for public transit. The results indicate that the speed limit reduction in highways lowered gasoline consumption by 2% to 3%, while an increase in the biofuel content of gasoline increased this consumption. This last result is consistent with experimental evidence that indicates that mileage per liter falls with an increase in the biofuel content in gasolines. As for the reduction in transit fares, we do not find a significant effect for this policy. However, in specifications including the urban transit fare for the major cities in each province the estimated cross-price elasticity of the demand for gasoline – used as a proxy for car use – with respect to the price of transit is within the range reported in the literature. This is important since one of the main efficiency justifications for subsidizing public transit rests on the positive value of this parameter and most of the estimates reported in the literature are quite dated.

Implications of a lowered damage trajectory for mitigation in a continuous-time stochastic model

- Energy Economics---2014---Jon Strand

We provide counterexamples to the idea that mitigation of greenhouse gas emissions, and adaptation to climate change, are always substitutes. We consider optimal mitigation policy when climate damages follow a geometric Brownian motion process with positive drift and mitigation is lumpy. Climate damages can be affected by adaptation in two main ways: 1) reduced proportionately for given climate impact; or 2) their growth path down-shifted. In either case expectation and variance of the climate damage are both reduced by adaptation. In case 1, the variance effect (which leads to more rapid mitigation as the option value of waiting is reduced) may dominate over the expectation effect (which reduces mitigation), thus on balance increasing mitigation when damages are reduced. Mitigation and adaptation are then complements. A family of functions relating climate damage to adaptation cost in this way includes the Cobb–Douglas specification. In case 2, mitigation and adaptation are always substitutes.

Commodity futures and market efficiency

- Energy Economics---2014---Ladislav Kriřtousek, Miloslav Vořvda

We analyze the market efficiency of 25 commodity futures across various groups—metals, energies, soft commodities, grains and other agricultural commodities. To do so, we utilize the recently proposed Efficiency Index to find out that the most efficient among all of the analyzed commodities is heating oil, closely followed by WTI crude oil, cotton, wheat, and coffee. On the other end of the ranking scale we find live cattle and feeder cattle. The efficiency is also found to be characteristic for specific groups of commodities, with energy commodities being the most efficient and other agricultural commodities (composed mainly of livestock) the least efficient groups. We also discuss contributions of long-term memory, fractal dimension and approximate entropy to the total inefficiency. Last but not least, we come across the nonstandard relationship between the fractal dimension and the Hurst exponent. For the analyzed dataset, the relationship between these two variables is positive, meaning that local persistence (trending) is connected to global anti-persistence. We attribute this behavior to specifics of commodity futures: they may be predictable over a short term and locally, but over a long term they return to their fundamental prices.

Estimating welfare aspects of changes in energy prices from preference heterogeneity

- Energy Economics---2014---Panos Pashardes, Nicoletta Pashourtidou, Theodoros Zachariadis

The European Union's energy and climate policy package is expected to cause an increase in end-user prices of electricity and fuels. This paper assesses the distributional effects of these price increases in Cyprus by specifying and estimating a consumer demand system with price heterogeneity between households. This novel method allows obtaining robust parameter estimates even when household expenditure surveys are limited, as is the case in many European countries.

The empirical analysis is conducted both conditional on energy-related household characteristics and unconditionally. We then use the estimated demand system to conduct welfare analysis. We find that the rise in energy prices results in welfare losses of EUR 101 per household (in 2009 prices) in year 2020, or a nationwide welfare loss of more than EUR'2009 33 million. Price increases will be regressive and will affect small and urban households more strongly than the rest of the population. Furthermore, we find that the largest proportion of welfare loss is due to loss of household's income purchasing power caused by higher energy prices, while the changes in relative prices induce deadweight loss which is a small part of welfare loss because of the limited substitutability of energy with other goods.

Biomass feedstock contracts: Role of land quality and yield variability in near term feasibility

- Energy Economics---2014---Adaora Okwo, Valerie M. Thomas

In the absence of an infrastructure for the harvest, storage and purchase of cellulosic biomass, contracting is an important mechanism through which biorefineries can ensure adequate feedstock supply. We develop an optimization model to assess the economic potential of dedicated energy crops when profit-maximizing farmers allocate croplands of varying quality toward biomass in response to multi-year contracts. We evaluate the economic competitiveness of perennial grasses with traditional commodity crops, in a case study of switchgrass production in Tennessee. Assuming short-term contracts, we consider the importance of payment structure, land quality, energy crop yield and projected commodity crop returns on a farmer's decision to accept a contract for biomass production. We find that a wholesale contract, in which the farmer is guaranteed a price per unit biomass, is most effective on the highest quality of land, while a contract in which the farmer is guaranteed a price per acre is most effective on lower quality land. From the biorefinery perspective, a wholesale contract is most effective for short-term contracts while an acreage contract is most effective for

long-term contracts. Breakeven pricing will only secure feedstock from farmers who produce commodity crops with unfavorable price outlooks on lower quality land; therefore, the contract price must include a premium in order to compete for space in the crop mix. The yield profile of energy crops has a significant effect on the terms at which short-term contracts will be accepted and land allocated toward feedstock production. The extent to which energy crop yields observed in field trials can be maintained at commercial scale also has a substantial effect on the scale at which farmers would be willing to participate in energy crop production.

Estimating the changes in the distribution of energy efficiency in the U.S. automobile assembly industry

- Energy Economics---2014---Gale Boyd

This paper describes the EPA's voluntary ENERGY STAR program and the results of the automobile manufacturing industry's efforts to advance energy management as measured by the updated ENERGY STAR Energy Performance Indicator (EPI). A stochastic single-factor input frontier estimation using the gamma error distribution is applied to separately estimate the distribution of the electricity and fossil fuel efficiency of assembly plants using data from 2003 to 2005 and then compared to model results from a prior analysis conducted for the 1997–2000 time period. This comparison provides an assessment of how the industry has changed over time. The frontier analysis shows a modest improvement (reduction) in “best practice” for electricity use and a larger one for fossil fuels. This is accompanied by a large reduction in the variance of fossil fuel efficiency distribution. The results provide evidence of a shift in the frontier, in addition to some “catching up” of poor performing plants over time.

Can carbon taxes be progressive?

- Energy Economics---2014---Yazid Dis-sou,Muhammad Shahid Siddiqui

Most studies have assessed the distributional impact of carbon taxes through their effects on commodity

prices alone, while ignoring their impact on individual welfare brought about by changes in factor prices. Yet, the remunerations of capital and labor are not affected by these taxes similarly, and their shares in earned incomes are not uniform across households. This paper provides a comprehensive analysis of the incidence of carbon taxes on inequality by considering simultaneously the commodity and the income channels. We propose a decomposition of the change in individual welfare metrics. Then, we develop a general equilibrium model to assess the impact of carbon taxes on factor and commodity prices, and subsequently their distributional impact on households, using the Lorenz and concentration curves and the Gini index. Our results suggest that changes in factor prices and changes in commodity prices (especially those of energy commodities) have opposing effects on inequality. Carbon taxes tend to reduce inequality through the changes in factor prices and tend to increase inequality through the changes in commodity prices. Hence, we find a non-monotonic (U-shaped) relationship between carbon taxes and inequality. Our results suggest that the traditional approach of assessing the impact of carbon taxes on inequality through changes in commodity prices alone may be misleading. The findings cast light on the desirability of using both channels in the assessment of carbon taxes on inequality.

Preference heterogeneity for renewable energy technology

- Energy Economics---2014---James Yoo,Richard Ready

This study explores heterogeneity in individual willingness to pay (WTP) for a public good using several different variants of the multinomial logit (MNL) model for stated choice data. These include a simple MNL model with interaction terms between respondent characteristics and attribute levels, a latent class model, a random parameter (mixed) logit model, and a hybrid random parameter-latent class model. The public good valued was an increase in renewable electricity generation. The models consistently show that preferences over renewable technologies are heterogeneous among

respondents, but that the degree of heterogeneity differs for different renewable technologies. Specifically, preferences over solar power appear to be more heterogeneous across respondents than preferences for other renewable technologies. Comparing across models, the random parameter logit model and the hybrid random parameter-latent class model fit the choice data best and did the best job capturing preference heterogeneity.

Inter-firm collaborations on carbon emission reduction within industrial chains in China: Practices, drivers and effects on firms' performances

- Energy Economics---2014---Bin Zhang,Zhao-Hua Wang

The purpose of this paper is to explore the determinants that influence the industrial firms to cooperate on carbon emission reduction (CER) within their industrial chains. And whether the CER collaborations could improve the performance of participants is another focus of our study. This paper provides a questionnaire survey about CER inter-firm collaborations on energy intensive industries in China. Three regression models including Multiple Linear Regression, Binary Choice Model, and Ordinal Choice Regression are employed to identify the determinants that drive or impede the implementation of CER collaborations. The results show that inter-firm CER collaborations are generally at an infancy stage in China. The main driver for CER collaborations derives from the CER demands of other stakeholders in the industrial chains. And the lack of infrastructure and mechanism is the main barrier that impedes the inter-firm collaborations. Moreover, CER collaborations through industrial symbiosis play a positive role in improving economic performance. However, the effects are to a large extent related to the improved environmental performance through the CER collaborations. Our results also indicate that there is much room for industrial firms to conduct CER collaborations in China, and market tools are somewhat more effective than compulsive regulations for promoting CER collaborations.

Oil and US dollar exchange rate dependence: A detrended cross-correlation approach

- Energy Economics---2014---Juan Reboredo,Miguel A. Rivera-Castro,Gilney F. Zebende

This paper examines the relationship between oil prices and the US dollar exchange rate using detrended cross-correlation analysis. For a wide set of currencies in the periods before and since the onset of the recent global financial crisis, we characterized the oil price-exchange rate relationship at different time scales and documented two main findings. First, the cross-correlation analysis indicated that oil price-exchange rate correlations were negative and low, having in general lower values for longer time scales. Second, negative dependence between oil and the US dollar increased after the onset of the global financial crisis for all time scales, thereby providing evidence of both contagion and interdependence. This empirical evidence has important implications for monetary and fiscal policies, asset management and risk assessment.

Using real option analysis to quantify ethanol policy impact on the firm's entry into and optimal operation of corn ethanol facilities

- Energy Economics---2014---Christian Maxwell,Matt Davison

Ethanol crush spreads are used to model the value of a facility which produces ethanol from corn. A real option analysis is used to investigate the effects of model parameters on the related managerial decisions of (i) how to operate the facility through optimal switching from idled to operational status and (ii) the decision to enter into the project given its expected real option net present value. We present evidence of increased correlation between corn and ethanol prices, perhaps as a result of government policy which has induced more players to enter into the market. This paper investigates the subsequent negative effects on firms. Further, this paper illustrates the impact of an abrupt change in government policy, as what happened in January 2012, on a firm's decision to enter the business.

Causality and predictability in distribution: The ethanol–food price relation revisited

- Energy Economics---2014---Andrea Bastianin, Marzio Galeotti, Matteo Manera

This paper examines the relationship between biofuels, field crops and cattle prices in the U.S. from a new perspective. We focus on predictability in distribution by asking whether ethanol returns can be used to forecast different parts of field crops and cattle returns distribution, or vice versa. Density forecasts are constructed using Conditional Autoregressive Expectile models estimated with Asymmetric Least Squares. Forecast evaluation relies on quantile-weighted scoring rules, which identify regions of the distribution of interest to the analyst. Results show that both the centre and the left tail of the ethanol returns distribution can be predicted by using field crops returns. On the contrary, there is no evidence that ethanol can be used to forecast any region of the field crops or cattle returns distributions.

Energy intensity: A decomposition and counterfactual exercise for Latin American countries

- Energy Economics---2014---Raul Jimenez, Jorge Mercado

This paper investigates trends in energy intensity over the last 40 years. Based on a sample of 75 countries, it applies the Fisher Ideal Index to decompose the energy intensity into the relative contributions of energy efficiency and economic structure. Then, the determinants of these energy indexes are examined through panel data regression techniques. Special attention is lent to Latin American countries (LAC) by comparing its performance to that of a similar set of countries chosen through the synthetic control method. When analyzed by income level, energy intensity has decreased in a range between 40 and 54% in low and medium income countries respectively. Efficiency improvements drive these changes, while the structural effect does not represent a clear source of change. The regression analysis

shows that per capita income, petroleum prices, fuel-energy mix, and GDP growth are main determinants of energy intensity and efficiency, while there are no clear correlations with the activity component. In the case of LAC the energy intensity decreased around 20% which could be interpreted as an under-performance. However, the counterfactual exercise suggests that LAC has closed the gap with respect to its synthetic control.

Oil price fluctuation, volatility spillover and the Ghanaian equity market: Implication for portfolio management and hedging effectiveness

- Energy Economics---2014---Boqiang Lin, Presley K. Wesseh, Michael Owusu Appiah

This study attempts to contribute to the literature on stock markets and energy prices by examining the dynamic volatility and volatility transmission between oil and Ghanaian stock market returns in a multivariate setting using the recently developed VAR–GARCH, VAR–AGARCH and DCC–GARCH frameworks. In turn, the models' results are used to compute and analyze the optimal weights and hedge ratios for oil-stock portfolio holdings. For comparison purposes and to put the paper more in the perspective of West Africa, the Nigerian stock market is also included in the analysis. Our findings point to the existence of significant volatility spillover and interdependence between oil and the two stock market returns. While spillover effects are stronger for Nigeria, the transmission of volatility is much more apparent from oil to stock than from stock to oil in the case of Ghana. Also, the study demonstrates evidence of short-term predictability in oil and stock price changes through time and reveals that conditional volatility changes more rapidly as result of substantial effects of past volatility rather than past news/shocks for all market returns. Moreover, we show that there is a slightly more effective hedge in the two stock markets under the DCC–GARCH framework (our preferred model) compared to the other two models, although hedging effectiveness is much greater for Ghana. On the whole, our findings for optimal hedge ratios are consistent with other studies and particularly the view that oil assets should be an integral part of a

diversified portfolio of stocks and suggest that a better understanding of volatility links is crucial for portfolio management in the presence of oil price risk. Finally, the existence of multivariate asymmetric effects and dynamic conditional correlations as revealed by the VAR-AGARCH and DCC-GARCH models make it clear that the assumptions of symmetric effects and constant conditional correlations are not supported empirically.

Evaluating the impacts of priority dispatch in the European electricity market

- Energy Economics---2014---G. Oggioni,F.H. Murphy,Y. Smeers

This paper compares the impact of the Nodal Pricing and European Market Coupling organizations on different economic agents of the power system under two main wind policies. Under the “priority dispatch” policy, Transmission System Operators (TSOs) must accommodate all wind energy produced, which thus has the priority over energy produced by conventional plants; in the “no priority dispatch” policy, TSOs can decide not to inject all potential wind power in the grid in order to limit congestion problems. The effects of these two wind policies are measured by developing simple stochastic programming models that consider cases with different wind penetration levels, existing capacities and endogenous investments, as well as assumptions on the EU-ETS.

Cost–benefit analysis under uncertainty — A note on Weitzman’s dismal theorem

- Energy Economics---2014---John Horowitz,Andreas Lange

Weitzman’s (2009) famous dismal theorem argues that “fat tails” in the distribution of warming may pose problems for cost–benefit analysis as it may imply that society might be willing to exchange today’s consumption for future consumption at an infinite rate. His analysis is based on the stochastic discount factor. We show that in situations in which the stochastic discount factor is applicable, it is optimal for society to devote

only a finite amount of resources to protect against climate change. For general assumptions on the investment returns, cost–benefit analysis must consider the joint distribution of the marginal utility of future consumption and marginal returns to investment in the different future states of nature. We explore the range of situations under which challenges for applying cost–benefit analysis under uncertainty remain.

Will economic restructuring in China reduce trade-embodied CO2 emissions?

- Energy Economics---2014---Tianyu Qi,Niven Winchester,Valerie Karplus,Xiliang Zhang

We calculate carbon dioxide (CO₂) emissions embodied in China’s net exports using a multi-regional input–output database. We find that the majority of China’s export-embodied CO₂ is associated with production of machinery and equipment rather than energy-intensive products, such as steel and aluminum. In 2007, the largest net recipients of embodied CO₂ emissions from China include the EU (360millionmetric-tons, mmt), the US (337mmt) and Japan (109mmt). Overall, annual CO₂ emissions embodied in China’s net exports totaled 1177mmt, equal to 22% of China’s total CO₂ emissions. We also develop a global general equilibrium model with a detailed treatment of energy and CO₂ emissions. We use the model to analyze the impact of a sectoral shift in the Chinese economy away from industry and towards services, both without and with a decrease in China’s trade surplus, and a tax on energy-intensive exports, which reflect policy objectives in China’s Twelfth Five-Year Plan (2011–2015). We find that without a decrease in the trade surplus, both policies will have a limited impact on China’s net exports of embodied CO₂ emissions. The policies have an even smaller effect on global emissions, as reduced production in China is partially offset by increased production elsewhere.

Modelling the redirection of technical change: The pitfalls of incorporeal visions of the economy

- Energy Economics---2014---Antonin Pottier,Jean-Charles Hourcade,Etienne Espagne

This paper discusses attempts to represent the role of R&D in the transition towards a low carbon economy through models with no meaningful granularity to inform the studied phenomenon. By means of a critical analysis of (Acemoglu et al., 2012), we show that the advantage of these models, their analytical tractability, does not make up for their disadvantages, lack of control over policy implications and questionable numerical results. On the one hand, a comprehensive analysis of the results of Acemoglu et al. (2012) shows that even research subsidies do not pave the way for ambitious climate policies with low transitory costs, thus contradicting their policy message. On the other hand, critical parameters such as the elasticity of substitution between clean and dirty technologies, carbon sinks, or the productivity of researchers are not in accordance with existing scientific knowledge. We show that using more realistic parameters leads to even more pessimistic conclusions and that their model provides no leeway for overcoming them. We suggest that a too highly aggregated model can only describe an incorporeal economy and comes to a deadlock. We propose a more promising route for economic research in order to break this deadlock.

When to invest in carbon capture and storage technology: A mathematical model

- Energy Economics---2014---Darragh Walsh,O'Sullivan, K.,W.T. Lee,M.T. Devine

We present two models of the optimal investment decision in carbon capture and storage technology (CCS)—one where the carbon price is deterministic (based on the newly introduced carbon floor price in Great Britain) and one where the carbon price is stochastic (based on the ETS permit price in the rest of Europe). A novel feature of this work is that in both models investment costs are time dependent which adds an extra dimension to the decision problem. Our deterministic model allows for quite general dependence on carbon price and consideration of time to build and simple calculus techniques determine the optimal time to invest. We then analyse the effect of carbon price volatility on the optimal investment decision by solving a Bellman

equation with an infinite planning horizon. We find that increasing the carbon price volatility increases the critical investment threshold and that adoption of this technology is not optimal at current prices, in agreement with other works. However reducing carbon price volatility by switching from carbon permits to taxes or by introducing a carbon floor as in Great Britain would accelerate the adoption of carbon abatement technologies such as CCS.

Renewable energy, output, CO2 emissions, and fossil fuel prices in Central America: Evidence from a nonlinear panel smooth transition vector error correction model

- Energy Economics---2014---Nicholas Apergis,James Payne

This study examines the determinants of renewable energy consumption per capita for a panel of seven Central American countries over the period 1980 to 2010. Specifically, we find that a long-run cointegrated relationship exists between renewable energy consumption per capita, real GDP per capita, carbon emissions per capita, real coal prices, and real oil prices with the respective coefficients positive and statistically significant. A structural break in the cointegrating relationship appears in 2002 which coincides with the establishment of the Energy and Environment Partnership with Central America initiative to expand the use of renewable energy sources. Recognizing the regime shift in 2002, we estimate a nonlinear panel smooth transition vector error correction model to show that for the post-2002 period, the influence of renewable energy consumption per capita upon real coal and oil prices strengthened relative to the pre-2002 period as well as a greater sensitivity of real GDP per capita to carbon emissions per capita.

Near-term limits to mitigation: Challenges arising from contrary mitigation effects from indirect land-use change and sulfur emissions

- Energy Economics---2014---Katherine Calvin,Marshall Wise,Leon Clarke,James Edmonds,Andrew Jones,Allison Thomson

We explore the implications of potentially counteractive greenhouse gas mitigation responses to carbon prices and the complications that could ensue for limiting radiative forcing in the near-term. Specifically we consider the problem of reproducing the radiative forcing pathway for Representative Concentration Pathway, RCP4.5, which stabilizes radiative forcing at 4.5Wm^{-2} (650ppm CO₂-e) under a different terrestrial policy assumption. We show that if indirect land-use change emissions are not priced, carbon prices that can replicate this pathway in the near-term may not exist. We further show that additional complexities could emerge as a consequence of the co-production of CO₂ and sulfur emissions as byproducts of fossil fuel combustion.

Examining the regional pattern of renewable energy CDM power projects in India

- Energy Economics---2014---Aparna Sawhney,M. Rahul

India is one of the leading host countries of Clean Development Mechanism (CDM) projects, but these projects have been concentrated within ten states of the country. While the skewed distribution of CDM projects across countries is well recognized, little attention has been given to the skewed distribution of CDM projects within a country like India. We examine the different factors that account for the regional distribution of renewable energy based CDM power projects in India using state-specific and renewable form-specific explanatory variables including natural potential, economic conditions, and government policies. We find that state implementation of fiscal incentive measures and CDM benefit-sharing were the most significant factors in locating these projects within the states, apart from natural renewable potential. In the top ten states, controlling for the government incentives and subsidies, the pre-installed renewable power capacity was also a significant factor. State financial incentives and CDM benefit clause were also found to be the most significant factor in the generation of certified emission reductions from CDM projects. Unfortunately states with relatively higher natural potential lost out on the additional product gains through CERs, and an im-

portant aspect of the CDM approach seems to have been missed in India — that of promoting development in other regions of the country which had natural potential.

On the environmental, economic and budgetary impacts of fossil fuel prices: A dynamic general equilibrium analysis of the Portuguese case

- Energy Economics---2014---Alfredo Pereira,Rui Pereira

This paper examines the influence of fossil fuel prices on carbon dioxide emissions, economic activity, and the public sector account in Portugal. It uses a dynamic general equilibrium model which highlights the mechanisms of endogenous growth and includes a detailed modeling of the public sector. Fuel price scenarios are based on forecasts by the US Department of Energy (DOE-US), the International Energy Agency (IEA-OECD) and IHS Global Insight Inc. The differences in relative fuel prices among the three scenarios lead to substantially different environmental impacts. Higher fuel prices in the DOE-US scenario lead to a 10.2% reduction in the policy effort required to meet the EU 2020 emission targets, while relative price changes in the IEA-OECD scenario result in a 19.2% increase in the required policy effort and decreasing fuel prices increase the emissions deficit by 95.9% under the IHS scenario. In terms of the long term economic impacts, our results suggest a 2.2% reduction in GDP in the DOE-US scenario and 1.9% in the IEA-OECD scenario and an increase of 1.4% in the IHS scenario. As to the budgetary impact, higher fuel prices lead to lower tax revenues, which, coupled with a reduction in public spending translates to lower public deficits. From a methodological perspective, our results highlight the importance of the mechanisms of endogenous growth. A scenario of higher fuel prices would, under exogenous economic growth assumptions, result in larger baseline emissions growth, substantially smaller economic effects, and rather different budgetary effects. From a policy perspective, our results highlight the importance of fossil fuel prices in defining the level of policy intervention required for compliance with international

and domestic climate change legislation.

Scenarios for Russia's natural gas exports to 2050

- Energy Economics---2014---Sergey Paltsev

Russia is an important energy supplier as it holds the world's largest natural gas reserves and it is the world's largest exporter of natural gas. Despite a recent reduction in Russia's exports to Europe, it plans to build new pipelines. We explore the long-term (up to 2050) scenarios of Russian natural gas exports to Europe and Asia using the MIT Emissions Prediction and Policy Analysis (EPPA) model, a computable general equilibrium model of the world economy. We found that over the next 20–40 years natural gas can still play a substantial role in Russian exports and there are substantial reserves to support a development of the gas-oriented energy system both in Russia and in its current and potential gas importers. Based on the considered scenarios, Russia does not need any new pipeline capacity to the EU unless it wants to diversify its export routes to supply the EU without any gas transit via Ukraine and Belarus. Asian markets are attractive to Russian gas and substantial volumes may be exported there. Relatively cheap shale gas in China may sufficiently alter the prospects of Russian gas, especially in Asian markets. In the Reference scenario, exports of natural gas grow from Russia's current 7Tcf to 11–12Tcf in 2030 and 13–14Tcf in 2050. Alternative scenarios provide a wider range of projections, with a share of Russian gas exports shipped to Asian markets rising to more than 30% by 2030 and almost 50% in 2050. Europe's reliance on LNG imports increases, while it still maintains sizable imports from Russia.

Photovoltaic power stations in Germany and the United States: A comparative study by data envelopment analysis

- Energy Economics---2014---Toshiyuki Sueyoshi, Mika Goto

This study compares Photovoltaic (PV) power stations between Germany and the United States to examine

which country more efficiently provides renewable energy in their usages. For the comparative analysis, this study utilizes Data Envelopment Analysis (DEA) as a methodology to evaluate the performance of PV power stations from the perspective of both solar and land usages. A total of one hundred sixty PV power stations (eighty in Germany and eighty in the United States) are used for this comparison. The demand for sustainable energy and energy security has been rapidly increasing over the past decade because of concerns about environment and limited resources. PV solutions are one of many renewable technologies that are being developed to satisfy a recent demand of electricity. Germany is the world's top installer and consumer of PV power and the United States is one of the top five nations. Germany leads the way in installed PV capacity even though the nation has less solar resources and land area. Due to limited solar resources, low insolation and sunshine, and land area, the United States should have a clear advantage over Germany. However, the empirical result of this study exhibits that PV power stations in Germany operate more efficiently than those of the United States even if the latter has many solar and land advantages. The surprising result indicates that the United States has room for improvement when it comes to utilizing solar and land resources and needs to reform the solar policy. For such a purpose, Feed-In Tariff (FIT) may be an effective energy policy at the state level in the United States because the FIT provides investors such as utility companies and other types of energy firms with financial incentives to develop large PV power stations and generation facilities for other renewable energy. It may be true that the FIT is a powerful policy tool to promote PV and other renewable installation and support a reduction of an amount of greenhouse gases. However, the FIT poses a large financial burden to consumers with a massive increase in renewable energy installation like in Germany and Spain. Therefore, it is necessary for the United States to consider how to align a policy with a speed of technology innovation to balance between the benefit and the cost derived from the policy implementation on renewable energy. In addition, this study discusses policy issues regarding cost allocation due to

FIT among stakeholders related to the electric power industry. At the end, this study proposes a new type of wholesale electricity market that provides simultaneous trading on electricity and greenhouse gas emissions by fully utilizing modern computer science technology that exists in universities and national laboratories of the United States.

Time-varying Granger causality tests for applications in global crude oil markets

- Energy Economics---2014---Feng-bin Lu, Yong-miao Hong, Shou-yang Wang, Kin-keung Lai, John Liu

This paper proposes time-varying Granger causality tests based on the tests developed by Hong (2001) and two dynamic correlation estimators (i.e., rolling correlation and dynamic conditional correlation multivariate GARCH), here called the rolling Hong and DCC-MGARCH Hong tests, respectively. The proposed tests are used to examine time-varying information spillover among global crude oil markets. The results provide empirical evidence of time-varying information spillover. In particular, the instantaneous causal effects of Dubai and Tapis crudes on Brent and WTI become stronger when a major event or events occur in major oil-producing countries. Such events include the Iraq War in March 2003, OPEC's announcement of a record production cut in December 2008, and the Libyan civil war in early 2011. And consistent with previous studies, WTI and Brent play dominant roles in global crude markets. Impulse response analysis shows that market information has a positive influence on the spillover effect in global crude oil markets. Moreover, the DCC-MGARCH Hong test consistently leads the rolling Hong test, which indicates that the former performs better.

Investment strategy for sustainable society by development of regional economies and prevention of industrial pollutions in Japanese manufacturing sectors

- Energy Economics---2014---Toshiyuki Sueyoshi, Mika Goto

A balance between industrial pollution prevention and economic growth becomes a world-wide issue to develop a sustainable society in many industrial nations. To discuss the issue, this study proposes a new use of DEA environmental assessment to determine how to effectively allocate capital for developing regional industries. The amount of capital is used to invest for technology innovation for both local economic growth and environmental protection. In this study, the proposed approach separates outputs into desirable and undesirable categories. Inputs are also separated into two categories, one of which indicates an amount of investment on capital assets. The other category is used for production activities. The proposed approach unifies them by two disposability concepts. This study has evaluated the performance of manufacturing industries in 47 prefectures (local government units in Japan) by Unified Efficiency under Natural disposability (UEN), Unified Efficiency under Managerial disposability (UEM) and Unified Efficiency under Natural and Managerial disposability (UENM). The UENM is further separated into its two cases: with and without a possible occurrence on desirable congestion, or technology innovation, on undesirable outputs. This study has empirically confirmed that Japanese manufacturing industries need to make their efforts to reduce greenhouse gas emissions and air pollution substances by investing in technology innovation. Furthermore, most of economic activities are currently located at metropolitan regions (e.g., Tokyo) in Japan. To develop a sustainable society, Japan needs to allocate capital into regions with a high level of investment effectiveness by shifting the manufacturing industries from the metropolitan regions to much promising local areas identified in this study. Such a shift, along with technology innovation, makes it possible to reduce air pollutions in the entire Japan by balancing economic growth and pollution prevention. This empirical study confirms that the proposed approach is useful in both guiding regional planning and developing a sustainable society. It is easily envisioned that the proposed approach is useful for not only Japan but also the other industrial and developing nations.

Willingness to pay for vehicle-to-grid (V2G) electric vehicles and their contract terms

- Energy Economics---2014---George Parsons,Michael K. Hidrue,Willett Kempton,Meryl P. Gardner

Vehicle-to-grid (V2G) electric vehicles can return power stored in their batteries back to the power grid and be programmed to do so at times when the grid needs reserve power. Since providing this service can lead to payments to owners, it effectively reduces the life-cycle cost of owning an electric vehicle. Using data from a national stated preference survey, this paper presents a study of the potential consumer demand for V2G electric vehicles. In a choice experiment, 3029 respondents compared their preferred gasoline vehicle with two V2G electric vehicles. The V2G vehicles were described by a set of electric vehicle attributes and V2G contract requirements such as “required plug-in time” and “guaranteed minimum driving range” . The contract requirements specify a contract between drivers and a power aggregator for providing reserve power to the grid. Our findings suggest that the V2G concept is most likely to help EVs on the market if power aggregators operate either on pay-as-you-go basis (more pay for more service provided) or provide consumers with advanced cash payment (upfront discounts on the price of EVs), rather than imposing fixed requirements on participants.

Bidirectional causality in oil and gas markets

- Energy Economics---2014---Marketa Wolfe,Robert Rosenman

Do events in the natural gas market cause repercussions in the crude oil market? This paper studies linkages between the two markets using high-frequency, intraday oil and gas futures prices. By analyzing the effect of weekly oil and gas inventory announcements on price volatility, we show a bidirectional causal relationship. Both inventory gluts and shortages have a cross-commodity effect on price volatility not only for the next-month nearby futures contract but also for the following six months' contracts.

Dependence and extreme dependence of crude oil and natural gas prices with applications to risk management

- Energy Economics---2014---Riadh Aloui,Mohamed Ben Aissa,Shawkat Hammoudeh,Duc Khuong Nguyen

In this article, we show how the copula-GARCH approach can be appropriately used to investigate the conditional dependence structure between the crude oil and natural gas markets as well as to derive implications for portfolio risk management in extreme economic conditions. Using daily price data from January 1997 to October 2011, our in-sample results show evidence of asymmetric dependence between the two markets. The crude oil and gas markets tend to comove closely together during bullish periods, but not at all during bearish periods. Moreover, taking the extreme comovement into account leads to an improvement in the accuracy of the out-of-sample Value-at-Risk forecasts.

How do OPEC news and structural breaks impact returns and volatility in crude oil markets?

Further evidence from a long memory process

- Energy Economics---2014---Walid Mensi,Shawkat Hammoudeh,Seong-Min Yoon

Since its formation, OPEC through its conference decisions has been a major player in the world oil markets. The purpose of this paper is to examine the impacts of OPEC's different news announcements on the conditional expectations and volatility of crude oil markets in the presence of long memory and structural changes. To do so, we first discern OPEC's oil production behavior in response to its “cut” , “maintain” , and “increase” decisions. Then by applying the ARMA–GARCH class models to the two global benchmarks WTI and Brent over the period May 1987 through December 2012, we find strong evidence of long memory. The empirical evidence also shows that OPEC's announcements especially the “cut” and the “maintain” decisions have a significant effect on both returns and volatility of the crude oil markets,

particularly that of the WTI. Moreover, we explore the possibility of structural breaks in the crude oil prices and detect five (six) breakpoints for the WTI (Brent) oil markets. The presence of structural breaks reduces the persistence of volatility. Accounting for OPEC's scheduled news announcements in the presence of structural changes reduces the degree of volatility persistence and enhances the understanding of this volatility in the oil markets. These results have several implications for policy makers, oil traders and other participants in the crude oil markets.

The economics of exploiting gas hydrates

- Energy Economics---2014---Lena-Katharina Döpke,Till Requate

We investigate the optimal exploitation of methane hydrates, a recent discovery of methane resources under the sea floor, mainly located along the continental margins. Combustion of methane (releasing CO₂) and leakage through blow-outs (releasing CH₄) contribute to the accumulation of greenhouse gases. A second externality arises since removing solid gas hydrates from the sea bottom destabilizes continental margins and thus increases the risk of marine earthquakes. We show that in such a model three regimes can occur: i) resource exploitation will be stopped in finite time, and some of the resource will stay in situ, ii) the resource will be used up completely in finite time, and iii) the resource will be exhausted in infinite time. We also show how to internalize the externalities by policy instruments.

Oil price shocks and stock market returns:

Evidence for some European countries

- Energy Economics---2014---Juncal Cuñado,Fernando Pérez de Gracia

In this paper we examine the impact of oil price shocks on stock returns in 12 oil importing European economies using Vector Autoregressive (VAR) and Vector Error Correction Models (VECM) for the period 1973:02–2011:12. We propose an alternative oil price shock specification that takes into account both world

oil production and world oil prices in order to disentangle oil supply and oil demand shocks. We find that the response of the European real stock returns to an oil price shock may differ greatly depending on the underlying causes of the oil price change. The results suggest the existence of a negative and significant impact of oil price changes on most European stock market returns. Furthermore, we find that stock market returns are mostly driven by oil supply shocks.

The timeline of trading frictions in the European carbon market

- Energy Economics---2014---Vicente Medina,Ángel Pardo,Roberto Pascual

During its trial phase (Phase I), the EU Greenhouse Gas Emission Trading Scheme (EU-ETS) collapsed because of an over-allocation of emission allowances. We evaluate the progress of this market from the trial phase to the next commitment period (Phase II) from a microstructure angle. We show that trading frictions, as measured by the relative spread, information-asymmetry risk, and market-making profits decreased from Phase I to Phase II. Although volatility decreased, its noise-related component gained in importance at the expense of its information-related component, resulting in lower quality of the price changes.

On oil investment and production: A comparison of production sharing contracts and buyback contracts

- Energy Economics---2014---Zhuo Feng,Shui-Bo Zhang,Ying Gao

Production sharing contracts (PSCs) and buyback contracts are two important contract modes in the upstream oil industry. In this paper, we build a theoretical model to compare investment and production levels under these two contracts. Our model results show that PSCs lead to higher investment levels than buyback contracts. Moreover, investment level increases with international oil companies' (IOCs') share under buyback contracts. The comparison of optimal oil production depends on IOCs' share under PSCs

and the host government's marginal operating costs from oil production under buyback contracts. When IOCs' share of gross revenues or the host government's marginal operating costs are low, optimal oil production is higher under buyback contracts; otherwise, optimal oil production is higher under PSCs. Based on such a comparison, we investigate the host government's best decisions on revenue division under these two contract types. We demonstrate that optimal share ratios exist for the host government to obtain maximum oil revenues under both contract types. We also find that under both contracts the discount factor and oil price positively affect optimal investment and production levels, respectively. Our results can provide policy implications for the host government when selecting upstream oil contracts in international oil cooperation.

Volatility forecasting and risk management for commodity markets in the presence of asymmetry and long memory

- Energy Economics---2014---Walid Chkili,Shawkat Hammoudeh,Duc Khuong Nguyen

This paper explores the relevance of asymmetry and long memory in modeling and forecasting the conditional volatility and market risk of four widely traded commodities (crude oil, natural gas, gold, and silver). A broad set of the most popular linear and nonlinear GARCH-type models is used to investigate this relevancy. Our in-sample and out-of-sample results show that volatility of commodity returns can be better described by nonlinear volatility models accommodating the long memory and asymmetry features. In particular, the FIAPARCH model is found to be the best suited for estimating the VaR forecasts for both short and long trading positions. This model also gives for all four commodities the lowest number of violations under the Basel II Accord rule, given a risk exposure at the 99% confidence level. Several implications for commodity market risks, policy regulations and hedging strategies can be drawn from the obtained results.

Access to natural gas storage facilities: Strategic and regulation issues

- Energy Economics---2014---Edmond Baranes,François Mirabel,Jean-Christophe Poudou

In this paper, we analyze the strategic function of gas storage focusing on how gas storage decisions impact competition between gas companies on both spot and downstream markets. Using a two-tier oligopolistic structure, we first show that gas storage is actually used strategically even in a symmetric oligopolistic setting along the gas value chain. Storage is then a way to intensify competition on the spot market. Second, we analyze the setting where a company has favored access to storage, for example due to a historical monopolistic position, and we analyze this as a leadership situation in the context of TPA regulation. We then show that this setting compels the leader to adopt a strategic storage decision. This strategy consists of levels of gas stored being greater than supplies available in the downstream market. Such a leader decision is part of a strategy to raise a rival's costs. Furthermore, one can think that optimal regulation of the access to storage facilities would prevent such a behavior. However, especially when storage is not too costly, we show that preventing a storage strategy for the leader is not optimal, since the strategy helps to reduce the spot market price.

Oil demand shocks reconsidered: A cointegrated vector autoregression

- Energy Economics---2014---Marek Kolodziej,Robert Kaufmann

We reconsider the conclusions about the importance of oil demand shocks and the unimportance of supply shocks reported by Kilian (2009). We investigate whether the proxy for worldwide real economic activity, dry bulk maritime freight costs, represents anything more than transportation costs by analyzing the relation between these costs and oil prices. The meaning of this variable is critical because transportation costs appear on both sides of the equations estimated by Kilian,

directly as dry bulk maritime freight costs and as part of the measure for oil prices. We also investigate the effects of representing oil supply with an aggregate of OPEC and non-OPEC production because they likely use different criteria to chose output. Finally we investigate Kilian's use of the first difference of supply while the other variables in his model are represented as levels. The results suggest that OPEC and nonOPEC nations use different criteria to set output and that reductions (increases) in OPEC production raise (lower) oil prices. The elements of the cointegrating relations, their loadings, and impulse response functions suggest that the positive relation between dry bulk maritime freight costs and oil prices simply represents the effect of higher oil prices on transportation costs. Sensitivity analyses suggest that these differences are caused by including transportation costs in the measure of oil prices, aggregating OPEC and non-OPEC productions, and using a very long lag length to estimate the VAR. Together, these results suggest that conclusions about the importance of demand shocks and the unimportance of supply shocks are not robust to alternative specifications that are consistent with many empirical findings about the world oil market.

Energy consumption and output: Evidence from a panel of 14 oil-exporting countries

- Energy Economics---2014---Hassan Mohammedi,Shahrokh Parvaresh

We examine the long-run relation and short-run dynamics between energy consumption and output in a panel of 14 oil-exporting countries over 1980–2007. Panel unit root tests, which account for common cross-sectional factors, fail to reject non-stationarity in both variables. Thus, we explore their long-run relation and short-run dynamics using three alternative panel estimation techniques — dynamic fixed effect, pooled and mean-group estimators before and after accounting for common cross-sectional factors. These estimators allow for various degrees of heterogeneity in long-run parameters and short-run dynamics. The results based on the mean group estimator with common correlated effects suggest (a) a stable relation between energy

consumption and output; (b) bi-directional causality in both long- and short-run; and (c) the robustness of the long-run causality results to the inclusion of additional variables. As such, environmental policies designed to curtail energy may have significant long-run ramifications for economic growth, and policies designed to promote economic growth may have adverse environmental consequences.

Energy intensity developments in 40 major economies: Structural change or technology improvement?

- Energy Economics---2014---Sebastian Voigt,Enrica De Cian,Michael Schymura,Elena Verdolini

This study analyzes energy intensity trends and drivers in 40 major economies using the WIOD database, a novel harmonized and consistent dataset of input–output table time series accompanied by environmental satellite data. We use logarithmic mean Divisia index decomposition to (1) attribute efficiency changes to either changes in technology or changes in the structure of the economy, (2) study trends in global energy intensity between 1995 and 2007, and (3) highlight sectoral and regional differences. For the country analysis we apply the traditional two factor index decomposition approach, while for the global analysis we use a three factor decomposition which includes the consideration of regional structural changes in the global economy. We first show that heterogeneity within each sector across countries is high. These general trends within sectors are dominated by large economies, first and foremost the United States. In most cases, heterogeneity is lower within each country across the different sectors. Regarding changes of energy intensity at the country level, improvements between 1995 and 2007 are largely attributable to technological change while structural change is less important in most countries. Notable exceptions are Japan, the United States, Australia, Taiwan, Mexico and Brazil where a change in the industry mix was the main driver behind the observed energy intensity reduction. At the global level we find that despite a shift of the global economy to more

energy-intensive countries, aggregate energy efficiency improved mostly due to technological change.

How do the stock prices of new energy and fossil fuel companies correlate? Evidence from China

- Energy Economics---2014---Xiaoqian Wen,Yanfeng Guo,Yu Wei,Dengshi Huang

This study documents the return and volatility spillover effect between the stock prices of Chinese new energy and fossil fuel companies using the asymmetric BEKK model. Based on daily samples taken from August 30, 2006 to September 11, 2012, the dynamics of new energy/fossil fuel stock spillover are found to be significant and asymmetric. Compared with positive news, negative news about new energy and fossil fuel stock returns leads to larger return changes in their counter assets. News about both new energy and fossil fuel stock returns spills over into variances of their counter assets, and the volatility spillovers depend complexly on the respective signs of the return shocks of each asset. The empirical results demonstrate that new energy and fossil fuel stocks are generally viewed as competing assets, that positive news about new energy stocks could affect the attractiveness of fossil fuel stocks and that new energy stock investment is more speculative and riskier than fossil fuel stock investment. These results have potential implications for asset allocation, financial risk management and energy policymaking.

Technology spillovers embodied in international trade: Intertemporal, regional and sectoral effects in a global CGE framework

- Energy Economics---2014---Ramiro Parado,Enrica De Cian

This paper uses a dynamic Computable General Equilibrium (CGE) model to assess the intertemporal and spatial dimension of technology spillovers embodied in international trade. Three are the main contributions of the study. First, link capital- and energy-productivity to machinery and equipment (M&E) imports using an empirical estimated relationship. Second, analyze the implications of specific spillovers em-

bodied in trade of M&E. Third, analyze the interaction of climate and trade policies when accounting for indirect effects induced by spillovers. We find that explicitly modeling trade spillovers reveals significant effects thanks to the transmission mechanisms underlying imports of M&E. We then assess the net contribution of modeling trade spillovers within three policy scenarios. The aggregated net effects of spillovers are rather small confirming findings from previous studies. However, international and intersectoral redistribution effects can be significant.

CO2 emissions from household consumption in India between 1993–94 and 2006–07: A decomposition analysis

- Energy Economics---2014---Aparna Das,Saikat Kumar Paul

CO2 emission from anthropogenic activities is one of the major causes of global warming. India being an agriculture dependent country, global warming would mean monsoon instability and consequent food scarcity, natural disasters and economic concerns. However with proper policy interventions, CO2 emissions can be controlled. Input–output analysis has been used to estimate direct and indirect CO2 emissions by households for 1993–94, 1998–99, 2003–04 and 2006–07. Complete decomposition analysis of the changes in CO2 emissions between 1993–94 and 2006–07 has been done to identify the causes into pollution, energy intensity, structure, activity and population effects according to broad household consumption categories. Results indicate that activity, structure and population effects are the main causes of increase in CO2 emission from household fuel consumption. To identify the causes at the sectoral level a second decomposition has been done for changes between 2003–04 and 2006–07 to identify the causes in the next stage. Finally alternative energy policy options have been examined for each consumption category to reduce emissions. Combined strategies of technology upgradation, fuel switching and market management in order to reduce CO2 emissions for sectors like Batteries, Other non-electrical machinery, Construction and Electronic equipments

(including Television), for which all the effects are positive, need to be adopted.

When energy storage reduces social welfare

- Energy Economics---2014---Ramteen Sioshansi

This paper examines the potential welfare effects of storage under different market structures. This includes combinations of perfectly competitive and strategic generation and storage sectors, and standalone and generator-owned storage. We demonstrate that if the generation sector is perfectly competitive and does not own storage, then storage cannot be welfare-diminishing. Otherwise, generator-owned storage or standalone storage in a market with strategic generating firms can reduce welfare compared to the no-storage case. This contradicts conventional wisdom that adding firms to an imperfectly competitive market typically reduces welfare losses.

Oil price risk exposure: The case of the U.S. Travel and Leisure Industry

- Energy Economics---2014---Sunil Mohanty,Mohan Nandha,Essam Habis,Eid Juhabi

We investigate the oil price risk exposure of the U.S. Travel and Leisure industry. In this paper, we utilize the Fama–French–Carhart’s (1997) four-factor asset pricing model augmented with oil price risk factor. The results of our study suggest that oil price sensitivities vary significantly across six subsectors: airlines, gambling, hotels, recreational services, restaurants and bars, and travel & tourism. The extent of the exposure is generally negative, but it is particularly significant for a number of subsectors including airlines, recreational services and restaurants and bars. We also document that oil price risk exposures vary considerably over time. In particular, the 2007–2009 recession triggered by the U.S. subprime lending crisis has significantly contributed to the oil price risk exposure of airline industry. These results should be of much interest to financial analysts, corporate executives, money managers, regulators, and policy makers.

The cross-section of returns, benchmark model parameters, and idiosyncratic volatility of nuclear energy firms after Fukushima Daiichi

- Energy Economics---2014---Kerstin Lopatta,Thomas Kaspereit

This study analyzes how the stock market returns, the factor loadings from the Carhart (1997) 4-factor model, and the idiosyncratic volatility of shares in energy firms have been affected by the Fukushima nuclear accident. Unlike existing studies, which provide evidence of a wealth transfer from nuclear to renewable energy firms for specific countries, we use an international sample and investigate whether changes in the regulatory environment and the firm-specific commitment to nuclear and renewable energies correlate with the capital market’s reactions to the Fukushima Daiichi accident. Our findings suggest that the more a firm relies on nuclear power, the more its share price declined after the accident. A commitment to renewable energies does not prevent declines in share prices but significantly helps to reduce the increase in market beta that is associated with this event. Nuclear energy firms domiciled in countries with a higher number of regulatory interventions that were triggered by the catastrophe have lower abnormal returns than those that are domiciled elsewhere. However, as a cross-sectional analysis reveals, a stronger commitment to nuclear power is the main driver for negative stock market returns. Furthermore, nuclear energy firms domiciled in countries with stronger regulatory shifts away from nuclear energy experience significant increases in market beta and the book-to-market equity factor loading according to the Carhart (1997) 4-factor model. We conclude that capital market participants are able to differentiate between the affectedness of firms with respect to their product portfolio. Energy firms could prevent increases in market beta due to catastrophes such as the Fukushima Daiichi accident by shifting some of their energy production from nuclear to renewable or other sources.

Do oil prices predict economic growth? New global evidence

- Energy Economics---2014---Paresh Narayan,Susan Sharma,Wai-Ching Poon,Joakim Westerlund

In this paper, we test whether oil price predicts economic growth for 28 developed and 17 developing countries. We use predictability tests that account for the key features of the data, namely, persistency, endogeneity, and heteroskedasticity. Our analysis considers a large number of countries, shows evidence of more out-of-sample predictability with nominal than real oil prices, finds in-sample predictability to be independent of the use of nominal and real prices, and reveals greater evidence of predictability for developed countries.

The effect of urbanization on CO2 emissions in emerging economies

- Energy Economics---2014---Perry Sadorsky

The theories of ecological modernization and urban environmental transition both recognize that urbanization can have positive and negative impacts on the natural environment with the net effect being hard to determine a priori. This study uses recently developed panel regression techniques that allow for heterogeneous slope coefficients and cross-section dependence to model the impact that urbanization has on CO2 emissions for a panel of emerging economies. The estimated contemporaneous coefficients on the energy intensity and affluence variables are positive, statistically significant and fairly similar across different estimation techniques. By comparison, the estimated contemporaneous coefficient on the urbanization variable is sensitive to the estimation technique. In most specifications, the estimated coefficient on the urbanization variable is positive but statistically insignificant. The implications of these results for sustainable development policy are discussed.

Climate change policy's interactions with the tax system

- Energy Economics---2013---Lawrence H. Goulder

This paper presents a range of insights from recent literature on how climate-change policies and other environmental policies interact with the fiscal system. It explores four issues associated with fiscal interactions. First, it examines how these interactions influence the prospects for a “double dividend:” both an environmental improvement and a reduction in the costs of the tax system. Second, it analyzes how the use of revenues from a carbon tax or from a cap-and-trade system involving auctioned emissions allowances influences these policies' economic costs. Third, it addresses the question whether carbon taxes or cap-and-trade programs represent more efficient sources of government revenue than other, more traditional revenue sources such as income, sales, or payroll taxes. Finally, it analyzes how fiscal interactions affect the choice between CO2 emissions-pricing instruments (carbon taxes and cap and trade) and other climate policy instruments.

On the economics of renewable energy sources

- Energy Economics---2013---Ottmar Edenhofer,Lion Hirth,Brigitte Knopf,Michael Pahle,Steffen Schlömer,Eva Schmid,Falko Ueckerdt

With the global expansion of renewable energy (RE) technologies, the provision of optimal RE policy packages becomes an important task. We review pivotal aspects regarding the economics of renewables that are relevant to the design of an optimal RE policy, many of which are to date unresolved. We do so from three interrelated perspectives that a meaningful public policy framework for inquiry must take into account. First, we explore different social objectives justifying the deployment of RE technologies and review model-based estimates of the economic potential of RE technologies, i.e. their socially optimal deployment level. Second, we address pivotal market failures that arise in the course of implementing the economic potential of RE sources in decentralized markets. Third, we discuss multiple policy instruments curing these market failures. Our framework reveals the requirements for an assessment of the relevant options for real-world decision makers in the field of RE policies. This review makes it clear

that there are remaining white areas on the knowledge map concerning consistent and socially optimal RE policies.

Economic ideas for a complex climate policy regime

- Energy Economics---2013---Dallas Burtraw,Matt Woerman

The parsimony of economic theory provides general insights into an otherwise complex world. However, the most straightforward organizing principles from theory have not often taken hold in environmental policy or in the decentralized climate policy regime that is unfolding. One reason is inadequate recognition of a variety of institutions. This paper addresses three ways that the standard model may inadequately anticipate the role of institutions in the actual implementation of climate policy, with a U.S. focus: multilayered authority across jurisdictions, the impressionistic rather than deterministic influence of prices through subsidiary jurisdictions, and the complementary role of prices and regulation in this context. The economic approach is built on the premise that incentives affect behavior. We suggest that an important pathway of influence for economic theory is to infuse incentive-based thinking into the conventional regulatory framework. In a complex policy regime, incentives can be shaped by shadow prices as well as market prices.

“Green” fuel tax on private transportation services and subsidies to electric energy. A model-based assessment for the main European countries

- Energy Economics---2013---Anna Bartocci,Massimiliano Pisani

This paper evaluates the environmental and macroeconomic implications for France, Germany, Italy and Spain of taxing motor vehicle fuels for private transportation, a sector not subject to the Emissions Trading System, so as to reduce taxes on electricity consumption and increase subsidies to renewable sources of electricity generation. The assessment is based on a

dynamic general equilibrium model calibrated for each of the four countries. The results suggest that the measures posited will reduce carbon dioxide emissions in the transportation sector and favor the development of electricity generation from renewable sources, thus limiting the growth of emissions from electricity generation. The measures do not jeopardize economic activity. The results are robust whether implementation is unilateral in one country or simultaneous throughout the EU.

Regional impact of changes in disposable income on Spanish electricity demand: A spatial econometric analysis

- Energy Economics---2013---Leticia M. Blázquez Gomez,Massimo Filippini,Fabian Heimsch

This paper presents an empirical analysis of residential electricity demand considering the existence of spatial effects. This analysis has been performed using aggregate panel data at the province level for 46 Spanish provinces for the period from 2001 to 2010. For this purpose, we estimated a log-log demand equation using a spatial autoregressive model with autoregressive disturbances (SARAR). The purpose of this empirical analysis is to determine the influence of price, income, and spatial spillovers on residential electricity demand in Spain. We are particularly interested in analyzing the impact of household disposable income variation across provinces observed during the economic crisis period 2009–2010. The estimation results show relatively low income elasticity and an inelastic demand to prices. Furthermore, the results show the presence of spatial effects in Spanish residential electricity consumption.

Energy poverty alleviation and climate change mitigation: Is there a trade off?

- Energy Economics---2013---Shoibal Chakravarty,Massimo Tavoni

Energy poverty alleviation has become an important political issue in the most recent years. Several initiatives and policies have been proposed to deal with

poor access to modern sources of energy in many developing countries. Given the large number of people lacking basic energy services, an important question is whether providing universal access to modern energy could significantly increase energy demand and associated CO₂ emissions. This paper provides one of the few formal assessments of this problem by means of a simple but robust model of current and future energy consumption. The model allows mapping energy consumption globally for different classes of energy use, quantifying current and future imbalances in the distribution of energy consumption. Our results indicate that an encompassing energy poverty eradication policy to be met by 2030 would increase global final energy consumption by about 7% (roughly 20EJ). The same quantity of energy could be saved by reducing by 15% energy consumption of individuals with standards above current European levels. The additional energy infrastructure needed to eradicate energy poverty would produce 44–183GtCO₂ over the 21st century and contribute at most 0.13°C of additional warming.

Paying for the smart grid

- Energy Economics---2013---Luciano De Castro, Joísa Dutra

Smart grid technologies may bring substantial advantages to society, but the required investments are sizable. This paper analyzes three main issues related to smart grids: reliability, demand response and cost recovery of investments. In particular, we show that generators will lose profits as a direct effect of demand response initiatives, and most of the benefits of smart grids cannot be easily converted into payments. Moreover, there are potential issues in the choices made by utilities for providing smart grids, and the reliability pertinent to smart grids is a kind of public good.

The effect of transport policies on car use: A bundling model with applications

- Energy Economics---2013---Francisco Gallego, Juan-Pablo Montero, Christian Salas

Borrowing from the bundling literature, the paper

presents a novel model of vertical and horizontal differentiation applied to transport decisions: households differ in their preferences for transportation modes — cars vs public transport — and in the amount of travel. Using few observables, the model is then used to interpret and compute policy costs associated to the effects of two major transport policies: the driving restriction program introduced in Mexico-City in November of 1989 and the public transport reform carried out in Santiago-Chile in February of 2007. Both policies had the unintended impact of increasing the number of cars on the road; and their associated transport costs are estimated, respectively, to be about 5% and 9% of the value of the vehicle stock at the time of implementation.

Efficiency, effectiveness and implementation feasibility of energy efficiency rebates: The “Renove” plan in Spain

- Energy Economics---2013---Ibon Galarraga, Luis M. Abadie, Alberto Ansuategi

State-sponsored incentive policies frequently include subsidies or rebates for the purchase of more efficient appliances. However, more research is required into the effects of this tool in isolation. A case in point is the so-called “Renove” plan in Spain. First, the inefficiency losses (dead-weight losses) associated with energy efficiency rebates must be taken into account. Such a policy may also encourage the large-scale purchasing of energy-efficient appliances, which may finally result in an increase in electricity consumption (rebound effect). Furthermore, although a subsidy is more widely accepted than other tools from social and political viewpoints, especially than taxes, the fiscal consolidation challenge faced by many countries reduces the scope for environmental policy measures on the expenditure side of the budget and strengthens the need to use taxes to meet the agreed policy objectives. This paper shows that the current application of the Spanish “Renove” plan with rebates on the dishwasher market for energy efficient appliances generates some welfare losses, a rebound effect and a considerable deficit in public budgets. The paper examines and assesses the

effect of different combinations of taxes and rebates in the case of dishwashers in Spain based on their performance in terms of economic efficiency, environmental effectiveness and implementation feasibility.

From shadow to green: Linking environmental fiscal reforms and the informal economy

- Energy Economics---2013---Anil Markandya,Mikel González-Eguino,Marta Escapa

In the past few decades many papers have analysed in some depth different environmental tax reforms and the double dividend hypothesis, i.e. the possibility of improving not only the environment but also the economy through the reduction of distortions in the tax system. However, such studies have not modelled the effects of the presence of a shadow economy, even though informal markets account for a significant and growing part of GDP in many developed economies. This paper analyses this important link using a Computable General Equilibrium model for the case of Spain, with historically high unemployment rates and a large informal economy. Since the informal labour is not taxed, when the green tax is introduced and the tax on formal labour is reduced, the pre-existing non-environment-related inefficiency of the tax system is remarkably reduced. Our analysis shows that if the distortions created by the shadow economy are considered, the case for an environmental tax reform where revenues are used to reduce labour taxes is strengthened and the possibility to find a double dividend is more likely. Our sensitivity analysis also shows that these results can also be extrapolated to some extent to other countries with different sizes of the shadow economy or different labour market conditions.

The economics of new nuclear power plants in liberalized electricity markets

- Energy Economics---2013---Pedro Linares,Adela Conchado

Even after Fukushima, the nuclear debate is strong in many countries, with the discussion of its economics being a significant part of it. However, most of the

estimates are based on a levelized-cost methodology, which presents several shortcomings, particularly when applied to liberalized electricity markets. Our paper provides results based on a different methodology, by which we determine the break-even investment cost for nuclear power plants to be competitive with other electricity generation technologies. Our results show that the cost competitiveness of nuclear power plants is questionable, and that public support of some sort would be needed if new nuclear power plants are to be built in liberalized markets.

Transport and low-carbon fuel: A study of public preferences in Spain

- Energy Economics---2013---Maria Loureiro,Xavier Labandeira,Michael Hanemann

Transport is essential for the control of future greenhouse gas (GHG) emissions and thus a target for active policy intervention in the future. Yet, social preferences for policies are likely to play an important role. In this paper we first review the existing literature on preferences regarding low-GHG car fuels, but also covering policy instruments and strategies in this area. We then present the results of a survey of Spanish households aimed at measuring preferences for climate change policies. We find a positive willingness to pay (WTP) (in the form of higher car fuel prices) for a policy to reduce GHG emissions through biofuels. There is, however, significant heterogeneity in public preferences due to personal motivations (accounted for via factor analysis of responses to attitudinal questions) and to socio-demographic variables.

Fiscal consolidation and climate policy: An overlapping generations perspective

- Energy Economics---2013---Sebastian Rausch

This paper examines the distributional and efficiency impacts of public debt consolidation financed through a carbon tax employing a dynamic general-equilibrium model with overlapping generations of the U.S. economy. The numerical model features government taxes

and spending and a multi-sectoral production structure including intermediate production, specific detail on the energy sector both in terms of primary energy carriers and energy-intensive industries, and sector- and fuel-specific carbon inputs. In contrast to revenue-neutral carbon tax swaps, using the carbon revenue for deficit reduction implies a relaxation of future public budgets as debt repayment results in lower future interest obligations. While intergenerational welfare impacts depend importantly on what tax recycling instrument is used, we find that combining public debt consolidation with a carbon policy entails the possibility of sustained welfare gains for future generations. If social discount rates are sufficiently low or if social preferences exhibit a large aversion with respect to intergenerational inequality, combining fiscal consolidation and climate policy may offer the chance for societal gains even without considering potential benefits from averted climate change.

CO2 abatement from renewables in the German electricity sector: Does a CO2 price help?

- Energy Economics---2013---Hannes Weigt,Denny Ellerman,Erik Delarue

The overlapping impact of the Emission Trading System (ETS) and renewable energy (RE) deployment targets creates a classic case of interaction effects. Whereas the price interaction is widely recognized and has been thoroughly discussed, the effect of an overlapping instrument on the abatement attributable to an instrument has gained little attention. This paper estimates the actual reduction in demand for European Union Allowances that has occurred due to RE deployment focusing on the German electricity sector, for the five years 2006 through 2010. Based on a unit commitment model we estimate that CO2 emissions from the German electricity sector are reduced by 35 to 60Mtons, or 10% to 18% of what estimated emissions would have been without any RE policy but with the CO2 price remaining in place at the observed level. Furthermore, we find that the abatement attributable to RE injections is greater in the presence of an allowance price than otherwise. The same holds for the

ETS effect in presence of RE injection. This interaction effect is consistently positive for the German electricity system, at least for the considered years, and on the order of 0.5% to 1.5% of emissions.

Renewable generation and electricity prices: Taking stock and new evidence for Germany and Austria

- Energy Economics---2013---Klaas Würzburg,Xavier Labandeira,Pedro Linares

Economic theory predicts that the increase of renewable electricity production should reduce the price of electricity in the short-run, which is also known as the ‘merit-order effect’. Although the merit-order effect is only one of several consequences of renewable production on the electricity system, it is crucial to determine its size for the economic evaluation of renewable energies. In this paper we present a comprehensive overview of relevant past research results on the price effect of renewables. Additionally, we conduct a new empirical analysis of the price effect of renewable production for the Austrian–German region, a market that clearly qualifies for a merit-order effect analysis given its characteristics. Based on the review and our own analysis, we show that the merit-order effect varies depending on the region and the assessment method chosen. We also find that the size of this effect is less dispersed throughout different markets than previously suggested by the literature.

A new approach to congestion pricing in electricity markets: Improving user pays pricing incentives

- Energy Economics---2013---Tim Nelson,Fiona Orton

Electricity pricing has traditionally been based on average cost pricing where consumers pay a ‘flat’ tariff based upon the average cost of production and transportation of electricity. The introduction of new ‘smart’ meters allows electricity providers to differentiate tariffs on the basis of time. Utilising congestion pricing theory, the energy industry has embraced

‘time-of-use’ (ToU) tariffs with a view to more efficiently pricing electricity. This paper demonstrates that pricing as a function of demand variability (reflecting capacity utilisation) is a more appropriate alternative to existing ToU tariffs for more efficiently allocating costs to end users. We call this new alternative pricing model ‘first derivative ratio’ FDR pricing. This new approach to congestion pricing could be applied to markets other than electricity, such as road transportation.

The dynamic links between energy consumption, economic growth, financial development and trade in China: Fresh evidence from multivariate framework analysis

- Energy Economics---2013---Muhammad Shahbaz,Saleheen Khan,Mohammad Iqbal Tahir

This study investigates the relationship between energy use and economic growth by incorporating financial development, international trade and capital as important factors of production function in case of China over the period of 1971–2011. The ARDL bounds testing approach to cointegration was applied to examine long run relationship among the series while stationarity properties of the variables was tested by applying structural break test.

An empirical analysis of the CO2 shadow price in Chinese thermal power enterprises

- Energy Economics---2013---Chu Wei,Andreas Löschel,Bing Liu

This paper estimates the shadow price of CO₂ and explores its determinants for thermal power enterprises in China. Using a parametric quadratic directional distance function, we evaluate the inefficiency and shadow price of CO₂ for 124 power enterprises in 2004, applying deterministic and econometric methods. A regression analysis is undertaken to examine the factors that drive shadow prices. Our results indicate that there are large inefficiencies in terms of electricity production and CO₂ emissions. The shadow price is a negative function of

firm size, age, and coal share, and is positively correlated with the technology level. This correlation between shadow prices and its determinants is not sensitive to changing assumptions regarding directional vectors, although such changes do alter the distribution of shadow prices. The large variation witnessed in shadow prices across power enterprises argues in favor of market-based regulation such as an emissions trading system as opposed to the command-and-control regulation currently used in China to minimize overall abatement cost.

A model of competition in the solar panel industry

- Energy Economics---2013---Unni Pillai,Jamison McLaughlin

We develop a model of competition in the solar panel industry. Solar firms manufacture panels that are differentiated both vertically and horizontally, and compete by setting quantities. The equilibrium of the model is consistent with a set of stylized facts that we document, including variation in prices, markups and market shares across firms. We calibrate the model using a new dataset data on prices, costs and shipments of leading solar companies, as well as solar sales in four leading markets. The calibrated model is applied to evaluate the impact of a decline in the price of polysilicon, a key raw material used in the manufacture of solar panels, on the equilibrium price of solar panels.

Alternative policy impacts on US GHG emissions and energy security: A hybrid modeling approach

- Energy Economics---2013---Kemal Sarica,Wallace Tyner

This study addresses the possible impacts of energy and climate policies, namely corporate average fleet efficiency (CAFE) standard, renewable fuel standard (RFS) and clean energy standard (CES), and an economy wide equivalent carbon tax on GHG emissions in the US to the year 2045. Bottom-up and top-down modeling approaches find widespread use in energy

economic modeling and policy analysis, in which they differ mainly with respect to the emphasis placed on technology of the energy system and/or the comprehensiveness of endogenous market adjustments. For this study, we use a hybrid energy modeling approach, MARKAL–Macro, that combines the characteristics of two divergent approaches, in order to investigate and quantify the cost of climate policies for the US and an equivalent carbon tax. The approach incorporates Macro-economic feedbacks through a single sector neoclassical growth model while maintaining sectoral and technological detail of the bottom–up optimization framework with endogenous aggregated energy demand. Our analysis is done for two important objectives of the US energy policy: GHG reduction and increased energy security. Our results suggest that the emission tax achieves results quite similar to the CES policy but very different results in the transportation sector. The CAFE standard and RFS are more expensive than a carbon tax for emission reductions. However, the CAFE standard and RFS are much more efficient at achieving crude oil import reductions. The GDP losses are 2.0% and 1.2% relative to the base case for the policy case and carbon tax. That difference may be perceived as being small given the increased energy security gained from the CAFE and RFS policy measures and the uncertainty inherent in this type of analysis.

Energy consumption, energy R&D and real GDP in OECD countries with and without oil reserves

- Energy Economics---2013---Siang Leng Wong, Youngho Chang, Wai-Mun Chia

The objective of the study is to shed light on the contributions of energy consumption and energy R&D on economic growth. We examine two sets of causal relationship between (1) capital stock, energy consumption and real GDP and (2) capital stock, energy R&D and real GDP using panel-based fully-modified ordinary least squares (FMOLS) and dynamic ordinary least squares (DOLS) for 20 OECD countries over the period of 1980–2010. Since different countries may respond differently to energy consumption and energy R&D, the sample is further divided into two groups: OECD

countries with oil reserves and without oil reserves. Similarly, energy consumption and energy R&D are also further divided into fossil fuel energy and renewable energy. The results show that the role of energy R&D should not be overlooked and fossil fuel R&D is found to drive economic growth more than fossil fuel consumption. The findings also show that while capital stock and fossil fuels are the key factors driving economic growth, renewable energy promotes real output, specifically in the countries without oil reserves.

Benefit–cost analysis of non-marginal climate and energy projects

- Energy Economics---2013---Simon Dietz, Cameron Hepburn

Conventional benefit–cost analysis incorporates the normally reasonable assumption that the policy or project under examination is marginal. Among the assumptions this entails is that the policy or project is small, so the underlying growth rate of the economy does not change. However, this assumption may be inappropriate in some important circumstances, including in climate-change and energy policy. One example is global targets for carbon emissions, while another is a large renewable energy project in a small economy, such as a hydropower dam. This paper develops some theory on the evaluation of non-marginal projects, with empirical applications to climate change and energy. We examine the conditions under which evaluation of a non-marginal project using marginal methods may be wrong, and in our empirical examples we show that both qualitative and large quantitative errors are plausible.

Quantifying the risk to crude oil imports in China: An improved portfolio approach

- Energy Economics---2013---Fenglong Ge, Ying Fan

China's rapid economic development caused a sharp increase in crude oil demand. In 2011, China imported 254million tons of crude oil in total, with its dependence on imported oil reaching 56.5%. This paper carries out a quantitative study on the risk of China's crude

oil imports by establishing an assessment model which has two primary characteristics. First, the model not only uses portfolio theory to assess the risk to China's crude oil imports, taking into consideration the effect of the diversified sources of imports, but also introduces a correlation coefficient which considers the risks associated with importing oil from overseas sources. Second, the correlation between import prices and global oil prices is analyzed with respect to each exporting country. The Ease of Doing Business Index grading system is introduced in order to represent the risk weight for each exporting country. Because of these improvements, the model provides operable methods for studying how global oil prices, import volumes, the diversification index, and the political and economic situation of the exporting countries affects China's crude oil import risks as well as offers a method for implementing optimal crude oil import strategies. It is concluded that China's crude oil import risks associated with the Middle East are not as precarious as researchers traditionally reported. Among countries in the Middle East, there exist obvious disparities and differences affecting the kinds and types of risks involved. Therefore, these risks should be treated piecemeal when performing an overall assessment of crude oil import risks in China. It should also be noted that with respect to the Middle East there is still room for China to optimize the mix of source countries in order to reduce risks. China should raise the volume of imports coming from low risk countries as well as add new low risk exporting countries to its importing portfolio.

Asymmetric substitutability between energy and capital: Evidence from the manufacturing sectors in 10 OECD countries

- Energy Economics---2013---Jihyo Kim,Eunbyeong Heo

This paper investigates the substitutability between energy and capital in the manufacturing sectors of ten OECD countries since 1980 by applying a cost function approach that has been widely used to analyze industrial energy demand. First, we attempt to determine

the source of the disagreement in the literature on the substitutability between energy and capital and reach a conclusion regarding the substitutability between energy and capital. Dividing energy and capital into sub-inputs, we analyze their substitutability. The empirical results indicate that fuel tends to complement capital in most countries, whereas electricity and capital are substitutes. Thus, this study confirms that heterogeneity in energy sources is a primary component of the systematic variation in the substitutability between energy and capital. Second, we examine asymmetric substitutability between energy and capital by estimating the Morishima elasticity of substitution. The estimates of the Morishima elasticity of substitution demonstrate that the substitution of energy for capital has dominated the substitution of capital for energy. This asymmetric substitutability is natural from the producer perspective because capital costs are much greater than energy costs in most countries. These results imply that the adoption of energy-saving technologies has not been induced in response to increased energy prices.

How sensitive to time period sampling is the asymmetric price response specification in energy demand modelling?

- Energy Economics---2013---Yaw Osei Adofo,Joanne Evans,Lester Hunt

The purpose of this paper is to investigate the criticism that energy demand estimates based on a specific price decomposition are sensitive to the chosen time period used for the estimation. To analyse this in a systematic way, different time series sample periods are constructed from annual data for 17 OECD countries covering the overall period 1960 to 2008. The specific price decomposition under consideration, often used to estimate asymmetric price response models of energy demand, separates the impact of prices above the previous maximum, of a price recovery below the previous maximum and of a price cut. Therefore, the analysis does not just involve using different time periods; instead, for each time period investigated, a new dataset is constructed and for each dataset, the price

variable is decomposed in this way. An energy demand relationship allowing for asymmetric price responses is therefore estimated for each different sample period and the results suggest that recalculation of the decomposed price variables for each different period does affect the stability of the estimated energy demand responses. In contrast, a similarly estimated energy demand relationship with symmetric price responses for each different sample period is found to have less instability.

Carbon dioxide emissions and governance: A nonparametric analysis for the G-20

- Energy Economics---2013---George Halkos,Nickolaos Tzeremes

This paper applies nonparametric estimators to examine the carbon dioxide emissions–governance relationship. By using data for the twenty largest economies (Group of twenty, G-20) the dynamics of the considered relationship are analyzed for the time period 1996–2010. Six governance measures are included in our analysis (Voice and Accountability, Political Stability and Absence of Violence, Government Effectiveness, Regulatory Quality, Rule of Law and Control of Corruption) as have been defined by the World Bank. The empirical findings reveal a high nonlinear relationship between countries' carbon dioxide emissions and the examined governance measures. The results reveal significant differences on the number of governance measures influencing countries' carbon dioxide emission levels. It is evident that these differences are subject to countries' specific regional and development variations. Finally, it appears that increasing the quality of countries' different governance factors does not always result to lower carbon dioxide emission levels.

Do energy prices stimulate food price volatility? Examining volatility transmission between US oil, ethanol and corn markets

- Energy Economics---2013---Cornelis Gardebreek,Manuel Hernandez

This paper examines volatility transmission in oil,

ethanol and corn prices in the United States between 1997 and 2011. We follow a multivariate GARCH approach to evaluate the level of interdependence and the dynamics of volatility across these markets. The estimation results indicate a higher interaction between ethanol and corn markets in recent years, particularly after 2006 when ethanol became the sole alternative oxygenate for gasoline. We only observe, however, significant volatility spillovers from corn to ethanol prices but not the converse. We also do not find major cross-volatility effects from oil to corn markets. The results do not provide evidence of volatility in energy markets stimulating price volatility in the US corn market.

A comparative study among fossil fuel power plants in PJM and California ISO by DEA environmental assessment

- Energy Economics---2013---Toshiyuki Sueyoshi,Mika Goto

This study compares among fossil fuel power plants in PJM and California ISO by their unified (operational and environmental) performance. DEA (Data Envelopment Analysis) is used as a methodology. For comparative analysis, DEA incorporates strategic concepts such as natural and managerial disposability into the computational process. This study explores both how to measure Returns to Scale (RTS) under natural disposability and how to measure Damages to Scale (DTS) under managerial disposability. This empirical study obtains two implications on US energy policy. One of the two policy implications is that California ISO outperforms PJM in terms of the three unified efficiency measures. The result implies that strict regulation on undesirable outputs, as found in California, is important in enhancing the performance of US fossil fuel power plants. Thus, it is necessary for federal and local governments to regulate the fossil fuel power plants under the strict implementation of environmental protection. Under such a policy direction, it is possible for US fossil fuel power plants to attain economic prosperity (by enhancing their operational efficiencies) and to satisfy environmental regulation (by enhancing their environmental efficiencies). The

other policy implication is that coal-fired and gas-fired power plants in PJM and California ISO need to reduce their operational sizes or introduce technology innovation on desirable and undesirable outputs and/or new management for environmental protection within their operations. Meanwhile, oil-fired power plants may increase their operational sizes if they can introduce technology innovation and new management on undesirable outputs.

Economic analysis of alternatives for optimizing energy use in manufacturing companies

- Energy Economics---2013---Mayra Ivelisse Méndez-Piñero,Melitza Colón-Vázquez

The manufacturing companies are one of the main consumers of energy. The increment in global warming and the instability in the petroleum oil market have motivated companies to find alternatives to reduce energy use. In the academic literature several researchers have demonstrated that optimization models can be successfully used to reduce energy use. This research presents the use of an optimization model to identify feasible economic alternatives to reduce energy use. The economic analysis methods used were the pay-back and the internal rate of return. The optimization model developed in this research was applied and validated using an electronic manufacturing company case study. The results demonstrate that the main variables affecting the economic feasibility of the alternatives are the economic analysis method and the initial implementation costs. Several scenarios were analyzed and the best results show that the manufacturing company could save up to \$78,000 in three years if the recommendations based on the optimization model results are implemented.

The stochastic seasonal behavior of energy commodity convenience yields

- Energy Economics---2013---Andrés García Mirantes,Javier Población,Gregorio Serna

This paper contributes to the commodity pricing literature by consistently modeling the convenience yield

with its empirically observed properties. Specifically, in this paper, we show how a four-factor model for the stochastic behavior of commodity prices, with two long- and short-term factors and two additional seasonal factors, may accommodate some of the most important empirically observed characteristics of commodity convenience yields, such as the mean reversion and stochastic seasonality. Based on this evidence, a theoretical model is presented and estimated to characterize the commodity convenience yield dynamics that are consistent with previous findings. We also show that commodity price seasonality is better estimated through convenience yields than through futures prices.

Market-driven coal prices and state-administered electricity prices in China

- Energy Economics---2013---Ming-Hua Liu,Dimitris Margaritis,Yang Zhang

This paper analyzes how the Chinese government adjusts electricity prices for both industrial and residential users in response to changes in coal prices using an asymmetric error correction model. Our results show that there is a long-term relation between the coal price and electricity prices but the relationship is weak especially for residential pricing. In the short run, we find electricity prices are adjusting faster upwards than downwards. Price adjustment towards long-run equilibrium is faster for residential users upwards than downwards. On the other hand, we find no evidence of asymmetric equilibrium adjustment in the electricity price for industrial use. The weak long-term relationship reflects the rigidity in electricity pricing and government's reluctance to subject end users to fluctuations of raw materials cost shifts.

The role of trader positions in spot and futures prices for WTI

- Energy Economics---2013---Marek Kolodziej,Robert Kaufmann

We extend the analysis of causal relations between trader positions and oil prices and the process of price

discovery by estimating a cointegrating vector autoregression (CVAR) model that expands the cash-and-carry relation between spot and futures prices to quantify long- and short-run relations among oil prices, trader positions, interest rates, and oil inventories. Results indicate that oil inventories and trader positions are needed to generate cointegration between spot and futures prices. The presence of trader positions and oil inventories suggest that both play a role in price discovery. Furthermore, the cointegrating relation for price loads into the equation for both oil prices and trader positions. This suggests a bi-directional simultaneous adjustment process between oil prices and trader positions. This expands the unidirectional causal relation from oil prices to trader positions that is generated by previous studies. Additional results suggest that price discovery occurs in the market for heavily traded near-month futures contracts, but discovery for thin far-month futures markets occurs in the spot market. Together, these results suggest mechanisms by which speculation could affect oil prices but the results presented here are moot regarding their effects.

Natural gas scenarios in the U.S. power sector

- Energy Economics---2013---Jeffrey Logan,Anthony Lopez,Trieu Mai,Carolyn Davidson,Morgan Bazilian,Douglas Arent

The United States power sector is being transformed by the recent rise in the availability and use of unconventional natural gas, specifically shale gas. That transformation has already produced some of the most significant changes in the operation of the portfolio of electricity generation since WWII. Further implications are likely. To that end, we present results from numerical modeling of different United States (U.S.) power sector futures. These futures assess questions affecting today's natural gas and electric power markets, including the impacts of: forthcoming EPA rules on power plants, decarbonization options such as a clean energy standard (CES), potential improvements in key generation technologies, expanded use of natural gas outside of the power generation sector, and higher costs for natural gas production—assumed to arise from

more robust environmental and safety practices in the field. The simulations were done using the ReEDS model looking out to the year 2050. ReEDS is a capacity expansion model that determines the least-cost combination of generation options that fulfill a variety of user-defined constraints such as projected load, capacity reserve margins, emissions limitations, and operating lifetimes. The baseline scenario shows strong growth in natural gas generation, leading to a roughly 2.5-fold increase in gas demand by 2050. Many other scenarios also see strong growth in gas-fired generation, highlighting questions about portfolio diversity, climate change, and research and development prioritization.

The impact of residential density on vehicle usage and fuel consumption: Evidence from national samples

- Energy Economics---2013---Jinwon Kim,David Brownstone

This paper investigates the impact of residential density on household vehicle usage and fuel consumption. We estimate a simultaneous equations system to account for the potential residential self-selection problem. While most previous studies focus on a specific region, this paper uses national samples from the 2001 National Household Travel Survey. The estimation results indicate that residential density has a statistically significant but economically modest influence on vehicle usage, which is similar to that in previous studies. However, the joint effect of the contextual density measure (density in the context of its surrounding area) and residential density on vehicle usage is quantitatively larger than the sole effect of residential density. Moving a household from a suburban to an urban area reduces household annual mileage by 18%. We also find that a lower neighborhood residential density induces consumer choices toward less fuel-efficient vehicles, which confirms the finding in Brownstone and Golob (2009).

Forecasting carbon futures volatility using GARCH models with energy volatilities

- Energy Economics---2013---Suk Joon Byun, Hangjun Cho

This article examines the volatility forecasting abilities of three approaches: GARCH-type model that uses carbon futures prices, an implied volatility from carbon options prices, and the k-nearest neighbor model. Based on the results, we document that GARCH-type models perform better than an implied volatility and the k-nearest neighbor model. This result suggests that carbon options have little information about carbon futures due to their low trading volume. We also investigate whether the volatilities of energy markets, i.e., Brent oil, coal, natural gas, and electricity, forecast following day's carbon futures volatility. According to the results, we suggest that Brent oil, coal, and electricity may be used to forecast the volatility of carbon futures.

Nonlinearity in cap-and-trade systems: The EUA price and its fundamentals

- Energy Economics---2013---Benjamin Lutz, Uta Pigorsch, Waldemar Rotfuß

In this paper we examine the nonlinear relation between the EUA price and its fundamentals, such as energy prices, macroeconomic risk factors and weather conditions. By estimating a Markov regime-switching model, we find that the relation between the EUA price and its fundamentals varies over time. In particular, we are able to identify a low and a high volatility regime, both showing a strong impact of the fundamentals on the EUA price. The most important EUA price drivers are changes on the stock market and energy prices. The gas price and a broad European equity index affect the EUA price positively in both regimes, while the coal price and the oil price have a significant, but also positive impact only during the high and the low volatility regime, respectively. The high volatility regime is predominant in phases when economic activities are on a decrease or when institutional changes harm the confidence in the stringency of the

EU ETS. This holds during the recession of 2008 and 2009, as well as during 2011 and 2012 when the debt crisis impaired the European economic outlook.

Time–frequency dynamics of biofuel–fuel–food system

- Energy Economics---2013---Lukas Vacha, Karel Janda, Ladislav Křišťoufek, David Zilberman

For the first time, we apply the wavelet coherence methodology on biofuels (ethanol and biodiesel) and a wide range of related commodities (gasoline, diesel, crude oil, corn, wheat, soybeans, sugarcane and rapeseed oil). This way, we are able to investigate dynamics of correlations in time and across scales (frequencies) with a model-free approach. We show that correlations indeed vary in time and across frequencies. We find two highly correlated pairs which are strongly connected at low frequencies – ethanol with corn and biodiesel with German diesel – during almost the whole analyzed period (2003–2011). Structure of correlations remarkably changes during the food crisis — higher frequencies become important for both mentioned pairs. This implies that during stable periods, ethanol is correlated with corn and biodiesel is correlated with German diesel mainly at low frequencies so that they follow a common long-term trend. However, in the crisis periods, ethanol (biodiesel) is led by corn (German diesel) even at high frequencies (low scales), which implies that the biofuels prices react more rapidly to the changes in their producing factors.

Pricing option contracts on the strategic petroleum reserve

- Energy Economics---2013---Frederic Murphy, Fernando Oliveira

In this article we examine the pricing of option contracts on the strategic petroleum reserve (SPR) and consider how these can be used by both the government and refiners. We analyze the interaction between the call and put option contracts, taking into account the underlying game, in the infinite Markov decision process with discounting, explaining the relationship

between the valuation of options on the SPR by refiners and the valuation of financial options on a marker crude in financial markets. We conclude that the values of both call and put options on the SPR increase with oil prices and decrease with total inventory. Furthermore, our analysis shows that a more active management of the SPR creates higher social welfare (although refiners profit less from inventories) and larger volatility in inventory profits, decreasing private investment in petroleum stocks.

Electricity demand analysis and forecasting: A panel cointegration approach

- Energy Economics---2013---Alaa El-Shazly

This article analyzes the demand for electricity and provides out-of-sample forecasting at the sectoral level using a panel cointegration approach. The econometric model permits cross-sectional heterogeneity within a dynamic framework that incorporates information on relevant income and prices of domestic and foreign goods. Both the short-run dynamics and the long-run slope coefficients are allowed to vary across cross-sections. Also, the testing for unit roots and cointegration in panels allows for heterogeneous fixed effects and deterministic trends. Using Egyptian data, it is shown that the empirical model produces reliable ex-post forecasts near the end of the full sample period. These pseudo forecasts are representative of what one would expect if the forecasting relationship is stationary. The long-run parameter estimates are then used to conduct ex-ante forecasting under plausible assumptions for policy making.

On the speed towards the mean for continuous time autoregressive moving average processes with applications to energy markets

- Energy Economics---2013---Fred Espen Benth, Che Mohd Imran Che Taib

We extend the concept of half life of an Ornstein–Uhlenbeck process to Lévy-driven continuous-time autoregressive moving average processes with

stochastic volatility. The half life becomes state dependent, and we analyze its properties in terms of the characteristics of the process. An empirical example based on daily temperatures observed in Petaling Jaya, Malaysia, is presented, where the proposed model is estimated and the distribution of the half life is simulated. The stationarity of the dynamics yield futures prices which asymptotically tend to constant at an exponential rate when time to maturity goes to infinity. The rate is characterized by the eigenvalues of the dynamics. An alternative description of this convergence can be given in terms of our concept of half life.

Where the wind blows: Assessing the effect of fixed and premium based feed-in tariffs on the spatial diversification of wind turbines

- Energy Economics---2013---Johannes Schmidt, G. Lehecka, V. Gass, E. Schmid

Feed-in tariffs (FIT) are among the most important policy instruments to promote renewable electricity production. The fixed-price FIT (FFIT), which guarantee a fixed price for every unit of produced electricity and the premium based FIT (PFIT), which pay a premium on top of the market price are commonly implemented in the EU. Costs for balancing intermittent electricity production may be significantly higher with FFIT than with PFIT, and FFIT do not provide any incentive to produce electricity when marginal production costs are high. In contrast, PFIT do provide strong incentives to better match renewable power output with marginal production costs in the system. The purpose of this article is to assess the effects of the two tariff schemes on the choice of wind turbine locations. In an analytical model, we show that both the covariance between wind power supply and demand as well as between the different wind power locations matter for investors in a PFIT scheme. High covariance with other intermittent producers causes a decrease in market prices and consequently in revenues for wind power investors. They are therefore incentivized to diversify the locations of wind turbines to decrease the covariance between different wind power production locations. In an empirical optimization model, we analyze the effects of these

two different schemes in a policy experiment for Austria. The numerical results show that under a PFIT scheme, (1) spatial diversification is incentivized, (2) the covariance of wind power production with marginal electricity production costs increases, and (3) the variances of the wind power output and of residual load decrease if wind power deployment attains 10% of total national electricity consumption.

How households in Pakistan take on energy efficient lighting technology

- Energy Economics---2013---Natalie Chun,Yi Jiang

A household survey in Pakistan is used to examine drivers of more efficient compact fluorescent light bulb (CFL) adoption and the impact of CFL adoption on the demand for lighting services. Higher price of a CFL to an incandescent bulb (IB) and limited knowledge about the life span of CFLs versus IBs are found to lower adoption rates by as much as 20%. While CFL adoption increases the technical efficiency of household lighting, the lower cost for lighting services results in estimated rebound effects that decrease potential energy savings by 23% to 35% due to increased brightness and extended hours of use. These findings have important implications for household welfare and cost-benefit tradeoffs for CFL projects.

Explaining the diffusion of renewable energy technology in developing countries

- Energy Economics---2013---Birte Pfeiffer,Peter Mulder

In this paper we study the diffusion of non-hydro renewable energy (NHRE) technologies for electricity generation across 108 developing countries between 1980 and 2010. We use two-stage estimation methods to identify the determinants behind the choice of whether or not to adopt NHRE as well as about the amount of electricity to produce from renewable energy sources. We find that NHRE diffusion accelerates with the implementation of economic and regulatory instruments, higher per capita income and schooling levels, and stable, democratic regimes. In contrast, increasing

openness and aid, institutional and strategic policy support programs, growth of electricity consumption, and high fossil fuel production appear to delay NHRE diffusion. Furthermore, we find that a diverse energy mix increases the probability of NHRE adoption. Finally, we find a weak support for a positive influence of the Kyoto Protocol on NHRE diffusion and no evidence for any influence resulting from financial sector development.

Resource adequacy reliability and the impacts of capacity subsidies in competitive electricity markets

- Energy Economics---2013---R. J. Briggs,Andrew Kleit

Motivated by recent interventions by the states of New Jersey and Maryland and the introduction of PJM's Minimum Offer Price Rule (MOPR) for capacity markets, we analyze the impact of subsidized government investments in electrical generation on electricity markets. We extend the model of Joskow and Tirole (2007) to address the interconnected nature of the PJM grid by considering a market with two different locations connected by transmission lines. We assume that these lines are constrained during peak periods in a manner similar to Borenstein et al. (2000). We find that government intervention has a significant potential for adverse effects on grid resource adequacy and reliability. In our analysis, subsidized investment in baseload capacity is never optimal. In the short run government provision of base capacity displaces competitive base capacity, which reduces the private provision of peak capacity. In the long run, the threat of intervention imposes costs on suppliers in the form of an expected regulatory taking. As a result, resource adequacy decreases in both markets. If governments respond to this state of affairs by subsidizing further supply additions, expectations of intervention are reinforced and competitive capacity supply further diminishes. MOPR attempts to mitigate this vicious cycle by screening out non-economic bids for new capacity. To the extent market participants view MOPR as a credible policy, it succeeds in this goal. In this case, subsidized capac-

ity additions do not perturb the efficiency of market outcomes as long as any charges to consumers to support the subsidy are lump sum in nature. In this case, subsidized resources simply succeed in capturing rents from taxpayers.

Crude oil, equity and gold futures open interest co-movements

- Energy Economics---2013---Michael Soucek

The study is unique in its investigation of the co-movements between trading activity on the equity, crude oil, and gold futures market, proxied by open interest. It provides empirical evidence that stock and crude oil futures demand for hedging is positively related, but reacts negatively to sudden shocks in open interest on the other market. Furthermore, gold futures open interest reacts positively to shocks in the crude oil futures trading activity. The level of instantaneous linkage is related to external market conditions. During periods of unstable financial markets, the correlation between equity and energy futures open interest decreases, and the correlation of the open interest on the equity and gold futures market turns weak negative. This indicates hedging funds allocation toward gold market in periods of stock market uncertainty.

Substitution in the electric power industry: An interregional comparison in the eastern US

- Energy Economics---2013---Jing Gao,Robert Nelson,Lei Zhang

The electric power industry is restructuring as regulations move from states to regional and national levels. Estimates of regional fuel and input substitution are essential for practitioners and policy makers. This paper estimates substitution under static and dynamic scenarios, examining changes in technology and total factor productivity from 2001 to 2008. Two-stage estimation reveals regional characteristics and underlying elements in fuel and factor choice processes. Substitution varies widely depending on the region, coal technology, capital investment, and R&D activities.

Selective hedging in hydro-based electricity companies

- Energy Economics---2013---Gaute Egeland Sanda,Eirik Tandberg Olsen,Stein-Erik Fleten

We analyze risk management trends in electricity commodity markets using the production and transaction data and written hedging policies of 12 Norwegian hydropower companies. The scope of our analysis is the hedging of physical electricity production using the power derivatives available at NASDAQ OMX Commodities. In their hedging policy, these companies either use a Cashflow at Risk (C-FaR) approach or a hedge ratio approach, or follow no explicitly stated approach. We find that the derivative cashflows constitute substantial profits for these companies. Furthermore, hedging contributes to reducing the C-FaR for 10 of the companies. These findings are surprising considering that we expect hedging to yield zero expected profit and to smooth the earnings. Overall, our findings reveal that a practice of incorporating market views in hedging decisions is widespread in the sample companies, as both sanctioned in their written hedging policy and as indicated by the substantial hedging profits.

Modeling for insight using Tools for Energy Model Optimization and Analysis (Temoa)

- Energy Economics---2013---Kevin Hunter,Sarat Sreepathi,Joseph F. DeCarolis

This paper introduces Tools for Energy Model Optimization and Analysis (Temoa), an open source framework for conducting energy system analysis. The core component of Temoa is an energy economy optimization (EEO) model, which minimizes the system-wide cost of energy supply by optimizing the deployment and utilization of energy technologies over a user-specified time horizon. The design of Temoa is intended to fill a unique niche within the energy modeling landscape by addressing two critical shortcomings associated with existing models: an inability to perform third party verification of published model results and the difficulty of conducting uncertainty analysis with large, complex

models. Temoa leverages a modern revision control system to publicly archive model source code and data, which ensures repeatability of all published modeling work. From its initial conceptualization, Temoa was also designed for operation within a high performance computing environment to enable rigorous uncertainty analysis. We present the algebraic formulation of Temoa and conduct a verification exercise by implementing a simple test system in both Temoa and MARKAL, a widely used commercial model of the same type. In addition, a stochastic optimization of the test system is presented as a proof-of-concept application of uncertainty analysis using the Temoa framework.

Renewables in the energy transition: Evidence on solar home systems and lighting fuel choice in Kenya

- Energy Economics---2013---Jann Lay, Janosch Ondraczek, Jana Stoever

We study the determinants of households' choices of lighting fuels in Kenya including the option of using solar home systems (SHS). Our goal is to add new evidence on the factors that influence the introduction and adoption of decentralized and less carbon-intensive energy sources in developing countries, and, more generally, to the empirical debate on the energy ladder. We capitalize on a unique representative survey on energy use and sources from Kenya, one of the few relatively well-established SHS markets in the world. Our results reveal some very interesting patterns of the fuel transition in the context of lighting fuel choices. While we find clear evidence for a cross-sectional energy ladder, the income threshold for modern fuel use – including solar energy use – to move beyond traditional and transitional fuels is very high. Income and education turn out to be key determinants of SHS adoption, but we also find a very pronounced effect of SHS clustering, i.e. the prevalence of SHS in the proximity of a potential user increases the likelihood of adoption. In addition, we do not find a negative correlation between grid access and SHS use.

Do efforts on energy saving enhance firm values? Evidence from China's stock market

- Energy Economics---2013---Dezhu Ye, Shasha Liu, Dongmin Kong

This paper studies the impact of energy-saving efforts on firm value, using the carbon emission rights trading scheme (CERTS) of China as an exogenous shock. The results showed that the CERTS increases the market value of energy-related firms; moreover, the energy-saving efforts of firms further influence their market value and investor reaction. Energy-related firms improve their market value and gain benefits by strengthening their energy-saving activities. This paper offers an important policy implication that the Government should enact appropriate policies to improve the energy-saving activities of firms, especially in the energy industry.

DEA environmental assessment in a time horizon: Malmquist index on fuel mix, electricity and CO2 of industrial nations

- Energy Economics---2013---Toshiyuki Sueyoshi, Mika Goto

Climate change and global warming become a major policy issue in the world. Economic activities produce not only desirable outputs (e.g., electricity) but also undesirable outputs (e.g., CO2 emission). The important policy issue is how each nation can balance between economic development and environmental protection to attain a sustainable society. In attaining the sustainable society, environmental assessment is increasingly important because it can serve as an initial step toward the green growth of each nation. For the purpose, this study proposes a new use of DEA (Data Environment Analysis) for environmental assessment in a time horizon. The proposed use of DEA incorporates Malmquist index to examine the degree of a frontier shift among multiple periods. The frontier shift indicates a technology progress and/or managerial innovation during an observed period. The index is conceptually separated into six subcomponents, which are further divided into twelve different subcomponents

(six subcomponents×two disposability concepts) under the natural and managerial disposability. In the index measurement, it is necessary for us to consider a frontier crossover among different periods because technology innovation usually has a time lag until it really appears. As an empirical application, this study utilizes the proposed approach to identify the relationship among fuel mix, electricity and CO₂ of ten industrial nations. This study finds three important empirical findings. First, there is a time lag in technology innovation on electricity generation and CO₂ emission reduction. Consequently, it is necessary to consider the existence of a frontier crossover in assessing the electric power industry. Second, nuclear generation, as found in France, as well as hydro and renewable energy, as found in Netherlands, are important for the development of a sustainable society although the former is associated with a very high level of risk and the latter has a limited generation capacity. Finally, the electric power industry has been making a corporate effort to reduce the amount of CO₂ emission by utilizing nuclear and renewable energy.

International trade and emissions: The case of the Minas Gerais state — 2005

- Energy Economics---2013---Terciane Sabadini Carvalho, Flaviane Souza Santiago, Fernando Perobelli

In this paper, we present a hybrid regional input–output model that enables us to compute the intensity measures of CO₂ emissions in the state of Minas Gerais. The analysis uses a 2005 input–output matrix and presents the disaggregated data for 35 sectors. The results suggest that the sectors of Agriculture, Mining, and Metallurgy are key sectors for emissions, and that Petroleum and Alcohol, Nonmetallic Minerals, and Mining are the activities that consume more carbon per US\$ million sold. We also analyze the trading partners of the European Union, the United States, China, and Argentina. The findings indicate that they are net importers of the carbon generated by Minas Gerais.

A spatial panel data approach to estimating U.S. state-level energy emissions

- Energy Economics---2013---James Burnett, John Bergstrom, Jeffrey Dorfman

We take advantage of a long panel data set to estimate the relationship between U.S. state-level carbon dioxide (CO₂) emissions, economic activity, and other factors. We specify a reduced-form energy demand model to account for energy consumption activities that drive energy-related emissions. We contribute to the literature by exploring several spatial panel data models to account for spatial dependence between states. Estimation results and rigorous diagnostic analysis suggest that: (1) economic distance plays a role in intra- and inter-state CO₂ emissions; and (2) there are statistically significant, positive economic spillovers and negative price spillovers to state-level emissions.

Beyond one-step-ahead forecasting: Evaluation of alternative multi-step-ahead forecasting models for crude oil prices

- Energy Economics---2013---Tao Xiong, Yukun Bao, Zhongyi Hu

An accurate prediction of crude oil prices over long future horizons is challenging and of great interest to governments, enterprises, and investors. This paper proposes a revised hybrid model built upon empirical mode decomposition (EMD) based on the feed-forward neural network (FNN) modeling framework incorporating the slope-based method (SBM), which is capable of capturing the complex dynamic of crude oil prices. Three commonly used multi-step-ahead prediction strategies proposed in the literature, including iterated strategy, direct strategy, and MIMO (multiple-input multiple-output) strategy, are examined and compared, and practical considerations for the selection of a prediction strategy for multi-step-ahead forecasting relating to crude oil prices are identified. The weekly data from the WTI (West Texas Intermediate) crude oil spot price are used to compare the performance of the alternative models under the EMD–SBM–FNN modeling framework with selected counterparts. The

quantitative and comprehensive assessments are performed on the basis of prediction accuracy and computational cost. The results obtained in this study indicate that the proposed EMD–SBM–FNN model using the MIMO strategy is the best in terms of prediction accuracy with accredited computational load.

Tradable permits and unrealized gains from trade

- Energy Economics---2013---Rolf Färe, Shawna Grosskopf, Carl Pasurka

With the advent of tradable permit programs for bad outputs (e.g., SO₂ emissions); concerns arose over whether the theoretical gains from trade would be realized. We will employ a methodology that calculates the potential gains accruing to coal-fired electric power plants from implementing a tradable permit program. The magnitude of the potential gains in a plant's kilowatt hour output from a tradable permit program relative to its observed production provides insights into the existence of intertemporal allocative inefficiencies and spatial allocative inefficiencies after the implementation of a tradable permit program.

U.S. Disaggregated renewable energy consumption: Persistence and long memory behavior

- Energy Economics---2013---Carlos Barros, Luis Gil-Alana, James Payne

This study examines the degree of time persistence in U.S. disaggregated renewable energy consumption (hydropower, geothermal, solar, wind, wood, waste, and biofuels) using innovative fractional integration and autoregressive models with monthly data for the period 1994:2 to 2011:10. The results indicate that in the case of hydropower, solar, wind, waste, and biofuels the estimates of fractional integration are higher than 0.5 but less than 1.0 implying nonstationary, but mean reverting behavior. In the case of geothermal and waste the estimates of fractional integration are around 0.5 and in the boundary case between stationarity and nonstationarity. For wood, the estimate of fractional integration is significantly smaller than 0.5

and thus showing stationary behavior with long memory behavior. Furthermore, the study incorporates the presence of breaks in the data with the absence of breaks in hydropower, geothermal, solar, wind, wood, and biofuels, but a single break in the case of waste due to the inclusion of non-renewable waste from non-biogenic sources through 2000. The results reveal that U.S. disaggregated renewable energy consumption measures are better explained in terms of a long memory model that incorporates persistence components and seasonality.

Estimation of Japanese price elasticities of residential electricity demand, 1990–2007

- Energy Economics---2013---Shigeharu Okajima, Hiroko Okajima

This paper estimates elasticities of Japanese residential price electricity from 1990 to 2007. The first difference generalized method of moment estimator is employed to avoid dynamic panel bias, which is not considered in most previous studies. The results show that while short-run elasticities are similar to those in previous studies, long-run elasticities are significantly lower in our study. We also find that the price elasticity of Japanese residential electricity consumption is notably affected by income inequality and severe weather. Based on these results, we provide some insights to tailor environmental taxation so as to effectively attain the Kyoto Protocol.

An inexact robust optimization method for supporting carbon dioxide emissions management in regional electric-power systems

- Energy Economics---2013---C. Chen, Y.P. Li, G.H. Huang

In this study, an inexact robust optimization method (IROM) is developed for supporting carbon dioxide (CO₂) emission management in a regional-scale energy system, through incorporating interval-parameter programming (IPP) within a robust optimization (RO) framework. In the modeling formulation, penalties are exercised with the recourse against any infeasibility,

and robustness measures are introduced to examine the variability of the second-stage costs that are above the expected levels. The IROM is suitable for risk-averse planners under high-variability conditions. The IROM is applied to a case of energy systems and CO₂ emission planning under uncertainty. The results obtained can generate desired decision alternatives that are able to not only enhance electricity-supply safety with a low system-failure risk level but also mitigate CO₂ emissions. They can be used for generating decision alternatives and minimizing the system cost of energy system while meeting the CO₂-emission permit requirement.

Assessing the technological responsibility of productive structures in electricity consumption

- Energy Economics---2013---Vicent Alcantara,Miguel-Angel Tarancón,Pablo del Río

A methodology is developed which allows us to measure the responsibility of the productive structure of an economic system with respect to the consumption and generation of electricity within an input–output framework. We propose a technical indicator of technology responsibility in electricity consumption based on the assessment of technical coefficients. Technological responsibility refers to the capacity of a sector or economic transaction between sectors to induce electricity consumption regardless of the final demand vector. Sectors with a high technological responsibility are those whose technologies use inputs which either directly or indirectly require much electricity independently of the composition of the final demand in the economy. This methodology is applied to the productive sectors of the Spanish economy. It is found out that a few transactions between sectors are highly technologically responsible regarding electricity consumption. The results show that, although the service sectors are the ones with the greatest share in electricity consumption, the industrial sectors (particularly, the extractive, heavy and energy industries), the electricity generation sector and construction are the ones with the greatest technological responsibility, i.e., they have technology

mixes with a large propensity to consume electricity, propagating to the other sectors. The sectors with the highest technological responsibility are clustered around three broad sectors: energy, metal manufacturing and transport.

From oil to consumer energy prices: How much asymmetry along the way?

- Energy Economics---2013---Fabrizio Venditti

A longstanding question in macroeconomics is whether fuel prices react more to increases than to decreases of the price of oil. This paper analyzes the response of weekly gasoline and gasoil prices to oil prices in the U.S., the euro area and the four largest euro area countries (Germany, France, Italy and Spain) using nonlinear impulse response functions and forecast accuracy tests. While for the U.S. both approaches point to the presence of asymmetries in the adjustment of retail prices, for the euro area the evidence is mixed.

Deregulation, vertical unbundling and the performance of China's large coal-fired power plants

- Energy Economics---2013---Xiaoli Zhao,Chunbo Ma

In 2003, China's integrated electricity utility – the State Power Corporation (SPC) – was unbundled and dismantled into five generation groups and two grid companies in an effort to increase competition and improve efficiency. In this paper, we study the impact of this deregulation reform on the operational efficiency for a balanced panel of 34 large power plants for the period 1997–2010. We find that on average these power plants have converged to the technological frontier over the sample period. Controlling for substantial heterogeneity in the technical profile, we also find that the unbundling reform has boosted productivity of China's large thermal power plants; however, the presumably differential impacts of the reform on the previously SPC-managed power plants and the independent power producers in our sample are insignificant.

Energy intensity and foreign direct investment: A Chinese city-level study

- Energy Economics---2013---Robert Elliott,Puyang Sun,Siyang Chen

In this paper we investigate the relationship between the energy intensity of Chinese cities and the location of foreign firms employing a unique dataset of 206 of the largest prefecture-level cities between 2005 and 2008. Our results reveal a non linear inverted-U shaped relationship between energy intensity and city-level per capita income with the majority of cities on the downward slope of the curve. We also find evidence of a significant and negative relationship between the foreign direct investment (FDI) flows into a city and energy intensity. However, this effect varies by geographic location reflecting differences in the ability of regions to absorb and benefit from environmental spillovers. The relatively small economic effect of FDI can in part explained by the propensity for foreign firms to invest in energy intensive sectors coupled with the trend for China to invest heavily in capital intensive industries.

Energy subsidies, structure of electricity prices and technological change of energy use

- Energy Economics---2013---Adriana Diaz Arias,Cees van Beers

This paper addresses the impact of the structure of energy prices on technological change in renewable energy sources. It operates on two fields of research that are often not related to each other. Firstly, the increasing interest in environmental economics for the determinants of green technological change, and secondly the impact of government policies aimed at subsidizing energy prices. Recent research claims a positive relationship between energy prices and the number of patents in the fields of energy efficiency. This paper extends this research by investigating the impact of the price structure of electricity on patent counts in 1) renewable energy sources, 2) wind energy and 3) solar power. In nearly all OECD countries in the period 1990–2006 industrial energy users pay a lower price per

energy unit than households due, among others, to government subsidy policies. The empirical results show that reducing government subsidies and hence increasing the electricity price of (large) industrial electricity users relative to the price paid by (small) residential users provides a clear incentive to increase inventions as measured by number of patents in the technical fields of solar and wind energy. These results are an important input in the debate on reducing government support to large energy users.

Scale-specific importance of weather variables for explanation of variations of electricity consumption: The case of Prague, Czech Republic

- Energy Economics---2013---Milan Bařta,Karel Helman

In this paper we explore the relative importance of the outside temperature and sunshine duration for the explanation of variations of electricity consumption in Prague, Czech Republic. An assessment of relative importance is made on various time scales ranging from the shortest ones associated with abrupt changes up to those associated with medium-run changes. Wavelet analysis is used to accomplish this task. We show that relative importance is scale-specific, i.e. depends on the analyzed time scale. Sunshine duration is generally the more important explanatory variable on the shortest time scales and the outside temperature dominates on higher time scales. The reason for the outside temperature being an inferior explanatory variable on the shortest time scales is a low variability of the outside temperature on these time scales and a dampened reaction of electricity consumption to abrupt changes in the outside temperature. Our results show that sunshine duration should be considered relevant when modeling electricity consumption.

The optimal subsidy on electric vehicles in German metropolitan areas: A spatial general equilibrium analysis

- Energy Economics---2013---Georg Hirte,Stefan Tscharaktschiew

E-mobility and diffusion of electric vehicles have become a major policy issue in many countries. For example, the German federal government pursues the strategy of achieving one million electric vehicles by 2020. In this paper we examine whether it is optimal to subsidize the use of electric vehicles by granting electric power subsidies and how large the corresponding optimal rate is. We, first, analytically derive the optimal power tax in a spatial model of a city with two zones where commuting, carbon emissions, endogenous labor supply, fuel and power taxes are considered. It is shown that in a spatial urban environment, the optimal tax rate depends in particular on transport related externalities, tax interaction effects and redistribution effects working via the urban land market. Second, we extend the model to a full spatial general equilibrium model and employ simulations to calculate sign and size of the optimal tax/subsidy rate. This model is calibrated to a typical German metropolitan area. The results show that electric vehicles should not be subsidized but taxed. The results are robust with respect to changes in the willingness to adopt electric vehicles, the costs of driving electric vehicles, and even if emissions of electric vehicles are zero.

Technology gap and China's regional energy efficiency: A parametric metafrontier approach

- Energy Economics---2013---Boqiang Lin,Kerui Du

This paper analyzes the energy efficiency of China's 30 administrative regions during the period from 1997 to 2010. Most existing studies ignored the variation of production technologies among regions in China. Taking this factor into account, we introduce a parametric metafrontier approach based on the Shephard energy distance function. For further analysis, regions in China are divided into three groups using cluster analysis. We find that the regions in group 1 (mainly the regions in the east area of China) not only have the highest energy efficiency score, but also take the lead in terms of technology gap ratio. Meanwhile, due to their backward technology levels, the average energy efficiency score of the regions in group 3 (mainly the regions in the west area of China) is particularly low.

Moreover, the pooled estimation, which ignores the technology gap among the groups, tends to underestimate the energy efficiency.

A global and local endogenous experience curve model for projecting future uptake and cost of electricity generation technologies

- Energy Economics---2013---Jennifer A. Hayward,Paul W. Graham

A global and local learning model (GALLM) has been developed to project the cost and global uptake of different electricity generation technologies to the year 2050. This model features three regions, endogenous technological learning within and across those regions, various government policies to facilitate technological learning and a penalty constraint which is used to mimic the effect market forces play on the capital cost of electricity generation technologies. This constraint has been added as market forces have been a strong factor in technology pricing in recent years. Global, regional and component experience curves have been developed for some technologies. The model, with the inclusion of these features, projects a diverse range of technologies contributing to global electricity generation under a carbon price scenario. The penalty constraint leads to gradual and continual installations of technologies and because the constraint provides a disincentive to install too much of a technology, it reduces the impact of uncertainty in the learning rate. Alternative forms of the penalty constraint were tested for their suitability; it was found that, with a zero and lower-cost version of the constraint, photovoltaics are installed in a boom-and-bust cycle, which is not supported by past experience. When the constraint is set at a high level, there are fewer installations.

Total-factor carbon emission performance of fossil fuel power plants in China: A metafrontier non-radial Malmquist index analysis

- Energy Economics---2013---Ning Zhang,Yongrok Choi

This paper proposes the metafrontier non-radial

Malmquist CO₂ emission performance index (MNM-CPI) for measuring dynamic changes in total-factor CO₂ emission performance over time. The MNMCPI method allows for the incorporation of group heterogeneity and non-radial slack into the previously introduced Malmquist CO₂ emission performance index (MCPI). We derive the MNMCPI by solving several non-radial data envelopment analysis (DEA) models. We decompose the MNMCPI into an efficiency change (EC) index, a best-practice gap change (BPC) index, and a technology gap change (TGC) index, and based on the proposed indices, we examine the dynamic changes in CO₂ emission performance and its decomposition of fossil fuel power plants in China for the 2005–2010 period. The empirical results show a 0.38% increase in total-factor CO₂ emission performance as a whole and a U-shaped MNMCPI curve for the sample period. Because companies owned by the central government lack innovation and technological leadership, the results suggest a missing link in the role of the central government in promoting CO₂ emission performance.

Estimates of inter-fuel substitution possibilities in Chinese chemical industry

- Energy Economics---2013---Boqiang Lin, Presley K. Wesseh

The chemical sector is a key driver of China's remarkable growth record and accounts for about 10% of the country's GDP. This has made the industry energy-intensive and consequently a major contributor to greenhouse gas emissions (GHG) and other pollutants. This study has attempted to investigate the potential for inter-fuel substitution between coal, oil, natural gas and electricity in Chinese chemical sector by employing a translog production and cost function. Ridge regression procedure was adopted to estimate the parameters of the function. Estimation results show that all energy inputs are substitutes. In addition, the study produces evidence that the significant role of coal in the Chinese chemical fuel mix converges over time, albeit slowly. These results suggest that price-based policies, coupled with capital subsidy programs can be adopted to redi-

rect technology use towards cleaner energy sources like electricity and natural gas; hence, retaining the ability to fuel the chemical sector, while also mitigating GHG emissions. Notwithstanding, one must understand that the extent to which substituting electricity for coal will be effective depends on the extent to which coal or oil is used in generating electricity. The findings of this study provide general insights and underscore the importance of Chinese government policies that focus on installed capacity of renewable electricity, energy intensity targets as well as merger of enterprises.

Heterogeneous effects of regulation on the efficiency of the electricity industry across European Union countries

- Energy Economics---2013---Fabrizio Pompei

This paper focuses on the relationship between the stringency of regulation (OECD indicators) and total factor productivity (TFP) growth in the electricity sectors of 19 European Union countries for the period 1994–2007. Both the OECD regulatory indicator and the TFP growth index have been decomposed in order to bring to light a complex picture of interrelations in which the negative impact of the overall regulation on productivity is the result of opposite forces. Estimation results tell us that only the stringency of entry regulation significantly reduces technological change, whereas vertical integration exhibits a negative and significant impact only on the catching up process (pure efficiency change). Lastly, we found an interesting result concerning the explanatory variables of the scale efficiency change: in this case only public ownership matters, in other terms high levels of public in the structure ownership of electric companies guarantee improvements in reaching the optimal scale of production. These heterogeneous effects are also confirmed when we use a different measure of efficiency, that is, the distance of the actual from the optimal reserve margin.

Realized volatility transmission between crude oil and equity futures markets: A multivariate HAR approach

- Energy Economics---2013---Michael Soucek,Neda Todorova

This paper differs from extant literature because it studies volatility co-movements with a multivariate orthogonalized HAR model, a flexible specification for the time series of realized volatility, which is able to identify short-, mid- and long-term spillover effects. We examine volatility transmission mechanisms using high-frequency data of the stock index futures on S&P 500, Nikkei 225, FTSE 100 and the futures on the West Texas Intermediate crude oil during the period from September 2002 to September 2012. Considering the full sample, the short-term volatility of the equity futures contains information about future oil volatility incremental to the information inherent in the time series of oil volatility. On the other hand, weekly and monthly volatilities do not exhibit a significant spillover effect. Breaking the whole sample into three subsamples, no significant Granger causalities are observed in the pre-crisis period while in the crisis time and its aftermath, we document that the US and UK equity market volatilities to Granger cause the oil futures volatility which itself leads the Japanese market. In terms of magnitude, we observe an increase in the short-term volatility spillover over time. Studying the residuals of the HAR transmission models within a CCC/DCC-GARCH framework reveals increasing instantaneous correlation between the energy and equity volatilities in the course of time.

Risk–return incentives in liberalised electricity markets

- Energy Economics---2013---Maireann Lynch,Aonghus Shortt,Richard Tol,O'Malley, Mark J.

We employ Monte Carlo analysis to determine the distribution of returns for various electricity generation technologies. Costs and revenues for each technology are calculated by means of a unit commitment and

economic dispatch algorithm at hourly resolution. This represents a considerable contribution to the literature as costs and revenues are determined endogenously, which in turn allows the returns of midmerit and peaking plant to be examined. Market entry is determined on the basis of a heuristic while market exit is according to a predetermined retirement schedule. The results show that CCGT is the investment technology of choice for baseload-only portfolios, while OCGT proves optimal when all technologies are considered. The high capital costs of baseload generation reduce incentives to invest. The methodology can be expanded to consider random outages, revenues from scarcity prices, capacity markets and ancillary service payments.

Taxing international emissions trading

- Energy Economics---2013---Valeria Costantini,Alessio D'Amato,Chiara Martini,Maria Cristina Tommasino,Edilio Valentini,Mariangela Zoli

We investigate the efficiency and effectiveness consequences of emissions trading taxation. A theoretical partial equilibrium model is developed, showing that permits taxation distorts the equilibrium price and abatement efforts. Potentially counterintuitive conclusions concerning the tax revenue are also derived. A CGE model complements theoretical results, suggesting that the change in the equilibrium permits price brought about by taxation can be significant. Finally, we conclude that policy design based on cost effectiveness might lead to wrong conclusions: the socially desirable design of emissions trading taxation requires homogenous tax rates applied to net sellers and no rebate rates allowed for net buyers.

Decarbonizing Europe's power sector by 2050 — Analyzing the economic implications of alternative decarbonization pathways

- Energy Economics---2013---Cosima Jägemann,Michaela Fürsch,Simeon Hagspiel,Stephan Nagl

The European Union aims to reduce greenhouse gas

emissions by 80–95% in 2050 compared to 1990 levels. The transition towards a low-carbon economy implies the almost complete decarbonization of Europe's power sector, which could be achieved along various pathways. In this paper, we evaluate the economic implications of alternative energy policies for Europe's power sector by applying a linear dynamic electricity system optimization model in over 36 scenarios. We find that the costs of decarbonizing Europe's power sector by 2050 vary between 139 and 633bn €2010, which corresponds to an increase of between 11% and 44% compared to the total system costs when no CO₂ reduction targets are implemented. In line with economic theory, the decarbonization of Europe's power sector is achieved at minimal costs under a stand-alone CO₂ reduction target, which ensures competition between all low-carbon technologies. If, however, renewable energies are exempted from competition via supplementary renewable energy (RES-E) targets or if investments in new nuclear and CCS power plants are politically restricted, the costs of decarbonization significantly rise. Moreover, we find that the excess costs of supplementary RES-E targets depend on the acceptance of alternative low carbon technologies. For example, given a complete nuclear phase-out in Europe by 2050 and politically implemented restrictions on the application of CCS to conventional power plants, supplementary RES-E targets are redundant. While in such a scenario the overall costs of decarbonization are comparatively high, the excess costs of supplementary RES-E targets are close to zero.

Changing energy intensity of economies in the world and its decomposition

- Energy Economics---2013---Chunhua Wang

This paper decomposes energy intensity change across countries into five components attributable to technological catch-up, technological progress and changes in capital–energy ratio, labor–energy ratio and output structure. It is found that (1) technological progress, capital accumulation and output structure change contributed to the decline of energy intensity from 1980 to 2010, (2) changes in labor–energy ratio drove up

energy intensity, and (3) spatial and temporal heterogeneity existed regarding relative importance of the five components.

The influence of rebate programs on the demand for water heaters: The case of New South Wales

- Energy Economics---2013---Nada Wasi, Richard Carson

This paper examines the role of Australian hot water system rebate programs in shifting the existing stock of electric water heaters toward more climate friendly versions using two unique data sets from New South Wales homeowners. The first data set is based on a survey of households who recently purchased a water heater before and after the rebate programs were in place. The other is based on a set of stated preference questions asked of households soon to face a replacement decision. While the former allows us to look at recent responses, the latter enables us to forecast future demand. We find that the programs significantly increase shares of solar/heat pump systems. The programs, however, appear less effective in reducing the stock of electric heaters for households with access to natural gas. This pattern is consistent in both datasets. Results from the discrete choice experiments suggest considerable heterogeneity with respect to household preferences toward different types of water heaters and the discount rates they hold. The effective cost of reducing carbon emissions via incentives for water heater replacement is considered from the counterfactual perspective of no government incentives.

CO₂ emissions, energy consumption and economic growth nexus in MENA countries: Evidence from simultaneous equations models

- Energy Economics---2013---Anis Omri

This paper examines the nexus between CO₂ emissions, energy consumption and economic growth using simultaneous-equations models with panel data of 14 MENA countries over the period 1990–2011. Our empirical results show that there exists a bidirectional causal relationship between energy consumption and

economic growth. However, the results support the occurrence of unidirectional causality from energy consumption to CO₂ emissions without any feedback effects, and there exists a bidirectional causal relationship between economic growth and CO₂ emissions for the region as a whole. The study suggests that environmental and energy policies should recognize the differences in the nexus between energy consumption and economic growth in order to maintain sustainable economic growth in the MENA region.

Is there a homogeneous causality pattern between oil prices and currencies of oil importers and exporters?

- Energy Economics---2013---Joscha Beckmann,Robert Czudaj

Although the link between oil prices and dollar exchange rates has been frequently analyzed, a clear distinction between prices and nominal exchange rate dynamics and a clarification of the issue of causality has not been provided. In addition, previous studies have mostly neglected nonlinearities which for example may stem from exogenous oil price shocks. Using monthly data for various oil-exporting and oil-importing countries, this study contributes to the clarification of those issues. We discriminate between long-run and time-varying short-run dynamics, using a Markov-switching vector error correction model. In terms of causality, the results differ between the economies under observation but suggest that the most important causality runs from exchange rates to oil prices, with a depreciation of the dollar triggering an increase in oil prices. On the other hand, changes in nominal oil prices are responsible for ambiguous real exchange rate effects mostly through the price differential and partly also through a direct influence on the nominal exchange rate. Overall, the fact that the adjustment pattern frequently differs between regimes underlines the fact that the relationships are subject to changes over time, suggesting that nonlinearities are an important issue when analyzing oil prices and exchange rates.

The energy transition of the transition economies: An empirical analysis

- Energy Economics---2013---Fan Zhang

The aggregate manufacturing energy intensity of 28 countries in Eastern Europe and Central Asia had declined by 35% during 1998–2008. This study reveals a strong evidence of convergence: less efficient countries improved more rapidly and the cross-country variance in energy productivity narrowed over time. An index decomposition analysis indicates that energy intensities declined largely because of more efficient energy use rather than shifts from energy intensive to less intensive manufacturing activities. Income growth and energy price increases were the main drivers of the convergence. They dominated the impact of trade, which led to specialization in energy intensive industries.

Quantifying regional economic impacts of CO₂ intensity targets in China

- Energy Economics---2013---Da Zhang,Sebastian Rausch,Valerie Karplus,Xiliang Zhang

To address rising energy use and CO₂ emissions, China's leadership has enacted energy and CO₂ intensity targets under the Twelfth Five-Year Plan (2011–2015), which are defined at both the national and provincial levels. We develop a computable general equilibrium (CGE) model with global coverage that disaggregates China's 30 provinces and includes energy system detail, and apply it to assess the impact of the current binding provincial CO₂ emissions intensity targets. We compare the impact of the provincial targets approach to a single target for China that achieves the same reduction in CO₂ emissions intensity at the national level. The national target assumes trading of emissions allowances across provinces, resulting in the least-cost reductions nationwide. We find that the national target results in about 20% lower welfare loss in China relative to the provincial targets approach. Given that the regional distribution of impacts has been an important consideration in the target-setting process, we focus on the changes in provincial-level

CO2 emissions intensity, CO2 emissions, energy consumption, and economic welfare. We observe significant heterogeneity across provinces in terms of the energy system response as well as the magnitude of welfare impacts. We further model the current policy of fixed end-use electricity prices in China and find that national welfare losses increase. Assumptions about capital mobility have a substantial impact on national welfare loss, while changing assumptions about the future availability of domestic natural gas resources does not have a large effect.

Ownership unbundling and investment in electricity markets — A cross country study

- Energy Economics---2013---Klaus Gugler,Margarethe Rammerstorfer,Stephan Schmitt

This paper is the first to explicitly test for the presence of a trade-off between static and dynamic efficiency and a trade-off between vertical economies and competition in a regulated industry, the electricity industry. We show for 16 European countries over the period 1998–2008 that higher electricity end-user prices in a country subsequently lead to larger aggregate investments in the capital stock, i.e. in generation, distribution and transmission assets. Moreover, there is a trade-off between vertical economies and competition. Ownership unbundling and forced access to the incumbent transmission grid increases competition but come at the cost of lost vertical economies. Generally, we find that regulation that affects only the market directly, like the establishment of a wholesale market or free choice of suppliers, increases aggregate investment. Regulation, however, that adversely affects the incumbent directly, like ownership unbundling, decreases aggregate investment spending.

The influence of the international oil prices on the real effective exchange rate in Romania in a wavelet transform framework

- Energy Economics---2013---Aviral Tiwari,Mihai Ioan Mutascu,Claudiu Albulescu

The purpose of this paper is to assess the empirical influence of oil prices on the real effective exchange rate in Romania in a wavelet transform framework. More precisely, we investigate to what extent oil prices impact the real effective exchange rate in an Eastern European transition country, characterised by a low level of retail fuel prices and by an important growth rate of these prices as compared to the other EU countries. For this purpose we use a discrete wavelet transform approach and scale-by-scale Granger causality tests. We find that oil prices have a strong influence on the real effective exchange rate in the short run, but also for large time horizons. These results are important considering the fact that, in a classical Granger causality linear framework for the entire sample, we find that oil prices have no influence on the real effective exchange rate. The findings remain robust when resampling the initial 1986–2009 period, or when we use an alternative continuous wavelet transform. In addition, we discover that mainly the positive shocks associated with an increase in oil prices have an impact upon the real effective exchange rate movements in the short and long runs.

Piecewise smooth approximation of bottom-up abatement cost curves

- Energy Economics---2013---Olga Kiwila,T.F. Rutherford

Top-down models usually include piecewise-smooth functions to describe marginal cost curves, while bottom-up models use step function curves. When a bottom-up cost curve is available, we can explicitly represent this curve with a top-down model in order to replicate its shape instead of using arbitrary assumptions. We propose several methods to approximate a piecewise function from a step function using constant elasticity of substitution technologies. Specifically, we consider a pollution abatement sector and calibrate the parameters of the abatement function in order to allow proper assessment of the economic effects of an environmental policy. Our methodology can be applied to any sector characterized by decreasing returns to scale technologies. We conclude that the elasticities of substitution need not be estimated only on the basis of

historical data, but can be precisely calibrated on the basis of engineering estimates of technology potential.

The effects of terrorism and war on the oil price–stock index relationship

- Energy Economics---2013---Christos Kollias, Catherine Kyrtsov, Stephanos Papadamou

The effects war and terrorism have on the covariance between oil prices and the indices of four major stock markets – the American S&P500, the European DAX, CAC40 and FTSE100 – using non-linear BEKK–GARCH type models are investigated. The findings indicate that the covariance between stock and oil returns is affected by war. A tentative explanation is that the two wars examined here predispose investors and market agents for more profound and longer lasting effects on global markets. On the other hand, terrorist incidents that are one-off unanticipated security shocks, only the co-movement between CAC40, DAX and oil returns is affected and no significant impact is observed in the relationship between the S&P500, FTSE100 and oil returns. This difference in the reaction may tentatively be interpreted as indicating that the latter are more efficient in absorbing the impact of terrorist attacks.

What if energy time series are not independent? Implications for energy-GDP causality analysis

- Energy Economics---2013---Stephan Bruns, Christian Gross

Time series of electricity, petroleum products, and renewables are found to be highly correlated with total energy consumption. Applying this insight to the huge literature on energy-GDP causality explains that the results of total energy-GDP causality tests frequently coincide with the results of energy type-GDP tests. Using the test by Toda–Yamamoto in combination with a cointegration-based testing approach, we detect such cases of concordance for 92% of the countries in our sample of 65 countries. We infer that drawing specific economic conclusions with regard to single types of energy from bivariate causality analysis is difficult.

Renewable electric energy integration: Quantifying the value of design of markets for international transmission capacity

- Energy Economics---2013---Karsten Neuhoﬀ, Julian Barquin, Janusz W. Bialek, Rodney Boyd, Chris J. Dent, Francisco Echavarren, Thilo Grau, Christian von Hirschhausen, Benjamin Hobbs, Friedrich Kunz, Christian Nabe, Georgios Papaefthymiou, Christoph Weber, Hannes Weigt

Integrating large quantities of variable renewable electricity generation remains a political and operational challenge. One of the main obstacles in Europe to installing at least 200 GWs of power from variable renewable sources is how to deal with the insufficient network capacity and the congestion that will result from new flow patterns. We model the current methodology for controlling congestion at international borders and compare its results, under varying penetrations of wind power, with models that simulate an integrated European network using nodal/localised marginal pricing. The nodal pricing simulations illustrate that congestion and price patterns vary considerably between wind scenarios and within countries, and that a nodal price regime could make better use of existing network capacity, introducing substantial operational cost savings and reducing marginal power prices in the majority of European countries.

End use technology choice in the National Energy Modeling System (NEMS): An analysis of the residential and commercial building sectors

- Energy Economics---2013---Jordan T. Wilkerson, Danny Cullenward, Danielle Davidian, John P. Weyant

The National Energy Modeling System (NEMS) is arguably the most influential energy model in the United States. The U.S. Energy Information Administration uses NEMS to generate the federal government’s annual long-term forecast of national energy consumption and to evaluate prospective federal energy policies. NEMS is considered such a standard tool that other models are calibrated to its forecasts, in both government and

academic practice. As a result, NEMS has a significant influence over expert opinions of plausible energy futures. NEMS is a massively detailed model whose inner workings, despite its prominence, receive relatively scant critical attention.

The impacts of the Clean Air Act on production cost, and the substitution between inputs in the electric utility industry

- Energy Economics---2013---Finn Førsund, Gerald Granderson

The paper examines how having to comply with Phase 1 of Title IV of the 1990 Clean Air Act affected production cost and the substitution between fuel and non-fuel (labor, capital) inputs. Phase 1 required firms to reduce their sulfur dioxide emissions. Enacting procedures to reduce sulfur dioxide emissions (using lower sulfur content coal or other fuel sources) could lead to higher cost, and impact the substitution between fuel and non-fuel inputs. Using a 1992-2000 panel of 34 U.S. electric utilities, empirical results indicate that the procedures electric utilities enacted to comply with Phase 1 contributed to small increases in both marginal cost and total cost. Firms having to comply with Phase 1 were more willing, than firms not subject to Phase 1, to substitute from fuel to non-fuel (labor, capital) inputs following an increase in the price of fuel. Utilities subject to Phase 1 that had a fuel clause were more willing, than Phase 1 firms without a fuel clause, to substitute from non-fuel inputs to fuel when the price of the non-fuel input increased.

Scenario-based energy efficiency and productivity in China: A non-radial directional distance function analysis

- Energy Economics---2013---H. Wang, P. Zhou, D.Q. Zhou, Peng Zhou

Improving energy efficiency and productivity is one of the most cost-effective ways for achieving the sustainable development target in China. This paper employs non-radial directional distance function approach to

empirically investigate energy efficiency and energy productivity by including CO₂ emissions as an undesirable output. Three production scenarios, namely energy conservation (EC), energy conservation and emission reduction (ECER), and energy conservation, emission reduction and economic growth (ECEREG), are specified to assess China's energy efficiency and productivity growth during the period of Eleventh Five-Year Plan. Our empirical results show that there exist substantial differences in China's total-factor energy efficiency and productivity under different scenarios. Under the ECEREG scenario, the national average total-factor energy efficiency score was 0.6306 in 2005–2010, while the national average total-factor energy productivity increased by 0.27% annually during the period. The main driving force for energy productivity growth in China was energy technological change rather than energy efficiency change.

The effects of electricity reforms on productivity and efficiency of China's fossil-fired power plants: An empirical analysis

- Energy Economics---2013---Limin Du, Yanan He, Jianye Yan

This paper investigates the effects of electricity reforms on productivity and efficiency of China's generation plants, based on the third industrial census data and the first economic census data. Partial factor productivity (PFP) analysis indicates that the productivity improvements in labor and capital inputs associated with the reforms are approximately 26% and 45% respectively. The effect of the reforms on fuel expense is weakly significant, but there is evidence of significant productivity improvement in fuel usage. Further total factor productivity (TFP) analysis shows that the efficiency gain from the reforms is still significant when the substitution effect of labor and capital inputs are considered, though the magnitude is much lower than that of the PFP analysis. The effect of the reforms on technical efficiency becomes weakly significant when fuel expense is further included in TFP analysis, but a significant positive effect is expected if fuel input is measured in physical quantity.

An almost ideal supply system estimate of US energy substitution

- Energy Economics---2013---Alexi Thompson

This paper introduces a Linear Almost Ideal Supply System (LAISS) model to examine aggregate US energy demand. Based on the Almost Ideal Demand System (AIDS) model, the LAISS model is a flexible functional form for imposing and testing properties of demand for the inputs of production. Own and cross price elasticities are derived for aggregate capital, labor, and energy, and compared to the translog cost function. Both models reduce to estimating a system of input share equations on input prices and output, with output normalized by the Stone's input price index in the LAISS model. Results indicate that all inputs are substitutes in both models, but elasticities differ. A log likelihood dominance criterion shows that the LAISS model dominates the translog cost function for this dataset. Results suggest that inputs are substitutes, and that an energy import tariff would increase demand for labor and capital.

Economic feasibility of biodiesel production from Macauba in Brazil

- Energy Economics---2013---Daniela de Carvalho Lopes, Antonio José Steidle Neto, Adriano Aguiar Mendes, Débora Tamires Vítor Pereira

In this work the economic feasibility of biodiesel production in Brazil by using the Macauba oil as raw matter is studied. The software SIMB-E, in which a cash flow model applied to biodiesel production is implemented, was used during simulations. Economic indexes related to biodiesel production features, as well as the competitiveness between selling prices of biodiesel and petrodiesel were considered. It was found that all of the 8 simulated scenarios were potentially profitable, but only 2 of them presented competitive biodiesel selling prices, being considered as worthwhile projects. These were seed-oil plants with alkaline transesterification. Results also indicated that the success of biodiesel production still requires additional revenues beyond that derived from biodiesel itself, including income from the

feedstock coproducts and glycerol. Macauba showed to be a potential crop to be used in biodiesel production. However, the domestication and improvement on processing of this species are indispensable to ensure its availability of long-term use.

Does the source of oil price shocks matter for South African stock returns? A structural VAR approach

- Energy Economics---2013---Rangan Gupta, Mampho P. Modise

In this paper, we investigate the dynamic relationship between different oil price shocks and the South African stock market using a sign restriction structural VAR approach for the period 1973:01 to 2011:07. The results show that for an oil-importing country like South Africa, stock returns only increase with oil prices when global economic activity improves. In response to oil supply shocks and speculative demand shocks, stock returns and the real price of oil move in opposite directions. The analysis of the variance decomposition shows that the oil supply shock contributes more to the variability in real stock prices. The main conclusion is that different oil price shocks affect stock returns differently and policy makers and investors should always consider the source of the shock before implementing a policy and making investment decisions.

On the short- and long-run efficiency of energy and precious metal markets

- Energy Economics---2013---Mohamed Aroui, Shawkat Hammoudeh, Amine Lahiani, Duc Khuong Nguyen

This article contributes to the related literature by empirically investigating the efficiency of nine energy and precious metal markets over the last decades, employing several pronounced models. We test for both short- and the long-run efficiency using, in addition to linear cointegration models, nonlinear cointegration and error-correction models (ECMs) which allow the efficiency intensity to change per regime. Our findings can be summarized as follows: i) futures prices are

found to be cointegrated with spot prices, but they do not constitute unbiased predictors of future spot prices; ii) the hypothesis of risk neutrality is rejected; iii) the short-run efficiency hypothesis is rejected, suggesting that using past futures price returns improves the modeling and forecasting of future spot prices; and iv) the nonlinear modeling suggests the presence of two distinct regimes wherein the first regime the efficiency hypothesis is supported, whereas in the second it is rejected. The empirical findings have important implications for producers, hedgers, speculators and policymakers.

DEA window analysis for environmental assessment in a dynamic time shift: Performance assessment of U.S. coal-fired power plants

- Energy Economics---2013---Toshiyuki Sueyoshi,Mika Goto,Manabu Sugiyama

This study discusses a new use of window analysis for DEA environmental assessment in a time horizon where DEA stands for Data Envelopment Analysis. The data sets on environmental protection are often structured by time series. In applying DEA to environmental assessment, it is necessary for us to examine a frontier shift between different periods because it indicates a technology progress on desirable and undesirable outputs. An important feature of the proposed approach is that it incorporates the concept of natural and managerial disposability into the computational framework of DEA and extends the two disposability concepts in a time horizon. To capture the frontier shift, this study proposes a new type of DEA window analysis for environmental assessment. This study applies the proposed DEA window analysis to a data set on U.S. coal-fired power plants during 1995–2007. The application finds that the coal-fired power plants have gradually paid attention to environmental protections under Clean Air Act (CAA). Consequently, their performance under managerial disposability has increased from 1996 to 2007. This indicates the importance of CAA and regulation on industrial pollutions. Thus, it is necessary for the United States to extend the scope of CAA for controlling the amount of CO₂ emission be-

cause current regulation has a limited policy influence on the source of global warming and climate change in our modern society.

The profitability of electricity generating firms and policies promoting renewable energy

- Energy Economics---2013---Jūratė Jaraite-Kažukauskė,Andrius Kazukauskas

Using a cross-country firm-level dataset this study empirically analyses how the implemented renewable electricity promotion systems – Tradable Green Certificates vs. Feed-in-Tariffs – affected the profitability of the electricity production sector in Europe during the 2002–2010 period. In particular, it tests the hypothesis that due to market imperfections, namely because of higher investment risk, higher capital constraints and higher transaction costs, TGC schemes will be associated with excess profits for renewable electricity generating firms. The results somewhat support this hypothesis, showing that electricity generating firms, operating in EU countries that implemented TGC, were more profitable compared to FIT firms.

Risk aversion and technology mix in an electricity market

- Energy Economics---2013---Guy Meunier

This article analyzes the effect of risk and risk-aversion on the long-term equilibrium technology mix in an electricity market. It develops a model where firms can invest in baseload plants with a fixed variable cost and peak plants with a random variable cost, and demand for electricity varies over time but is perfectly predictable. At equilibrium the electricity price is partly determined by the random variable cost and the returns from the two kinds of plants are negatively correlated. When the variable cost of the peak technology is high the return of peak plants is low but the return to baseload plants is high. Risk-averse firms reduce the capacity of the riskiest technology and develop the capacity of the other, compared to risk-neutral firms. In the particular case where a risk-neutral firm invests heavily in baseload technology and only sparsely

in peak capacity, a risk-averse firm would invest less in baseload, increase peak capacity, and increase total installed capacity.

Are the crude oil markets becoming more efficient over time? New evidence from a generalized spectral test

- Energy Economics---2013---Bing Zhang

This paper utilizes the newly developed method of a generalized spectral test to examine the weak-form efficiency of the main worldwide crude oil markets. The generalized spectral test, unlike other methods, can detect both linear and nonlinear serial dependence in the conditional mean and allows for different forms of unknown conditional heteroscedasticity. By using a “rolling sample” approach instead of an analysis of different time periods, we find that the efficiency of oil markets may depend on time periods. The main global crude oil markets reach weak-form efficiency in the long-term and the degree of efficiency of global oil markets changes over time. Among the oil markets examined in this study, the Brent and the WTI oil markets possess the highest efficiency levels, whereas the Daqing oil market has the lowest efficiency level. Apparent anti-synchronization is detected between the efficiency of Brent and WTI markets in recent years, whereas synchronization is found between the efficiency of Daqing and Dubai oil markets during the last decade.

Modeling the co-movements between crude oil and refined petroleum markets

- Energy Economics---2013---Bin Tong,Chongfeng Wu,Chunyang Zhou

In this paper we investigate two types of asymmetries, i.e., the asymmetry in the lower and upper tail dependences and the asymmetry in the propagation of crisis (bubble), between crude oil market and refined petroleum markets based on copula models. Thirteen copula models with different types of dependence structures and time-varying dependence parameters are considered. We find that in general the MALM

copula fits our sample data best based on AIC criterion. We find that lower and upper tail dependences are both positive indicating that crude oil and refined product markets tend to move together. Using the asymmetric copulas, we find asymmetry in tail dependence between crude oil and heating oil returns and that between crude oil and jet fuel returns. Interestingly, upper tail dependence is significantly greater than the lower tail dependence for the pre-crisis period, while the result is reversed for the post-crisis period. Finally, although our data prefers the nonexchangeable MALM copula, the asymmetry in the propagation of crisis (bubble) between crude oil and refined product returns is very weak.

Measures of the environmental footprint of the front end of the nuclear fuel cycle

- Energy Economics---2013---E. Schneider,B. Carlsen,E. Tavrdes,C. van der Hoeven,U. Phathanapirom

Previous estimates of environmental impacts associated with the front end of the nuclear fuel cycle (FEFC) have focused primarily on energy consumption and CO₂ emissions. Results have varied widely. This work builds upon reports from operating facilities and other primary data sources to build a database of front end environmental impacts. This work also addresses land transformation and water withdrawals associated with the processes of the FEFC. These processes include uranium extraction, conversion, enrichment, fuel fabrication, depleted uranium disposition, and transportation.

A top-down assessment of energy, water and land use in uranium mining, milling, and refining

- Energy Economics---2013---E. Schneider,B. Carlsen,E. Tavrdes,C. van der Hoeven,U. Phathanapirom

Land, water and energy use are key measures of the sustainability of uranium production into the future. As the most attractive, accessible deposits are mined out, future discoveries may prove to be significantly,

perhaps unsustainably, more intensive consumers of environmental resources. A number of previous attempts have been made to provide empirical relationships connecting these environmental impact metrics to process variables such as stripping ratio and ore grade. These earlier attempts were often constrained by a lack of real world data and perform poorly when compared against data from modern operations. This paper conditions new empirical models of energy, water and land use in uranium mining, milling, and refining on contemporary data reported by operating mines. It shows that, at present, direct energy use from uranium production represents less than 1% of the electrical energy produced by the once-through fuel cycle. Projections of future energy intensity from uranium production are also possible by coupling the empirical models with estimates of uranium crustal abundance, characteristics of new discoveries, and demand. The projections show that even for the most pessimistic of scenarios considered, by 2100, the direct energy use from uranium production represents less than 3% of the electrical energy produced by the contemporary once-through fuel cycle.

Quantitative analysis of feasibility of hydrous ethanol futures contracts in Brazil

- Energy Economics---2013---Derick David Quintino,Sergio Adriani David

Brazil's first ethanol futures contract, which was implemented in 2000, failed to offer sufficient liquidity to attract market agents. The purpose of this study is to determine whether the new ethanol futures contracts launched by BMF-BOVESPA in 2010 meet the requirements to render them feasible. The originality of this work stems from its approach in analyzing different cross-hedging possibilities in the food and energy chains. This analysis, which covers the period of May 2010 to April 2012, evaluates the degree of competition in the sector, the price volatility of the spot market, the price correlations between its possible substitutes, as well as the possibility of cross-hedging Brazil's ethanol with contracts in international futures markets and their potential degree of substitution. The results of

this study indicate that the new configuration of BMF-BOVESPA ethanol futures contracts meets the most requirements for viability. Nevertheless, the ethanol distribution sector is relatively concentrated, which may limit the liquidity of BMF-BOVESPA ethanol futures contracts.

The impact of federal incentives on the adoption of hybrid electric vehicles in the United States

- Energy Economics---2013---Alan Jenn,Inês L. Azevedo,Pedro Ferreira

Starting in 2004, the federal government in the United States offered several nationwide incentives to consumers to increase the adoption of hybrid electric vehicles. This study assesses the effectiveness of the Energy Policy Act of 2005 in this regard using econometric methods and data between 2000 and 2010. Our model accounts for network externalities by using lagged sales as an independent variable. This approach helps to capture the exponential initial growth associated with the diffusion of new technologies and avoids overestimating the effect of the policy incentives. Our results show that the Energy Policy Act of 2005 increased the sales of hybrids from 3% to 20% depending on the vehicle model considered. In addition, we find that this incentive is only effective when the amount provided is sufficiently large.

The value of domestic building energy efficiency — evidence from Ireland

- Energy Economics---2013---Marie Hyland,Ronan Lyons,Sean Lyons

Following the transposition of the EU Energy Performance of Buildings Directive into Irish law, all properties offered for sale or to let in Ireland are obliged to have an energy efficiency rating. This paper analyses the effect of energy efficiency ratings on the sale and rental prices of properties in the Republic of Ireland. Using the Heckman selection technique we model the decision to advertise the energy efficiency rating of a property and the effect of energy efficiency ratings

on property values. Our results show that energy efficiency has a positive effect on both the sales and rental prices of properties, and that the effect is significantly stronger in the sales segment of the property market. We also analyse the effect of energy efficiency across different market conditions and we find that the effect of the energy rating is generally stronger where market conditions are worse.

Supplier choice and WTP for electricity attributes in an emerging market: The role of perceived past experience, environmental concern and energy saving behavior

- Energy Economics---2013---Francisco Javier Amador,Rosa González,Francisco Ramos-Real

This study analyzes customers' preferences and their willingness to pay (WTP) for certain service attributes in an electricity supplier choice context. Specifically, a stated preference choice experiment is conducted in the Canary Islands' residential market where limited competition exists. Preferences for different electricity suppliers and three level-of-service attributes are investigated, namely, supply reliability, share of renewable energies and availability of a complementary energy audit service. The results might be interpreted as an indication of different aspects new firms need to consider if they plan to enter in the market. There is an opportunity for new companies to establish in the market, though evidence of brand loyalty to the current company and/or significant switching costs are also found, especially in the case of older people. Regarding the estimated WTP, several results should be highlighted. First, customers who have experienced more serious outages in the past tend to show a higher WTP to reduce the outage frequency. Second, highly-educated respondents, those who state a great concern for the greenhouse gases (GHG) emissions and those who carry out energy saving actions in their homes exhibit a larger WTP for renewable energies. This empirical evidence provides useful information for authorities responsible for energy policy design.

The responsibility for carbon emissions and carbon efficiency at the sectoral level: Evidence from China

- Energy Economics---2013---Youguo Zhang

This work reviews benefit-based principles to measuring responsibility for carbon emissions at the sectoral level using environmental input-output analysis. Several new emissions multipliers are proposed to measure sectoral carbon efficiency. These principles are used in an empirical analysis of carbon emissions in China, and differences between the principles are compared. The results indicate that all principles considered can prevent double-counting of emissions but that different principles may lead to significantly different attributions of responsibility for carbon emissions and to different multiplier values for particular sectors. Electricity and heat supply is found to be the sector with the highest emissions responsibility under all but the consumer responsibility principle, as well as the highest carbon multiplier under all principles. However, this sector's responsibility under producer responsibility principles is greater than that under other principles. Basic metals and transportation and post and telecommunication are among the top five sectors with the greatest responsibilities under all but the consumer responsibility principle, whereas construction has the highest consumer responsibility among all sectors. The pros and cons and policy implications of each principle are also discussed.

A model for hedging load and price risk in the Texas electricity market

- Energy Economics---2013---Michael Coulon,Warren B. Powell,Ronnie Sircar

Energy companies with commitments to meet customers' daily electricity demands face the problem of hedging load and price risk. We propose a joint model for load and price dynamics, which is motivated by the goal of facilitating optimal hedging decisions, while also intuitively capturing the key features of the electricity market. Driven by three stochastic factors

including the load process, our power price model allows for the calculation of closed-form pricing formulas for forwards and some options, products often used for hedging purposes. Making use of these results, we illustrate in a simple example the hedging benefit of these instruments, while also evaluating the performance of the model when fitted to the Texas electricity market.

Humps in the volatility structure of the crude oil futures market: New evidence

- Energy Economics---2013---Carl Chiarella,Boda Kang,Christina Nikitopoulos-Sklivosios,Thuy-Duong Tô

This paper analyses the volatility structure of commodity derivatives markets. The model encompasses hump-shaped, unspanned stochastic volatility, which entails a finite-dimensional affine model for the commodity futures curve and quasi-analytical prices for options on commodity futures. Using an extensive database of crude oil futures and futures options spanning 21 years, we find the presence of hump-shaped, partially spanned stochastic volatility in the crude oil market. The hump shaped feature is more pronounced when the market is more volatile, and delivers better pricing as well as hedging performance under various dynamic factor hedging schemes.

Filtering and forecasting commodity futures prices under an HMM framework

- Energy Economics---2013---Paresh Date,Rogemar Mamon,Anton Tenyakov

We propose a model for the evolution of arbitrage-free futures prices under a regime-switching framework. The estimation of model parameters is carried out using the hidden Markov filtering algorithms. Comprehensive numerical experiments on real financial market data are provided to illustrate the effectiveness of our algorithm. In particular, the model is calibrated with data from heating oil futures and its forecasting performance as well as statistical validity is investigated. The proposed model is parsimonious, self-calibrating and can be very useful in predicting futures prices.

Tracking industrial energy efficiency trends using index decomposition analysis

- Energy Economics---2013---B.W. Ang,X.Y. Xu

Index decomposition analysis (IDA) has been widely used to track economy-wide and sectoral energy efficiency trends. An integral part of this application is identifying the drivers of energy use for the energy consuming sector studied. In the case of industry, a monetary activity indicator such as value added is often taken as the driver. With the availability of physical production data for some industry subsectors, such as in tonnes or cubic meters, effort has been made by researchers to incorporate physical activity indicators in order to produce results that can better capture energy efficiency trends. We review and consolidate two different approaches to incorporating physical activity indicators in industrial energy studies using IDA. Based on their underlying concept, they are referred to as the intensity refactorization (IR) approach and the activity revaluation (AR) approach. We refine the AR approach, and compare the AR, IR, and the conventional monetary-based IDA approaches. Numerical examples and recommendations are presented.

A note on allowing negative energy prices in a discretely constrained MPEC

- Energy Economics---2013---Daniel Huppmann,Steven A. Gabriel,Florian U. Leuthold

2013

Co-fluctuation patterns of per capita carbon dioxide emissions: The role of energy markets

- Energy Economics---2013---Ross McKittrick,Joel Wood

This paper applies principal component analysis to investigate the linkages, or dominant co-fluctuation patterns, of per capita carbon dioxide emissions across countries for the time period 1950–2000. Energy resource world markets are investigated as an offsetting mechanism possibly coordinating emission fluctuations between countries. The results of the analysis provide

evidence that world energy resource markets are acting as a coordinating mechanism for emission fluctuations in most cases. The results also suggest that until recently the dominant emission co-fluctuation pattern for developed countries differs from the dominant emission co-fluctuation pattern for developing countries. The common fluctuation pattern found in the 1984–2000 time period suggests that an offsetting mechanism does exist and will help contain global per capita emissions into the future. The strong degree that emissions are linked between countries and energy markets acting as an offsetting mechanism suggests that to be successful a global agreement to address climate change must require emission reductions by all major emitters, not just the developed countries.

Robust estimation and forecasting of the long-term seasonal component of electricity spot prices

- Energy Economics---2013---Jakub Nowotarski,Jakub Tomczyk,Rafał Weron

We present the results of an extensive study on estimation and forecasting of the long-term seasonal component (LTSC) of electricity spot prices. We consider a battery of over 300 models, including monthly dummies and models based on Fourier or wavelet decomposition combined with linear or exponential decay. We find that the considered wavelet-based models are significantly better in terms of forecasting spot prices up to a year ahead than the commonly used monthly dummies and sine-based models. This result questions the validity and usefulness of stochastic models of spot electricity prices built on the latter two types of LTSC models.

Crude oil prices and liquidity, the BRIC and G3 countries

- Energy Economics---2013---Ronald Ratti,Joaquin Vespignani

Unanticipated increases in the BRIC countries' liquidity lead to significant and persistent increases in real

oil prices, global oil production and global real aggregate demand. Unanticipated shocks to the liquidity of developed countries over 1997:01–2011:12 do not. The relative contribution to real oil price of liquidity in BRIC countries to liquidity in developed countries is much greater since 2005 than before 2005. China and India drive the results for the effect of BRIC countries' liquidity on real oil price and global oil production. China and India and Brazil and Russia reinforce one another on the effect of liquidity on global real aggregate demand. Due to the difference between countries as commodity importers/exporters, the liquidity of Brazil and Russia increases significantly with a rise in real oil price and that of China and India decreases significantly with a rise in real oil price. It is shown that the strong rebound in oil price during 2009 is mostly due to strong effects of shocks to liquidity in the BRIC countries. The analysis helps in assessing the importance of the BRIC economies in the upsurge of the real price of crude oil.

On the economics of ramping rate restrictions at hydro power plants: Balancing profitability and environmental costs

- Energy Economics---2013---Shilei Niu,Margaret Insley

This paper examines the impact of ramping rate restrictions imposed on hydro operations to protect aquatic ecosystems. A dynamic optimization model of the profit maximizing decisions of a hydro operator is solved for various restrictions on water flow, using data for a representative hydro operation in Ontario. Profits are negatively affected, but for a range of restrictions the impact is not large. Ramping restrictions cause a redistribution of hydro production over a given day, which can result in an increase in total hydro power produced. This affects the need for power from other sources with consequent environmental impacts.

Non-nuclear, low-carbon, or both? The case of Taiwan

- Energy Economics---2013---Yen-Heng Henry Chen

The Fukushima nuclear accident in Japan has renewed debates on the safety of nuclear power, possibly hurting the role of nuclear power in efforts to limit CO₂ emissions. I develop a dynamic economy-wide model of Taiwan with a detailed set of technology options in the power sector to examine the implications of adopting different carbon and nuclear power policies on CO₂ emissions and the economy. Without a carbon mitigation policy, limiting nuclear power has a small economic cost for Taiwan, but CO₂ emissions may increase by around 4.5% by 2050 when nuclear is replaced by fossil-based generation. With a low-carbon target of a 50% reduction from year 2000 levels by 2050, the costs of cutting CO₂ emissions are greatly reduced if both carbon sequestration and nuclear expansion were viable. This study finds that converting Taiwan's industrial structure into a less energy-intensive one is crucial to carry out the non-nuclear and low-carbon environment.

Do petrol prices rise faster than they fall when the market shows significant disequilibria?

- Energy Economics---2013---Abbas Valadkhani

This paper examines if the long-run relationship between retail and wholesale petrol prices is subject to adjustment asymmetric behaviour using weekly Australian data (2007–2012) across 111 locations. A short-run dynamic model is specified in which three feedback coefficients capture three different types of disequilibria: large and positive; large and negative; small positive/negative. Significant evidence of asymmetric behaviour is found in 28 locations, which are mainly in Tasmania, Queensland and New South Wales. In these locations when prices are conspicuously above the equilibrium path, retailers sluggishly lower their prices but when prices are substantially below the equilibrium values, the adjustment speed is significantly faster.

The nexus between financial development and energy consumption in the EU: A dynamic panel data analysis

- Energy Economics---2013---Serap Coban,Mert Topcu

The relationship between financial development and energy consumption has newly started to be discussed in energy economics literature. This paper investigates this issue in the EU over the period 1990–2011 by using system-GMM model. No significant relationship is found in the EU27. The empirical results, however, provide strong evidence of the impact of the financial development on energy consumption in the old members. Greater financial development leads to an increase in energy consumption, regardless of whether financial development stems from banking sector or stock market. By contrast, we find for the new members that the impact of financial development on energy consumption depends on how financial development is measured. Using bankindex the impact of financial development displays an inverted U-shaped pattern while no significant relationship is detected once it is measured using stockindex.

The carbon rent economics of climate policy

- Energy Economics---2013---Matthias Kalkuhl,Robert J. Brecha

By reducing the demand for fossil fuels, climate policy can reduce scarcity rents for fossil resource owners. As mitigation policies ultimately aim to limit emissions, a new scarcity for “space” in the atmosphere to deposit emissions is created. The associated scarcity rent, or climate rent (that is, for example, directly visible in permit prices under an emission trading scheme) can be higher or lower than the original fossil resource rent. In this paper, we analyze analytically and numerically the impact of mitigation targets, resource availability, backstop costs, discount rates and demand parameters on fossil resource rents and the climate rent. We assess whether and how owners of oil, gas and coal can be compensated by a carbon permit grandfathering

rule. One important finding is that reducing (cumulative) fossil resource use could actually increase scarcity rents and benefit fossil resource owners under a permit grandfathering rule. For our standard parameter setting overall scarcity rents under climate policy increase slightly. While low discount rates of resource owners imply higher rent losses due to climate policies, new developments of reserves or energy efficiency improvements could more than double scarcity rents under climate policy. Another important implication is that agents receiving the climate rent (regulating institutions or owners of grandfathered permits) could influence the climate target such that rents are maximized, rather than to limit global warming to a socially desirable level. For our basic parameter setting, rents would be maximized at approximately 650GtC emissions (50% of business-as-usual emissions) implying a virtual certainty of exceeding a 2°C target and a likelihood of 4°C warming.

Decomposing changes in competition in the Dutch electricity market through the residual supply index

- Energy Economics---2013---Machiel Mulder,Lambert Schoonbeek

We propose to assess the influence of a number of events on the degree of competition in the Dutch electricity wholesale market over the period 2006–2011 through a decomposition method based on the residual supply index. We distinguish regulatory market-integration events, firm-level events and changes in the level of residual demand. We conclude that market-integration measures to improve competition have been effective, but that changes in residual demand appear to have been equally important. Firm-level events have only had a minor impact on the intensity of competition.

Energy consumption and real GDP in G-7: Multi-horizon causality testing in the presence of capital stock

- Energy Economics---2013---Paraskevi Salamali,Ioannis Venetis

This paper applies two recent time series methods to re-examine the causal relationship among energy consumption, real GDP and capital stock in G-7 countries. These methods, the Dufour et al. [2006, *Journal of Econometrics*, 132:337–362] multiple horizon causality testing and the Hill [2007, *Journal of Applied Econometrics*, 22:747–765] sequential causality testing allow to test for (non)causality in a multivariate framework and can further reveal the time profile of causal effects, the presence of causation delays and the direct or indirect nature of the causal effects. Given the trending nature of the time series employed, we further take into account the presence of structural breaks in the form of trend changes. Our empirical results show that multi-horizon causality testing does uncover crucial information with respect to the dynamic interaction among energy consumption, real GDP and capital stock, while structural breaks do exist and appear to be critical for causality inference. In regard to causality direction, we find that real GDP dominates in anticipating energy consumption in G-7 countries.

Weighting vectors and international inequality changes in environmental indicators: An analysis of CO2 per capita emissions and Kaya factors

- Energy Economics---2013---Juan Duro

Analyses of international inequality in environmental factors, such as the well-known CO2 per capita or the Kaya factors (that is, carbon intensity, energy intensity and affluence), have overlooked the effect that weighting vectors of distance functions and their time variations can have on the evolution of the inequality observed. Thus, for example, increases in the relative weight of countries with low emissions tend, *ceteris paribus*, to increase the inequality, even when the vector of international per capita emissions remains unchanged. This effect, strictly associated with share variations, is assessed in this paper by means of a simple decomposition methodology. This methodology allows us to ascertain what part of the time variation of the inequality is attributable to the variations in the shares and/or the variations in the environmen-

tal variable analysed and, in turn, suggests extending the analysis to the group components of inequality (Shorrocks, 1980). This proposition is used empirically to assess international inequalities in CO₂ per capita and the Kaya factors for a variety of sub-periods during the 1971–2007 period and for various satisfactory inequality indices.

Testing the effect of defaults on the thermostat settings of OECD employees

- Energy Economics---2013---Zachary Brown,Nick Johnstone,Ivan Haščič,Laura Vong,Francis Baras-cud

We describe a randomized controlled experiment in which the default settings on office thermostats in an OECD office building were manipulated during the winter heating season, and employees' chosen thermostat setting observed over a 6-week period. Using difference-in-differences, panel, and censored regression models (to control for maximum allowable thermostat settings), we find that a 1°C decrease in the default caused a reduction in the chosen setting by 0.38°C, on average. Sixty-five percent of this effect could be attributed to office occupant behavior (p-value=0.044). The difference-in-differences models show that small decreases in the default (1°) led to a greater reduction in chosen settings than large decreases (2°). We also find that office occupants who were more apt to adjust their thermostats prior to the intervention were less susceptible to the default. We conclude that this kind of intervention can increase building-level energy efficiency, and discuss potential explanations and broader policy implications of our findings.

Causality between energy and output in the long-run

- Energy Economics---2013---David Stern,Kerstin Enflo

Though there is a very large literature examining whether energy use Granger causes economic output or vice versa, it is fairly inconclusive. Almost all existing studies use relatively short time series, or panels with

a relatively small time dimension. We apply Granger causality and cointegration techniques to a Swedish time series dataset spanning 150years to test whether increases in energy use and energy quality have driven economic growth or vice versa. We show that these techniques are very sensitive to variable definition, choice of additional variables in the model, sample periods and size, and the introduction of structural breaks. The relationship between energy and growth may also have changed over time – energy causes output in the full sample while output causes energy use in recent smaller samples. Energy prices have a more robust causal impact on both energy use and output.

Norwegian climate policy reforms in the presence of an international quota market

- Energy Economics---2013---Geir H. Bjert-næs,Marina Tsygankova,Thomas Martinsen

This study shows that the second-best optimal difference between tax rates on goods that generate greenhouse gas emissions and non-polluting goods is equal to the quota price plus a Ramsey tax on the quota price when emission quotas are traded between governments and the price elasticity of these goods is identical. This tax difference exceeds the second-best optimal difference between tax rates on goods that generate a negative externality equivalent to the quota price and non-polluting goods. Model simulations show that a unilateral increase in emission tax to above the international quota price generates a welfare gain for Norway. Model simulations also show that an international tax/quota price increase generates a welfare gain (loss) for Norway if Norwegian imports of oil become substantial (marginal) in the long run.

Does crude oil price play an important role in explaining stock return behavior?

- Energy Economics---2013---Kuang-Liang Chang,Shih-Ti Yu

Employing the MS-ARJI-GJR-GARCH-X model, in which the parameters for the jump process, the asymmetric GARCH effect and the impacts of oil price

shocks are regime-dependent, this paper analyzes the impact of crude oil price shock on stock return dynamics. Empirical results reveal three interesting findings. First, incorporating the asymmetric GARCH effect and the oil price shock can substantially improve fitting ability. Second, the GARCH and jump components show very different behaviors during turbulent and stable periods. Third, the effects of current and past oil price shocks differ. The conditional mean, mean of jump size and variance of jump size immediately respond to a current oil price shock. A one-period lagged oil price shock, no matter whether positive or negative, can affect the transition probability that the stock market will remain conditional in the next period. Moreover, the effects of lagged positive and negative shocks on transition probabilities are very different.

Modeling returns and volatility transmission between oil price and US–Nigeria exchange rate

- Energy Economics---2013---Afees Salisu,Hakeem Mobolaji

This paper models returns and volatility transmission between oil price (OP) and US–Nigeria exchange rate (EXR). Consequently, it provides five main innovations: (i) it analyzes OP and EXR using the recently developed test by Narayan and Popp (2010) (NP) which allows for two structural breaks in the data series (ii) it employs the Narayan and Liu (2011) (NL) GARCH unit root test to evaluate robustness of NP test (iii) it considers the newly developed VAR-GARCH model to capture the spillover effects in the returns and volatility of OP and EXR; (iv) it modifies the VAR-GARCH model to account for structural breaks obtained from the NP procedure and (v) using the results obtained from the VAR-GARCH model, it examines the optimal weights of holding oil and foreign exchange (FX) assets and also computes the hedging ratios in the presence of oil risk. Based on the NP and NL tests, it finds robust structural breaks that coincide with the period of global financial crisis as well as period of FX crisis in Nigeria. Also, it establishes a bidirectional returns and spillover transmission between oil and FX markets. Finally, its findings reveal evidence of hedging effec-

tiveness involving oil and FX markets in Nigeria and thus, the inclusion of oil into a diversified portfolio of FX will improve its risk-adjusted return performance.

Parcelling virtual carbon in the pollution haven hypothesis

- Energy Economics---2013---Luis Antonio López,Guadalupe Arce,Jorge Zafrilla

The methodology proposed in this paper allows us to parcel the pollution haven hypothesis (PHH) into a bi-regional input–output framework to analyse whether the specialisation of countries in different stages of production and/or in final goods trading generates an increase or a decrease in global emissions as a consequence of international trade. We apply the model to the Spain–China trade relationship as it existed in 2005, finding a PHH of 29,667 KtCO₂. If this trade had not existed (so each country had met its demand for intermediate and final goods), global emissions would have been reduced by these 29,667 KtCO₂. Of this PHH, 43.5% corresponds to imports of final goods; 32.4% is related to imports of intermediate goods for the last stage of production; the remainder, 24.1%, is caused by global value chains (GVC) between the countries. Only 3229 KtCO₂ of PHH emissions are linked to domestic emissions from the sector in which the imports are produced; the rest is explained by domestic linkages or successive rounds of domestic production, which supports the existence of an indirect PHH. Together with a trade growth in the last years, the fall of trade barriers would have implied a transformation of global production chains that have boosted global emissions.

Market power in renewable portfolio standards

- Energy Economics---2013---Makoto Tanaka,Yihsu Chen

Renewable portfolio standard (RPS), which requires a certain percentage of electricity production from renewables, has received considerable attention. One emerging issue is the possibility of strategic behavior in the renewable energy certificate/credit (REC) market, and its spillover effects on the electricity market.

This paper develops dominant firm-competitive fringe models that account for market power. We show that market power could have significant impacts on the REC and power prices. In particular, when a nonrenewable generator is a dominant firm and a renewable generator is a competitive fringe, the nonrenewable firm has a strong incentive to lower the REC price, even to zero for avoiding REC costs. The zero REC price would negate price impacts in the power market, thereby mitigating market power of the dominant firm. However, this could lead to an underinvestment in renewables in the long run as subsidies received by renewables in form of RECs vanish. Therefore, regulatory agencies need to carefully oversee the market performance to ensure a healthy development of renewable industries under the RPS policies.

Deconstructing the Rosenfeld curve: Making sense of California's low electricity intensity

- Energy Economics---2013---Anant Sudarshan

Regulatory regimes that have increased household energy efficiency are of widespread interest to policymakers today. A prominent example is the state of California where electricity intensities in the residential sector have stayed near constant since the 1970s in sharp contrast to nationwide trends in the United States. A structural model of residential energy consumption is used to show that the use of energy intensities alone to evaluate the success of California efficiency programs is misleading and glosses over important policy independent factors. We quantify important effects of price, climate conditions and demographic characteristics on energy consumption in California. We also provide evidence of split incentive considerations in residential energy consumption patterns. We conclude that while state policy may have had some effect on efficiency, caution needs to be exercised in using the California example to inform expectations from similar measures in other regions.

A time-varying copula approach to oil and stock market dependence: The case of transition economies

- Energy Economics---2013---Riadh Aloui,Shawkat Hammoudeh,Duc Khuong Nguyen

We employ the time-varying copula approach to investigate the conditional dependence between the Brent crude oil price and stock markets in the Central and Eastern European (CEE) transition economies. Our results show evidence of a positive dependence between the oil and the stock markets of the six CEE countries, which is indicative of a contagion between those markets, regardless of the changes in the oil price or the CEE stock index. Moreover, the dependence patterns in both the center and left tails of the return distributions change over time, particularly during the heart of the financial crisis, and are best described by the Survival Gumbel copulas. The empirical evidence also suggests that the lower tail dependence is much stronger than that of the upper tail, highlighting the importance of contagion during severe contractionary business cycles. Among the sample markets, Poland is shown to be particularly sensitive in this regard, while Hungary and Slovenia are the least sensitive.

Electricity prices and public ownership: Evidence from the EU15 over thirty years

- Energy Economics---2013---Carlo Florio,Massimo Florio

This paper studies the impact of corporate ownership on residential net-of-tax electricity prices, when the ownership effect is separated from the liberalisation effect and from other drivers of change. After a discussion of a simple conceptual model, and of earlier literature, we use IEA and OECD data for the EU15 over nearly three decades. Panel econometrics suggests that, after controlling for other factors, public ownership is associated with lower residential net-of-tax electricity prices in Western Europe. The impact of liberalisation on prices is smaller and more uncertain.

Energy substitution: When model selection depends on the focus

- Energy Economics---2013---Peter Behl,Holger Dette,Manuel Frondel,Harald Tauchmann

In contrast to conventional model selection criteria, the Focused Information Criterion (FIC) allows for the purpose-specific choice of model specifications. This accommodates the idea that one kind of model might be highly appropriate for inferences on a particular focus parameter, but not for another. Ever since its development, the FIC has been increasingly applied in the realm of statistics, but this concept appears to be virtually unknown in the literature on energy and production economics. Using the classical example of the Translog cost function and production data for 35 U.S. industry sectors (1960–2005), this paper provides for an empirical illustration of the FIC and demonstrates its usefulness in selecting production models, thereby focusing on the ease of substitution between energy and capital versus energy and labor.

A cross-country analysis of electricity market reforms: Potential contribution of New Institutional Economics

- Energy Economics---2013---Erkan Erdoğan

The paper explores whether the question of why some countries are able to implement more extensive reforms is closely related to the question of why some countries have better institutions than others. We analyze this question by using an empirical econometric model based on Poisson regression with cross-section data covering 51 states in the US, 13 provinces in Canada and 51 other countries. In the course of the study, we check the validity of three important arguments of New Institutional Economics (NIE) for the power market liberalization process. The first argument is the “path-dependency”. To test its impact on the reform progress, we try to explain whether the background of the chairperson of the regulatory agency when reforms started or that of the governor/minister responsible for energy policy at that time has an impact on the subsequent reform progress. The second argument is

the impact of “democracy” as an institution on the reform progress. We look at the effect of two important indicators of democracy (i.e., civil liberties and political rights) on the reform progress. The final argument of NIE is about transaction costs. We concentrate on the level of corruption in a country as one of the key factors that determine transaction costs and try to explore its impact on the reforms. The results show that the backgrounds of the chairperson and the minister/governor, the level of democracy and corruption in a country are significantly correlated with how far reforms have gone in that country. The negative relationship between reform progress and civil liberties may indicate that reforms may be limited in democratic countries with strong civil society institutions such as trade unions or other organized structures in the society that may consider reforms as ‘harmful’ to their self-interest.

Household energy mix in Uganda

- Energy Economics---2013---Lisa Lee

This paper presents evidence that household energy use in Uganda conforms to the energy ladder theory. As household income increases, solid and transitional fuel use evolves in an inverse U manner, while electricity consumption shows a direct relationship with income. Public infrastructure provision, income, and education are the key variables which can be targeted to reduce household dependence on solid-fuels while increasing non-solid fuel use. While education and public infrastructure have varying impacts on rural and urban households’ energy mix, these variables generally reduce rudimentary fuel use and increase modern fuel consumption. Timely investment in electricity infrastructure is necessary to cater for burgeoning electricity demand as households become affluent. Strategies for reforestation, dissemination of improved cookstoves, relieving supply side constraints for modern fuels, and staggered payment options to lower the cost of entry for modern fuels can improve Ugandan households’ energy security.

Power TAC: A competitive economic simulation of the smart grid

- Energy Economics---2013---Wolfgang Ketter,John Collins,Prashant Reddy

Sustainable energy systems of the future will need more than efficient, clean, low-cost, renewable energy sources; they will also need efficient price signals that motivate sustainable energy consumption as well as a better real-time alignment of energy demand and supply. The Power Trading Agent Competition (Power TAC) is a rich competitive simulation of future retail power markets. This simulation will help us to understand the dynamics of customer and retailer decision-making and the robustness of market designs, by stimulating researchers to develop broker agents and benchmark them against each other. This will provide compelling, actionable information for policymakers and industry leaders. We describe the competition scenario in detail, and we demonstrate behaviors that arise from the interaction of customer and broker models.

The causal nexus between oil prices and equity market in the U.S.: A regime switching model

- Energy Economics---2013---Mehmet Balilar,Zeynel Ozdemir

The aim of this paper is to analyse the causal link between monthly oil futures price changes and a sub-grouping of S&P 500 stock index changes. The causal linkage between oil and stock markets is modelled using a vector autoregressive model with time-varying parameters so as to reflect changes in Granger causality over time. A Markov switching vector autoregressive (MS-VAR) model, in which causal link between the series is stochastic and governed by an unobservable Markov chain, is used for inferring time-varying causality. Although we do not find any lead-lag type Granger causality, the results based on the MS-VAR model clearly show that oil futures price has strong regime prediction power for a sub-grouping of S&P 500 stock index during various sub-periods in the sample, while there is a weak evidence for the regime prediction power of a sub-grouping of S&P 500 stock indexes. The

regime-prediction non-causality tests on the MS-VAR model show that both variables are useful for making inference about the regime process and that the evidence on regime-prediction causality is primarily found in the equation describing a sub-grouping of S&P 500 stock market returns. The evidence from the conditional non-causality tests shows that past information on the other series fails to improve the one step ahead prediction for both oil futures and stock returns.

The Double Dividend hypothesis in a CGE model: Specific factors and the carbon base

- Energy Economics---2013---Iain Fraser,Robert Waschik

We use a Computable General Equilibrium model to empirically examine the Double Dividend (DD) hypothesis. Using the GTAP model data for Australia, we examine three environmental taxes on the production of energy goods. Following Bento and Jacobsen (2007), we examine the role played by specific factors in the production of energy goods. Our results provide support for the existence of a strong DD in Australia when revenue is recycled through reductions in consumption taxes. The strong DD is larger when the share of specific factors is higher, and is much more pronounced when carbon taxes are charged on the production (origin-based accounting) rather than the usage (destination-based accounting) of carbon. These results draw attention to the importance of the definition of the carbon base and have implications for the scale of carbon leakage.

Voluntary electricity conservation of households after the Great East Japan Earthquake: A stated preference analysis

- Energy Economics---2013---Makoto Tanaka,Takanori Ida

This paper examines the voluntary electricity-saving awareness of households after the Great East Japan Earthquake and the subsequent accident at the Fukushima nuclear power station. We conduct a joint analysis of consumer stated preferences for the set-

tings of air conditioners, refrigerators, and the standby power of electrical appliances, based on a web questionnaire survey administered in the areas supplied by the Tokyo Electric Power Company (TEPCO) and Kansai Electric Power Company (KEPCO). The main findings of this paper are as follows. First, we observe awareness of voluntary electricity conservation among the households in both the TEPCO and KEPCO areas after the disasters. Second, awareness of voluntary power saving is higher in the TEPCO area, which has been directly affected by the electric power shortages, in comparison with the KEPCO area, where there was no such direct impact. Third, if power prices are to be further raised, the consumer responses to the price changes would be small in both areas. Furthermore, we show that the potential voluntary reduction in electric power consumption of a household in the TEPCO area is 26% more than that in the KEPCO area during the summer peak periods.

Fukushima's impact on the European power sector: The key role of CCS technologies

- Energy Economics---2013---Sandrine Selosse,Olivia Ricci,Nadia Maïzi

The accident in Fukushima, Japan, in March 2011 has reactivated the discussion on how to meet ambitious climate mitigation objectives as some European countries reconsider the contribution of nuclear power in their energy mix. This study evaluates the impact of nuclear power reduction in Europe on the electricity mix under carbon emission reduction scenarios while considering the availability of carbon capture and storage technological options (CCS). The potential cost of carbon reduction is also addressed using the bottom-up optimization model TIAM-FR. The results suggest that CCS technologies constitute an interesting option in a case of stringent climate targets and limited nuclear electricity. However, the unavailability of CCS technologies induces a significant increase in carbon marginal cost and energy system cost to achieve the climate policy.

Production function with electricity consumption and its applications

- Energy Economics---2013---Zheng Hu,Zhaoguang Hu

Researchers have tried to track the pattern of economy activities for decades. Cobb–Douglas production function has been adopted for almost one hundred years, while modern economists tend to analyze the economy via the aspect of individual agents. A different perspective of reviewing Cobb–Douglas function is needed. This paper finds a closer relationship between electricity consumption and economy, which can be represented via a strong similarity between four characteristics of “genes” . A second finding is that countries after post-industrialization should enter the phase of up-industrialization, which largely focuses on technology accumulated value added for the secondary industry. Case study in this paper illustrates that the U.S. is entering the up-industrialization period. Countries that deemphasize on technology innovations will sooner or later result in severe economic consequences or financial crisis. This paper also initially encourages the wide application of smart meters and integration of smart grid to obtain timely and accurate data of electricity consumption to observe unusual economic activities.

Hurricane forecast revisions and petroleum refiner equity returns

- Energy Economics---2013---Jason Fink,Kristin E. Fink

We test the return reaction of an index of petroleum refining firms to the official forecast revisions for major tropical storms in the refinery-dense region of the north-west Gulf of Mexico. First, we find that improvements in official hurricane forecasts over the last twenty years have had a direct effect on when asset prices react in anticipation of tropical storms. In the 1990s, traders react to forecasts at the 24-hour horizon. A decade later they react earlier — price movements in the 2000s react to forecast information at the 48-hour horizon. Second, we find that the effect of upward revisions

in storm intensity is associated with increases in the returns to our index. These increases only accrue to large firms, perhaps due to these firms' ability to utilize geographic diversification and previously idle capacity to take advantage of storm-induced increases in refined petroleum prices.

Evaluating a seasonal fuel tax in a mass tourism destination: A case study for the Balearic Islands

- Energy Economics---2013---Mohcine Bakhat,Jaume Rossello

This paper estimates the monthly aggregate demand for diesel oil and gasoline in a mass tourism region, characterized for a high level of seasonality. Using time series models, price elasticities are estimated with special emphasis in evaluating differences between seasons in order to assess the consequences of a fuel tax applied exclusively during the high season. Using the case study of the Balearic Islands (Spain) from January-1999 to December-2010 results from a partial adjustment model show a relatively low price-elasticity, evidencing how the internalizing mechanism that could be argued for introducing the tax in order to reduce transport externalities does not work. Additionally no statistical differences have been found between seasons for both fuels invalidating the argument that tourism activity reacts differently to host activity.

Power outages and economic growth in Africa

- Energy Economics---2013---Thomas Andersen,Carl-Johan Dalgaard

This paper estimates the total effect of power outages on economic growth in Sub-Saharan Africa over the period 1995–2007. We pay close attention both to potential errors of measurement of African economic growth and to the endogeneity of outages. As suggested by Henderson et al. (American Economic Review 102(2): 994–1028, 2012), we combine Penn World Tables GDP data with satellite-based data on nightlights to arrive at a more accurate measure of economic growth. Following Andersen et al. (Review of Economics and

Statistics 94(4): 903–924, 2012), we also employ lightning density as an instrument for power outages. Our results suggest a substantial growth drag of a weak power infrastructure in Sub-Saharan Africa.

Is the energy-led growth hypothesis valid? New evidence from a sample of 85 countries

- Energy Economics---2013---Nicholas Apergis,Chor Foon Tang

The energy-growth literature contains a large number of discussions on the causal relationship between energy consumption and economic growth. The central debate focuses on whether energy consumption contributes or not to economic growth since it has direct implications for the formulation of strategic policies. Nevertheless, current studies cannot provide a conclusive suggestion due to mixed causality results. This inconclusive evidence is potentially attributed to model specifications and the stage of economic development of the countries under investigation. Hence, this study attempts to empirically re-investigate the validity of the energy-led growth hypothesis using a different model specification and different stages of economic development for 85 selected countries around the globe. Overall, although the causality results are mixed among countries, we do find a systematic pattern. In particular, Granger causality models with three and four variables are more likely to support the hypothesis compared to their counterparts that contain only two variables. In addition, both developed and developing countries are more likely to support the energy-led growth hypothesis compared to the less developed or low income countries. Therefore, causality results are very sensitive to the choice of the model specification along with the stages of economic development. Finally, energy conservation policies should only focus on low income countries as these policies may not retard the process of economic growth.

Implications of CO2 reduction policies for a high carbon emitting economy

- Energy Economics---2013---John Asafu-Adjaye,Renuka Mahadevan

This paper uses a dynamic computable general equilibrium model to compare the macroeconomic and sectoral impacts of three environmental policies in Australia — an emissions trading scheme (ETS), an ETS combined with technological innovation in the renewable energy sector and a fuel tax as an alternative to the ETS. Overall, the impacts of the ETS were not significantly adverse. Although the fuel tax had similar impacts to the ETS on key macro-variables such as real GDP, employment, household consumption, exports and imports, it was however not effective compared to the latter in reducing emissions. Neither policy led to inflation growth of more than 0.8% for any coal mining and non-mining Australian state. At the sectoral level, the GDP growth of energy-intensive industries such as coal, iron ore, steel and coal-powered electricity generators is adversely affected while electricity generators who use gas and renewable energy sources and the forestry sector gain. It was also found that a 10% technological change in the renewable energy sector over a decade did not significantly improve the outcome when coupled with the ETS. Thus the Australian government's industry assistance to invest in low pollution technologies needs to be more aggressive to meet current and future international emission abatement targets.

Energy literacy, awareness, and conservation behavior of residential households

- Energy Economics---2013---Dirk Brounen,Nils Kok,John Quigley

The residential sector accounts for one-fifth of global energy consumption, resulting from the requirements to heat, cool, and light residential dwellings. It is therefore not surprising that energy efficiency in the residential market has gained importance in recent years. In this paper, we examine awareness, literacy and behavior of households with respect to their residential energy expenditures. Using a detailed survey of 1721 Dutch households, we measure the extent to which consumers are aware of their energy consumption and whether they have taken measures to reduce their energy costs. Our results show that “energy literacy”

and awareness among respondents is low: just 56% of the respondents are aware of their monthly charges for energy consumption, and 40% do not appropriately evaluate investment decisions in energy efficient equipment. We document that demographics and consumer attitudes towards energy conservation, but not energy literacy and awareness, have direct effects on behavior regarding heating and cooling of the home. The impact of a moderating factor, measured by thermostat settings, ultimately results in strong variation in the energy consumption of private consumers.

Saving money vs investing money: Do energy ratings influence consumer demand for energy efficient goods?

- Energy Economics---2013---Luca Panzone

The article analyses economic barriers leading to the energy efficiency gap in the market for energy-using products by observing several million transactions in the UK over two years. The empirical exercise estimates AIDS models for refrigerators, washing machines, TVs, and light bulbs. Results indicate that market barriers are crucial in the demand for energy efficient options, and consumer response to changes in appliance prices, total expenditures, and energy prices depends on the possibility of behavioural adjustments in consumption. In contrast with the induced innovation hypothesis, current electricity prices can fail to induce innovation because of their short-term impact on disposable income, while consumers invest in energy efficiency when expecting electricity prices to rise in the future.

Energy risk management through self-exciting marked point process

- Energy Economics---2013---Rodrigo Herrera

Crude oil is a dynamically traded commodity that affects many economies. We propose a collection of marked self-exciting point processes with dependent arrival rates for extreme events in oil markets and related risk measures. The models treat the time among extreme events in oil markets as a stochastic process. The main advantage of this approach is its capability

to capture the short, medium and long-term behavior of extremes without involving an arbitrary stochastic volatility model or a prefiltration of the data, as is common in extreme value theory applications. We make use of the proposed model in order to obtain an improved estimate for the Value at Risk in oil markets. Empirical findings suggest that the reliability and stability of Value at Risk estimates improve as a result of finer modeling approach. This is supported by an empirical application in the representative West Texas Intermediate (WTI) and Brent crude oil markets.

Are car manufacturers on the way to reduce CO2 emissions?: A DEA approach

- Energy Economics---2013---Augusto Voltes-Dorta,Jordi Perdigueró,Juan Jiménez González

One of the pillars of the fight against climate change is reducing the amount of greenhouse gases that are emitted into the atmosphere. In that regard, curtailing CO2 emissions from transport activities is a major objective. In its attempts of “decarbonising” transport, the European Commission set in 2009 different emission limits on the vehicles sold in Europe. With this background, this paper aims to test the ability of the major car manufacturers to meet these present and future targets with the existing technological trends. To that end, we provide an in-depth analysis on the temporal evolution of emission efficiencies in the Spanish car market. The well-known DEA-Malmquist method is applied over a large sample of car models sold in Spain between 2004 and 2010. A second-stage regression allows us to identify the main drivers of efficiency, catch-up and technical change over the period. Finally, the estimated trends are extrapolated to predict future emission levels for the car manufacturers. Using post-regulation rates of technical change, results show that the vast majority of companies would meet the 2015 target, 27% of the current market would meet the 2020 target, and around 3% would be able to comply with the 2025 target. Thus, since all targets are technologically feasible, stricter regulation is the recommended approach to encourage manufacturers to meet the goals set by the European Commission.

An evaluation framework for oil import security based on the supply chain with a case study focused on China

- Energy Economics---2013---Hai-Ying Zhang,Qiang Ji,Ying Fan

The import risks confronting oil consumers are influenced by transport conditions, oil prices, geopolitics, etc. This paper constructs an evaluation framework for oil import security from a perspective of supply chain process, and builds a two-phase DEA-like model to evaluate oil import security. China is taken as an example to measure its oil import security during 1993–2011 and to identify the main risk factors in different periods. Results indicate that China’s oil import risks have kept rising since 1993 and face multiple potential threats from each stage of oil import supply chain, among which the threat from external dependence has become the biggest challenge. Under different economic situations and changing energy environment, the risk factors affecting China’s oil import security switched among different stages of the supply chain, showing a phase-transitioning characteristic from import over-dependence to increasing external supply pressure. The threat of external supply has become a new risk since the pressure of decreasing availability of external resource rose.

Identifying spikes and seasonal components in electricity spot price data: A guide to robust modeling

- Energy Economics---2013---Joanna Janczura,Stefan Trück,Rafał Weron,Rodney C. Wolff,Stefan Trueck

An important issue in fitting stochastic models to electricity spot prices is the estimation of a component to deal with trends and seasonality in the data. Unfortunately, estimation routines for the long-term and short-term seasonal pattern are usually quite sensitive to extreme observations, known as electricity price spikes. Improved robustness of the model can be achieved by (a) filtering the data with some reasonable procedure for outlier detection, and then (b) using estimation

and testing procedures on the filtered data. In this paper we examine the effects of different treatments of extreme observations on model estimation and on determining the number of spikes (outliers). In particular we compare results for the estimation of the seasonal and stochastic components of electricity spot prices using either the original or filtered data. We find significant evidence for a superior estimation of both the seasonal short-term and long-term components when the data have been treated carefully for outliers. Overall, our findings point out the substantial impact the treatment of extreme observations may have on these issues and, therefore, also on the pricing of electricity derivatives like futures and option contracts. An added value of our study is the ranking of different filtering techniques used in the energy economics literature, suggesting which methods could be and which should not be used for spike identification.

Gasoline price volatility and the elasticity of demand for gasoline

- Energy Economics---2013---C.-Y. Cynthia Lin Lawell, Lea Prince

We examine how gasoline price volatility impacts consumers' price elasticity of demand for gasoline. Results show that volatility in prices decreases consumer demand for gasoline in the intermediate run. We also find that consumers appear to be less elastic in response to changes in gasoline price when gasoline price volatility is medium or high, compared to when it is low. Moreover, we find that when we control for variance in our econometric model, gasoline price elasticity of demand is lower in magnitude in the long run.

Assessing the U.S. oil security premium

- Energy Economics---2013---Stephen Brown, Hillard Huntington

World oil supply disruptions lead to U.S. economic losses. Increased oil consumption increases the vulnerability of the economy to oil supply disruptions, but it matters where the additional oil is produced. Increased production from stable producers can dampen

future oil price shocks, whereas increased production from unstable producers can exacerbate future oil price shocks. Because oil is fungible, U.S. pricing and import policies can differentiate only between domestic and imported oil rather than between stable and unstable sources. The economic losses associated with oil supply disruptions—GDP losses and some transfers abroad—are externalities that can be quantified as oil security premiums. We estimate these premiums by taking into account projected world oil market conditions, probable oil supply disruptions, the market response to oil supply disruptions, and the resulting U.S. economic losses.

Spatiotemporal analysis of ethanol market penetration

- Energy Economics---2013---Xiaodong Du, Miguel Carriquiry

Consumption of ethanol in the United States has increased rapidly over the last few years, fueled by both higher crude oil prices and generous public support measures for renewable fuels. The contribution of ethanol to the transport energy mix varies markedly by state. Heterogeneity in ethanol adoption and market development is investigated using a hierarchical, spatiotemporal model. A Bayesian Markov chain Monte Carlo method is employed for estimation of the proposed flexible model structure. Besides spatial dependence among neighboring states, differential inclusion rates of ethanol are found to be largely determined by national- and state-level biofuel incentive policies, relative gasoline prices, feedstock availability, household median income, MTBE bans, and density of fuel retail infrastructure. Our findings imply that increasing renewable fuel support as well as investing in extending the transportation and fuel retail infrastructure can result in higher ethanol consumption.

Oil price asymmetric effects: Answering the puzzle in international stock markets

- Energy Economics---2013---Sofia Ramos, Helena Veiga

Although studies have found an asymmetric pattern in the response of aggregate output to oil price changes, parallel studies in stock markets have not been conclusive about their existence. This paper finds evidence that effects for oil-importing and oil-exporting countries run in opposite directions. Oil price hikes have a negative effect on the stock markets of oil-importing countries, while the impact is positive for the stock markets of oil-exporting countries. Statistical tests support the presence of asymmetric effects only in oil-importing countries. Oil price volatility has a negative impact in stock markets of oil-importing countries and positive in oil-exporting countries. Moreover, oil volatility seems to be affected asymmetrically by oil price changes. Oil price drops increase oil volatility more than oil price hikes do. Overall, the evidence seems to support that falls in oil prices do not impact stock markets because their positive effects are offset by negative effects of oil price volatility, canceling out effects for oil-importing countries.

A critique of non-parametric efficiency analysis in energy economics studies

- Energy Economics---2013---Chien-Ming Chen

The paper reexamines non-additive environmental efficiency models with weakly-disposable undesirable outputs appeared in the literature of energy economics. These efficiency models are used in numerous studies published in this journal and other energy-related outlets. Recent studies, however, have found key limitations of the weak-disposability assumption in its application to environmental efficiency analysis. It is found that efficiency scores obtained from non-additive efficiency models can be non-monotonic in pollution quantities under the weak-disposability assumption — which is against common intuition and the principle of environmental economics. In this paper, I present taxonomy of efficiency models found in the energy economics literature and illustrate the above limitations and discuss implications of monotonicity from a practical viewpoint. Finally, I review the formulations for a variable returns-to-scale technology with weakly-disposable undesirable outputs, which has been

misused in a number of papers in the energy economics literature. An application to evaluating the energy efficiencies of 23 European Union states is presented to illustrate the problem.

A marginal measure of energy efficiency: The shadow value

- Energy Economics---2013---Asgar Khademvatani, Daniel Gordon

Economists are well aware of the importance of marginal versus average measures of energy efficiency. Yet in the energy literature, there is no consensus on the appropriate method for defining and measuring energy efficiency. This paper sets out the shadow value of energy as a proper and meaningful marginal energy efficiency index. A restricted profit function is used to model the shadow value. We explore four scenarios to characterize and evaluate the shadow value of energy; a within country comparison of different production processes with different energy requirements, a comparison of different countries with different resource endowment, a government policy to impose a tax to alter the shadow value to address environmental issues and a within country comparison of externalities arising from two sources of energy. A comparative static analysis is carried out to sign the functional arguments defined for the shadow value.

Smooth transition regime shifts and oil price dynamics

- Energy Economics---2013---Giulio Cifarelli

The interaction between rational hedgers and informed oil traders is parameterized and tested empirically with the help of a complex non linear smooth transition regime shift CCC-GARCH procedure. In spite of their gyrations, futures price changes are usually self-correcting. Well informed producers and consumers will ensure that crude oil prices – and thus the prices of the corresponding futures contracts – fluctuate within a long run equilibrium range determined by market fundamentals. During a steep price upswing, however,

shifts in positions in the futures markets by well informed optimizing agents that usually dampen price changes, result in destabilizing positive feedback trading. Futures price changes that can be classified as speculative are due to destabilizing hedgers' reactions to movements in the variability of the return of their covered cash position. The paper provides in this way an innovative interpretation of the 2008 oil price bubble.

The liquidity of energy stocks

- Energy Economics---2013---Konstantinos Sklavos,Lammertjan Dam,Bert Scholtens

This study investigates the dynamics of stock market liquidity in the energy industry in the US for 130 firms for the period 2006–2011. We use a (structural) vector autoregression approach to model the simultaneous relationships between three liquidity measures, namely turnover, price impact and spread. In addition, we account for oil prices in this model. The liquidity measures exhibit a persistent (highly autocorrelated) pattern. The intensity of trading appears to be relevant for the interrelationships of the liquidity measures. Stocks that are traded more often seem to be less sensitive to changes in liquidity. The main contribution of this study is that we introduce and test a specific causality pattern between trading activity, price impact, and spreads of energy stocks. This causality pattern is stronger during illiquid periods, which makes these periods much more risky.

Hybrid modeling to support energy-climate policy: Effects of feed-in tariffs to promote renewable energy in Portugal

- Energy Economics---2013---Sara Proença,Miguel Aubyn

Feed-in tariffs have been the main policy instrument applied in Portugal for the promotion of electricity produced from renewable energy sources under the EU Directives on energy and climate regulation. In this paper, we provide an empirical impact assessment of the economic and environmental effects of Portugal's

FITs policy to promote RES-E generation. Impact assessment of policy instruments plays a crucial role on decision-making process. For numerical simulations, we make use of a hybrid top-down/bottom-up general equilibrium modeling approach, which represents a reliable tool to analyze the complex interactions between economic, energy, and environmental issues related to energy policies.

An assessment of the optimal timing and size of investments in concentrated solar power

- Energy Economics---2013---Emanuele Massetti,Elena Claire Ricci

We extend the WITCH model to consider the possibility to produce and trade electricity generated by large-scale concentrated solar power plants (CSP) in highly productive areas that are connected to demand centers through High Voltage Direct Current cables. We test the attractiveness of the CSP option by imposing a global cap on Greenhouse gases concentration equal to 535ppm CO₂-eq in 2100, with and without constraints to the expansion of nuclear power and IGCC coal with carbon capture and storage (CCS). We find that it becomes optimal to produce with CSP from 2040 and to trade CSP electricity across the Mediterranean from 2050. Therefore projects like DESERTEC seem to be premature. After 2050, CSP electricity shares become significant. CSP has a high stabilization cost option value: depending on the constraints, it ranges between 2.1% and 4.1% of discounted GDP in the Middle East and North Africa (MENA), between 1.1. and 3.4 in China, between 0.2% and 1.2% in the USA, between 0.1 and 1.3% in Eastern Europe and between 0.1 and 0.4% in Western Europe. A moderate level of subsidy to invest more and earlier in CSP might increase welfare. However, large-scale deployment should occur after 2040. We also show that MENA countries have the incentive to form a cartel to sell electricity to Europe at a price higher than the marginal cost. This suggests that a hypothetical Mediterranean market for electricity should be carefully regulated.

Assessing the impact of oil returns on emerging stock markets: A panel data approach for ten Central and Eastern European Countries

- Energy Economics---2013---Dimitrios Asteriou, Yuliya Bashmakova

This paper uses an international multi-factor model in order to investigate the relationship between oil price risk and stock market returns for the emerging capital markets of the Central and Eastern European Countries (CEECs). A panel data approach is being employed for the period covering 22 October 1999 until 23 August 2007. The oil price beta is found to be negative and statistically significant suggesting that the oil price is indeed an important factor in determining stock returns. No statistically significant non-linear dependency is found between market risk and emerging market stock returns or between oil price risk and returns. Observation of conditional models shows positive reaction of emerging stock market returns to upward movements of market returns. The reaction of the stock returns to upward and downward movements of the oil market is also negative but more significant when oil prices are low.

The relationship between spot and contract gas prices in Europe

- Energy Economics---2013---Frank Asche, Bård Miskund, Marius Sikveland

Following deregulations in the European gas market, spot trading of natural gas has been established in the UK, Belgium and the Netherlands, while long-term contracts remain the dominant pricing process in continental Europe. In this paper we investigate the degree of market integration between the three spot markets, the contract gas price in Germany and the oil price. The results indicate a highly integrated market, and there is no evidence of an independent price determination process for natural gas.

The market value of variable renewables

- Energy Economics---2013---Lion Hirth

This paper provides a comprehensive discussion of the market value of variable renewable energy (VRE). The inherent variability of wind speeds and solar radiation affects the price that VRE generators receive on the market (market value). During windy and sunny times the additional electricity supply reduces the prices. Because the drop is larger with more installed capacity, the market value of VRE falls with higher penetration rate. This study aims to develop a better understanding on how the market value with penetration, and how policies and prices affect the market value. Quantitative evidence is derived from a review of published studies, regression analysis of market data, and the calibrated model of the European electricity market EMMA. We find the value of wind power to fall from 110% of the average power price to 50–80% as wind penetration increases from zero to 30% of total electricity consumption. For solar power, similarly low value levels are reached already at 15% penetration. Hence, competitive large-scale renewable deployment will be more difficult to accomplish than as many anticipate.

What drives the commodity price beta of oil industry stocks?

- Energy Economics---2013---Edward Talbot, Tracy Artiach, Robert Faff

We test theoretical drivers of the oil price beta of oil industry stocks. The strongest statistical and economic support comes for market conditions-type variables as the prime drivers: namely, oil price (+), bond rate (+), volatility of oil returns () and cost of carry (+). Though statistically significant, exogenous firm characteristics and oil firms' financing decisions have less compelling economic significance. There is weaker support for the prediction that financial risk management reduces the exposure of oil stocks to crude oil price variation. Finally, extended modelling shows that mean reversion in oil prices also helps explain cross-sectional variation in the oil beta.

On the links between stock and commodity markets' volatility

- Energy Economics---2013---Anna Creti,Marc Joëts,Valérie Mignon

This paper investigates the links between price returns for 25 commodities and stocks over the period from January 2001 to November 2011, by paying a particular attention to energy raw materials. Relying on the dynamic conditional correlation (DCC) GARCH methodology, we show that the correlations between commodity and stock markets evolve through time and are highly volatile, particularly since the 2007–2008 financial crisis. The latter has played a key role, emphasizing the links between commodity and stock markets, and underlining the financialization of commodity markets. At the idiosyncratic level, a speculation phenomenon is highlighted for oil, coffee and cocoa, while the safe-haven role of gold is evidenced.

A model for sustainable land use in biofuel production: An application to the state of Alabama

- Energy Economics---2013---Ermanno Afluso,Diane Hite

The Renewable Fuel Standard aims to increase the production of biofuels to improve energy efficiency and decrease carbon dioxide emissions in the US. The effectiveness of this regulation is being debated by the scientific community regarding carbon emissions from direct and indirect land-use change. A valid alternative may be to design policies that stimulate sustainable land use in biofuel production. This article develops a model that simulates a voluntary program to increase the land use efficiency in production of biofuels. This stochastic dynamic model optimizes the sustainability of biofuels producible by including climate information and participatory decisions on land use. The model is parameterized using the Maximum Entropy econometric technique to present a simulation of the program in the State of Alabama. The results of this simulation show that participatory decisions on land-use may increase the net energy value of produced

biofuel up to 215.68% and reduce the carbon emissions by 19.67% towards the state energy goals.

From hero to zero: Evidence of performance reversal and speculative bubbles in German renewable energy stocks

- Energy Economics---2013---Martin T. Bohl,Philipp Kaufmann,Patrick M. Stephan

Stocks of German renewable energy companies have commonly been regarded as lucrative investment opportunities. Their innovative line of business initially seemed to promise considerable future earnings. As shown by two powerful bubble tests, the positive sentiment for renewable energy stocks even led to explosive price behavior in the mid-2000s. However, intense sector competition and the economic downturn following the global financial crisis erased profit margins to a large extent. As a result, the former fad stocks have recently turned into losers, loading negatively on price momentum and delivering significantly negative Carhart four-factor alphas. The radical shift in Germany's energy policy following the 2011 Fukushima nuclear disaster in Japan could thus only temporarily halt the continuing decline in alternative energy stock prices.

Do urbanization and industrialization affect energy intensity in developing countries?

- Energy Economics---2013---Perry Sadorsky

Against a backdrop of concerns about climate change, peak oil, and energy security issues, reducing energy intensity is often advocated as a way to at least partially mitigate these impacts. This study uses recently developed heterogeneous panel regression techniques like mean group estimators and common correlated effects estimators to model the impact that income, urbanization and industrialization has on energy intensity for a panel of 76 developing countries. In the long-run, a 1% increase in income reduces energy intensity by 0.45% to 0.35%. Long-run industrialization elasticities are in the range 0.07 to 0.12. The impact of

urbanization on energy intensity is mixed. In specifications where the estimated coefficient on urbanization is statistically significant, it is slightly larger than unity. The implications of these results for energy policy are discussed.

Oil prices: Breaks and trends

- Energy Economics---2013---José Noguera

This paper contributes to the literature of the stationarity of financial time series and the literature on oil and macroeconomics in several ways. First, it uses Kejriwal and Perron (2010) sequential procedure to endogenously determine multiple structural changes in real oil prices without facing the circular testing problem between structural changes and stationary assumptions of previous tests. Second, it performs a diagnostic check to detect the significance and magnitude of the potential breaks. Third, it uses the above information to test for the existence of stochastic trends in real oil prices, and fourth, it speculates about possible explanations for the break dates found in order to encourage further work and discussions. The exercise uses monthly data from January 1861 to August 2011.

The value of basic building code insulation

- Energy Economics---2013---Paul Thorsnes,Tim Bishop

We take advantage of unusually wide variation in thermal insulation in a sample of house sales to estimate the market value of basic code-level insulation. Insulation levels vary across the houses in our sample because standard practice in New Zealand was to build houses with no thermal insulation prior to implementation of insulation standards in 1978, and the extent of insulation retrofits varies across the sample. The estimated premium on an otherwise similar house insulated to code levels exceeds the cost of installation at construction: insulating to basic code levels at construction passes the market test. The premium instead reflects the higher cost of retro-fit installation. We suspect that price, cost, and performance risk have discouraged widespread code-level retro-fits in this market.

Natural resources and sub-national economic performance: Does sub-national democracy matter?

- Energy Economics---2013---Alexander Libman

The differentiation in the impact of resources on economic growth is often explained by the specifics of institutional factors. The aim of this paper is to investigate how sub-national political differences influence the effect of natural resources on economic growth. Using a dataset of Russian regions, this paper demonstrates that sub-national democratization influences the growth effects of resources and considers possible mechanisms for this influence. The paper finds that in Russia, natural resources are only capable of promoting growth in the regions with non-democratic political systems that, at the same time, have an efficient and non-corrupt bureaucracy.

A simple characterization of the optimal extraction policy of a non-renewable resource when extraction cost is stock-independent

- Energy Economics---2013---Sébastien Rouillon

This note provides a simple characterization of the optimal extraction of a non-renewable resource. The proposed formula determines the solution in its feedback form. It is shown to hold for a large class of models, as long as the utility is stock-independent.

Hold your breath: A new index of air pollution

- Energy Economics---2013---Andreas Buehn,Mohammad Reza Farzanegan

Environmental quality and climate change have been discussed prominently as urgent problems that – due to air pollution – produce severe consequences affecting the everyday life of millions of people. Using a Multiple Indicators Multiple Causes (MIMIC) model, we calculate a new index of air pollution and provide a ranking for 122 countries for every fifth year between 1985 and 2005. The empirical analysis supports the Environmental Kuznets Curve (EKC) hypothesis and shows a

significant influence of determinants such as energy efficiency, industrial production, the electricity produced from coal sources, and demographic transition on air pollution. According to the index, Norway, Switzerland, Japan, Luxembourg, and Iceland are among the top 5 countries in terms of air quality performance. Eritrea, Mozambique, Tajikistan, the Democratic Republic of Congo, and Ethiopia performed worst in 2005.

Evaluating interconnector investments in the north European electricity system considering fluctuating wind power penetration

- Energy Economics---2013---Stephan Spiecker, Philip Vogel, Christoph Weber

With increasing amounts of power generation from intermittent sources like wind, transmission planning has not only to account for the expected load curve but also for the stochasticity of volatile power infeeds. Moreover investments in power generation are no longer centrally planned in deregulated power markets but rather decided on competitive grounds by individual power companies. This poses particular challenges when it comes to evaluating the benefits of increased interconnection capacities in large-scale systems like the European transmission system.

Carbon taxation in Russia: Prospects for a double dividend and improved energy efficiency

- Energy Economics---2013---Anton Orlov, Harald Grethe, Scott McDonald

This study analyses the sectoral and macroeconomic impact of carbon taxes on the Russian economy, one of the world's most energy- and carbon-intensive economies, while assessing the hypothesis of a double dividend. Substituting carbon taxes for labour taxes can reduce GHG emissions and enhance welfare by improving the efficiency of the tax system — a strong double dividend. The analyses confirm, when capital is not internationally mobile, that a double dividend is likely to occur under (i) a high elasticity of labour supply, (ii) high elasticities of substitution between labour and the capital-energy aggregate, (iii) low elasticities of

substitution between capital and energy. It is the tax-shifting effect between capital and labour that is crucial. In contrast, welfare losses resulting from the environmental tax reform may be substantial if capital is internationally mobile.

Biofuel-related price transmission literature: A review

- Energy Economics---2013---Teresa Serra, David Zilberman

In this article, an extensive review of the rapidly growing biofuel-related time-series literature is carried out. The data used, the modeling techniques and the main findings of this literature are discussed. Providing a review of this flourishing research area is relevant as a guidepost for future research. This literature concludes that energy prices drive long-run agricultural price levels and that instability in energy markets is transferred to food markets.

Applying ARMA–GARCH approaches to forecasting short-term electricity prices

- Energy Economics---2013---Heping Liu, Jing Shi

Accurately modeling and predicting the mean and volatility of electricity prices can be of great importance to value electricity, bid or hedge against the volatility of electricity prices and manage risk. The paper applies various autoregressive moving average (ARMA) models with generalized autoregressive conditional heteroskedasticity (GARCH) processes, namely ARMA–GARCH models, along with their modified forms, ARMA–GARCH-in-mean (ARMA–GARCH-M), to model and forecast hourly ahead electricity prices. In total, 10 different model structures are adopted, and this paper thus conducts a comprehensive investigation on the ARMA–GARCH based time series forecasting of electricity prices. Multiple statistical measures are employed to evaluate the modeling sufficiency and predication accuracy of the ARMA–GARCH(-M) methods. The results show that the ARMA–GARCH-M models are in general an effective tool for modeling and forecasting

the mean and volatility of electricity prices, while ARMA–SGARCH-M models are simple and robust and the ARMA–GJRARCH-M model is very competitive. In addition, we observe that hourly electricity prices exhibit apparent daily, weekly and monthly periodicities, and have the nonlinear and asymmetric time-varying volatility together with an inverse leverage effect.

Purchasing reserves and commodity market timing as takeover motives in the oil and gas industry

- Energy Economics---2013---Alex Ng,Han Donker

Can broad factors such as natural resources endowment and global commodity markets influence corporate takeovers? This paper theorizes that managers are motivated in mergers and acquisitions to purchase energy reserves and to time the commodity market in the oil and gas industry. We find supportive evidence that shows that energy reserves and prices cause and affect takeover activity, value, and performance. Acquirers are motivated to purchase reserves, while targets are motivated to sell based on market timing. Acquirers have negative takeover performance from lower risk. Our conclusions are robust to the traditional explanations: equity valuation, synergy, free cash flow, equity and debt market conditions, and economic cycles.

Investment, firm value, and risk for a system operator balancing energy grids

- Energy Economics---2013---Engelbert Dockner,Dénes Kucsra,Margarethe Rammerstorfer

With the liberalization of energy markets integrated energy companies have separated into entities that specialize in production and/or transmission of energy. Transmission of energy requires balancing the grid to guarantee system security, which is performed by the (independent) system operator (SO). When the SO faces stochastic demand, grid balancing has sizeable consequences on current and future profits, and hence, on firm value and firm risk. We explore these value and risk consequences with and without an investment option to expand transmission capacity. We show that

firm value consists of the value of the transmission capacity in place plus the value of a short put and a short call option that are the result of the SO's balancing actions. Firm risk without investment option is nonlinear and determined by the short option positions. It is decreasing with increasing energy demand. The existence of an option to expand transmission capacity increases firm value and firm risk.

Energy as a driver of growth in oil exporting countries?

- Energy Economics---2013---Olivier Damette,Majda Seghir

This paper is a contribution to the on-going debate over whether there is a relationship between energy consumption and economic growth. Although the oil exporting countries are among the most energy-intensive economies in the world, little attention has been paid to the features of their energy consumption. Therefore, this study empirically investigates the two variables dynamic relationship in 12 oil exporting countries from 1990 to 2010. Using recently developed panel econometric techniques, the present paper accounts for cross-section dependence and structural breaks when analysing the energy-income nexus. The results of this study indicate that there exists a long-run equilibrium relationship between energy consumption and economic growth. Furthermore, the empirical evidence of a dynamic panel error-correction model reveals a short-run unidirectional causality from energy consumption to economic growth, whereas in the long-run, it is the economic process that determines the energy consumption trend.

U.S. stock returns and oil prices: The tale from daily data and the 2008–2009 financial crisis

- Energy Economics---2013---Andre Mollick,Tibebe Abebe Assefa

Using daily data from January 1999 to December 2011, we examine U.S. stock returns (S&P 500, Dow Jones, NASDAQ, and Russell 2000) based on a wide range

of information, including equity VIX volatility, inflation expectations, interest rates, gold prices, and the USD/Euro exchange rate. The focus is on oil price returns, which have been previously found to exert mostly negative effects on U.S. stock returns. Identifying the crisis of 2008–2009 as a significant period of economic contraction and subsequent “recovery”, we check the stability of the stock-oil relationship by GARCH and MGARCH-DCC models. Prior to the financial crisis, stock returns are slightly (negatively) affected by oil prices and by the USD/Euro. For the subsample of mid-2009 onwards, however, stock returns are positively affected by oil prices and a weaker USD/Euro. As with inflation expectations, we interpret these findings as U.S. stocks responding positively to expectations of recovery worldwide. Our proposed explanation is due to the changing correlation between stock markets and oil, either by standard GARCH models or by MGARCH-DCC models allowing the implied correlation to vary over time.

Functional form and aggregate energy demand elasticities: A nonparametric panel approach for 17 OECD countries

- Energy Economics---2013---Amin Karimu,Runar Brännlund

This paper studies whether the commonly used linear parametric model for estimating aggregate energy demand is the correct functional specification for the data generating process. Parametric and nonparametric econometric approaches to analyzing aggregate energy demand data for 17 OECD countries are used. The results from the nonparametric correct model specification test for the parametric model rejects the linear, log-linear and translog specifications. The nonparametric results indicate that the effect of the income variable is nonlinear, while that of the price variable is linear but not constant. The nonparametric estimates for the price variable is relatively low, approximately 0.2.

Dynamic spillovers between oil and stock markets in the Gulf Cooperation Council Countries

- Energy Economics---2013---Basel Awartani,Aktham Issa Maghyreh

This article exploits a new spillover directional measure proposed by Diebold and Yilmaz (2009, 2012) to investigate the dynamic spillover of return and volatility between oil and equities in the Gulf Cooperation Council Countries during the period 2004 to 2012. Our results indicate that return and volatility transmissions are bi-directional, albeit asymmetric. In particular, the oil market gives other markets more than it receives in terms of both returns and volatilities. These trends were more pronounced in the aftermath of the Global Financial Crisis in 2008 as the net contribution of oil has intensified after a burst during the crisis. The empirical evidence from the sample is consistent with a system in which oil is playing the dominant role in the information transmission mechanism between oil and equities in the GCC countries.

Asymmetric adjustment of the dynamic relationship between energy intensity and urbanization in China

- Energy Economics---2013---Yaobin Liu,Yichun Xie

This paper provides a comprehensive nonlinear analysis of asymmetric adjustment of the dynamic relationship between energy intensity and urbanization using the time series data of 1978–2010 in China at both the national and the macro regional levels. Two sets of unit root tests are applied first to check whether the variables of energy intensity and urbanization are heterogeneous with and without structural breaks, respectively. Cointegration tests are then applied to determine whether long-term relationships are present when structural breaks are or aren't accounted for. The asymmetric adjustment analyses are finally applied to examine how the variables in time-series respond to the deviations from the equilibrium through an integration of threshold vector error correction model (TVECM),

and to examine how they respond to the co-existence of TVECM and the threshold. The findings of the systematic tests and analyses confirm the existence of non-linear causal relationships between the energy intensity and urbanization in China. Energy intensity has an asymmetric adjusting effect to urbanization in the whole country and the Central belt. An asymmetric adjustment running from the energy intensity to urbanization is also identified when structural breaks are accounted for, which occurred in 1988, 1993, 2000 and 2006. Furthermore, the two-regime threshold vector error correction model shows that the adjustment process of the energy intensity toward equilibrium is highly persistent when a threshold is reached. There exists a mean-reverting behavior, indicating that the energy intensity grows faster than the urbanization in China when the threshold is reached.

An empirical study of the information premium on electricity markets

- Energy Economics---2013---Fred Espen Benth, Richard Biegler-König, Rüdiger Kiesel

Due to the non-storability of electricity and the resulting lack of arbitrage-based arguments to price electricity forward contracts, a significant time-varying risk premium is exhibited. Using EEX data during the introduction of emission certificates and the German “Atom Moratorium” we show that a significant part of the risk premium in electricity forwards is due to different information sets in spot and forward markets. In order to show the existence of the resulting information premium and to analyse its size we design an empirical method based on techniques relating to enlargement of filtrations and the structure of Hilbert spaces.

Oil price shocks and trade imbalances

- Energy Economics---2013---Thai-Ha Le, Youngho Chang

This study aims to examine whether a large part of the variability of trade balances and their oil and non-oil components is associated with oil price fluctuations.

The long-run causality running from oil price to overall, oil and non-oil trade balances and their short-run dynamics are investigated by applying the Toda and Yamamoto, 1995 (TY) causality approach and generalized impulse response functions (IRFs), respectively to the monthly data spanning from January 1999 to November 2011. Three Asian economies that represent three distinct characteristics in terms of oil are chosen and examined: Malaysia as an oil exporter, Singapore as an oil refinery and Japan as an oil importer. The stability of the causality is also checked and the estimated impulse responses across different periods are examined. The results have implications for both policy makers and economic modeling of the impact of oil price shocks.

Minimal variance hedging of natural gas derivatives in exponential Lévy models: Theory and empirical performance

- Energy Economics---2013---Christian-Oliver Ewald, Roy Nawar, Tak Kuen Siu

We consider the problem of hedging European options written on natural gas futures, in a market where prices of traded assets exhibit jumps, by trading in the underlying asset. We provide a general expression for the hedging strategy which minimizes the variance of the terminal hedging error, in terms of stochastic integral representations of the payoffs of the options involved. This formula is then applied to compute hedge ratios for common options in various models with jumps, leading to easily computable expressions. As a benchmark we take the standard Black–Scholes and Merton delta hedges. We show that in natural gas option markets minimal variance hedging with underlying consistently outperform the benchmarks by quite a margin.

Modeling a clean energy standard for electricity: Policy design implications for emissions, supply, prices, and regions

- Energy Economics---2013---Anthony Paul, Karen Palmer, Matt Woerman

The electricity sector is responsible for roughly 40% of U.S. carbon dioxide (CO₂) emissions, and a reduction in CO₂ emissions from electricity generation is an important component of the U.S. strategy to reduce greenhouse gas emissions. Toward that goal, several proposals for a clean energy standard (CES) have been put forth, including one espoused by the Obama administration that calls for 80% clean electricity by 2035 phased in from current levels of roughly 40%. This paper looks at the effects of such a policy on CO₂ emissions from the electricity sector, the mix of technologies used to supply electricity, electricity prices, and regional flows of clean energy credits. The CES leads to a 30% reduction in cumulative CO₂ emissions between 2013 and 2035 and results in dramatic reductions in generation from conventional coal. The policy also results in fairly modest increases on national electricity prices, but this masks a wide variety of effects across regions.

Mothballing in power markets: An experimental study

- Energy Economics---2013---Santiago Arango,Jaime A. Castañeda,Erik R. Larsen

The deregulation of many electricity markets over the last two decades raises a number of issues, among which: securing adequate investments in capacity, and the possibility of cyclical behavior in capacity, are important for security of supply. A number of policies and market mechanisms aiming for capacity adequacy and market stability exist; in this paper we focus on one of these, mothballing of generation capacity. In electricity markets, mothballing is the possibility for a power generation company to temporarily withdraw generation capacity for a time, often for a year or more. Our hypothesis is that mothballing will help to stabilize markets, but at the same time increase prices. We test this hypothesis using laboratory experiments, with a simplified model of a generic electricity market. We report an experiment with twelve markets, where subjects make investment decisions; half of them had full capacity utilization (T1) and the other half had the option to mothball capacity (T2). The predictions of

the effects of mothballing were confirmed in the experimental markets: prices and generation capacity exhibit clear cycles in T1, and damped cycles in the second set of experiments, T2. Furthermore, mothballing leads to higher prices on average.

If you build it, he will come: Anticipative power transmission planning

- Energy Economics---2013---David Pozo,Javier Contreras,Enzo Sauma

Like in the film *Field of Dreams*, the sentence “if you build it, he will come” also applies in power systems. In this sense, if a transmission planner suggests building some lines in anticipation of generation capacity investments, then it can induce generation companies to invest in a more socially efficient manner. In this paper, we solve for the optimal way of doing this anticipative power transmission planning. Inspired in the proactive transmission planning model proposed by Sauma and Oren (2006) we formulate a mixed integer linear programming optimization model that integrates transmission planning, generation investment, and market operation decisions and propose a methodology to solve for the optimal transmission expansion. Contrary to the proactive methodology proposed by Sauma and Oren (2006), our model solves the optimal transmission expansion problem anticipating both generation investment and market clearing. We use the marginalist theory with production cost functions inversely related to the installed capacity in a perfectly competitive electricity market and we find all possible generation expansion pure Nash equilibria. We illustrate our results using 3-node and 4-node examples.

Strategic behaviour in international metallurgical coal markets

- Energy Economics---2013---Johannes Trüby,Johannes Trueby

This paper analyses whether prices and trade-flows in the international market for metallurgical coals were subject to non-competitive conduct in the period 2008

to 2010. To do so, I develop mathematical programming models – a Stackelberg model, two varieties of a Cournot model, and a perfect competition model – for computing spatial equilibria in international resource markets. Results are analysed with various statistical measures to assess prediction accuracy of the models. The results show that real market equilibria cannot be reproduced with a competitive model. However, real market outcomes can be accurately simulated with the non-competitive models suggesting that market equilibria in the international metallurgical coal trade were subject to strategic behaviour of coal exporters.

The rebound effect in the aviation sector

- Energy Economics---2013---Antony Evans, Andreas Schäfer

The rebound effect, i.e., the (partial) offset of the energy efficiency improvement potential due to a reduction in marginal usage costs and the associated increase in consumer demand, has been extensively studied for residential energy demand and automobile travel. This study presents a quantitative estimate of the rebound effect for an air traffic network including the 22 busiest airports, which serve 14 of the highest O–D cities within the domestic U.S. aviation sector. To satisfy this objective, passenger flows, aircraft operations, flight delays and the resulting energy use are simulated. Our model results indicate that the average rebound effect in this network is about 19%, for the range of aircraft fuel burn reductions considered. This is the net impact of an increase in air transportation supply to satisfy the rising passenger demand, airline operational effects that further increase supply, and the mitigating effects of an increase in flight delays. Although the magnitude of the rebound effect is small, it can be significant for a sector that has comparatively few options for reducing greenhouse gas emissions.

The high-frequency asymmetric response of stock returns to monetary policy for high oil price events

- Energy Economics---2013---Chun-Li Tsai

This paper investigates whether a high oil price event that worsens the quality of a firm's balance sheet in turn provides an additional transmission channel to the stock market, which then affects stock returns. We examine the asymmetric impacts of monetary shocks on stock returns across high oil price events and non-high oil price events over the period from 1995 to 2008. We ask how these impacts respond to the relative ability of firms to obtain external finance. Our findings suggest that more energy-intensive industries and durable-goods industries react more significantly to monetary shocks based on high oil price events than on those based on non-high oil price events. By controlling for the capacity for external finance, the intraday windows reveal that a monetary surprise for the high oil price events has a bigger impact on stock returns than for the non-high oil price events. Firms with financing constraints find that the adverse impact of a surprise monetary policy action on high oil price events is amplified in the medium profitability category, while the impact of a surprise monetary policy action on non-high oil price events is amplified in the lowest profitability category.

Further evidence of an Environmental Kuznets Curve in Spain

- Energy Economics---2013---Peter Sephton, Janelle Mann

Using a long span of data in Spain, Esteve and Tamarit (2012b) reported evidence of a strong link between per capita income and per capita CO₂. In this paper we extend their work, finding evidence of both non-linear cointegration and asymmetric adjustment using a novel approach due to Sephton (1994) and Sephton and Mann (2012). The results suggest that there is a long-run non-linear attractor drawing per capita income and CO₂ levels together, with asymmetric adjustment.

A bilevel model for electricity retailers' participation in a demand response market environment

- Energy Economics---2013---Marco Zugno, Juan Miguel Morales, Pierre Pinson, Henrik Madsen

Demand response programmes are seen as one of the contributing solutions to the challenges posed to power systems by the large-scale integration of renewable power sources, mostly due to their intermittent and stochastic nature. Among demand response programmes, real-time pricing schemes for small consumers are believed to have significant potential for peak-shaving and load-shifting, thus relieving the power system while reducing costs and risk for energy retailers. This paper proposes a game theoretical model accounting for the Stackelberg relationship between retailers (leaders) and consumers (followers) in a dynamic price environment. Both players in the game solve an economic optimisation problem subject to stochasticity in prices, weather-related variables and must-serve load. The model allows the determination of the dynamic price-signal delivering maximum retailer profit, and the optimal load pattern for consumers under this pricing. The bilevel programme is reformulated as a single-level MILP, which can be solved using commercial off-the-shelf optimisation software. In an illustrative example, we simulate and compare the dynamic pricing scheme with fixed and time-of-use pricing. We find that the dynamic pricing scheme is the most effective in achieving load-shifting, thus reducing retailer costs for energy procurement and regulation in the wholesale market. Additionally, the redistribution of the saved costs between retailers and consumers is investigated, showing that real-time pricing is less convenient than fixed and time-of-use price for consumers. This implies that careful design of the retail market is needed. Finally, we carry out a sensitivity analysis to analyse the effect of different levels of consumer flexibility.

Oil price effects on personal consumption expenditures

- Energy Economics---2013---Yu Shan Wang

This paper uses a logistic smooth transition model to examine the impact of rising oil prices on personal consumption expenditures in open and industrialized economies. The empirical results suggest a nonlinear and asymmetric relation between oil price changes and personal consumption expenditures. In particular, the

effects of rising oil prices on personal consumption expenditures are greater than those of falling oil prices. While oil price changes affect personal consumption expenditures via real balance effects, smooth transition effects also come into play. Below a threshold value, an increase in oil prices reduces personal consumption expenditures. In other words, in the face of uncertainty regarding future oil prices, consumers initially rationally postpone spending. However, once oil prices above the threshold after a prolonged upward trend, the prices of domestic production factors rise. This fuels continued price hikes and further increases personal consumption expenditures until a cost-pushed inflation takes hold. Due to differences in economic developments and structures, the effects of rising oil prices vary from one country to another, with different countries usually to different monetary policies from each other. As a result, personal consumption expenditures also show various patterns across countries.

Environmental performance of state-owned and privatized eastern European energy utilities

- Energy Economics---2013---Andrew Meyer,Grzegorz Pac

Privatization in Eastern Europe has helped in the transition of the region's economies from planned to free market. However, the effects of privatization on the environment are relatively unknown and many firms remain under state ownership today. We compare the environmental performance of state-owned and privatized energy utility plants in Eastern Europe utilizing a novel panel data that includes reported sulfur dioxide emissions, energy input, and ownership status. We find that state-owned plants emit more sulfur dioxide than privately owned plants; this is environmentally significant as privatization is associated with a reduction in emissions of about 55%.

Competition and environmental policies in an electricity sector

- Energy Economics---2013---Corinne Chaton,Marie-Laure Guillerminet

We study the impact of competition and environmental policy (feed-in tariff vs. the EU ETS) on investment, CO₂ emissions and welfare in an electricity sector. We consider different market structures (a planner who maximises social welfare vs. duopoly) and two types of consumers (those whose behaviour depends on the weather vs. those whose behaviour does not). The demand specification is innovative and takes incompressible consumption into account.

Fuel demand in Brazil in a dynamic panel data approach

- Energy Economics---2013---Gervásio F. Santos

The purpose of this paper is to evaluate the sensitivity of fuel consumers regarding price and income, taking recent changes in the Brazilian fuel market into account. In this market, new market rules, energy policy towards fuel diversification and introduction of flex-fuel engines have determined fuel competition among gasoline, ethanol and compressed natural gas. Using a dynamic panel data model, demand equations for these three fuels are econometrically estimated to obtain consumer adjustment coefficients, price, cross-price and income elasticities in the short and long-run. In addition, the effect of the introduction of flex-fuel engines in the market and the rationality of consumers towards efficiency constraints of the engines were tested. Apart from considerable competition, results show that the dynamics of the Brazilian fuel market revolves around ethanol instead of gasoline. While demands for gasoline and natural gas are inelastic to price, demand for ethanol is elastic in Brazil. Furthermore, after the introduction of the flex-fuel technology the sensitivity of consumers to fuel prices changed, and ethanol consumers take efficiency constraints into account when ethanol prices reach the threshold of 70% of gasoline prices.

Energy policy and regional inequalities in the Brazilian economy

- Energy Economics---2013---Gervasio F. Santos, Eduardo Haddad, Geoffrey Hewings

The objective of this paper is to evaluate the long-run regional impacts of the tariff policy of the Brazilian electric power sector. This sector has undergone a reform process that started in the 1990s. Since the beginning of the reform, two spatial trends of distribution of electric power tariffs have emerged among the Brazilian states, one of convergence and another of spatial divergence. These trends have been guided by the new electric power tariff policy and by the spatial features of the Brazilian economy, which is marked by a high degree of spatial concentration and hierarchical distribution of large markets. In addition, because of the presence of strong economies of scale, the recent electric power prices differentials might be caused by differentials in market size that provide better conditions for the achievement of economies of scale for electric power utility companies located in larger markets. Given the role of electric power as an important intermediate input in the production process and the interdependence between sectors, an Energy Interregional Computable General Equilibrium model was used to simulate the long-run regional impacts of electric power tariff policy in Brazil. The simulations showed that the heterogeneity of energy-intensity and the differentials of energy substitution drive the spatial impacts of changes in electric power prices. On the other hand, the recent trend of spatial dispersion of electric power prices might contribute to a decrease in the long-run economic growth and to an increase in the regional inequalities in Brazil.

The value of supply security: The costs of power outages to Austrian households, firms and the public sector

- Energy Economics---2013---Johannes Reichl, Michael Schmidthaler, Friedrich Schneider

This paper presents a model for assessing economic losses caused by electricity cuts as well as Willingness-to-Pay to avoid these power outages as an approximation to the value of supply security. The economic effects for simulated power cuts from 1 to 48h, which take the affected provinces, the day of the week and the time of day into consideration, can be calculated

using the assessment tool APOSTEL. The costs due to power cuts are computed separately for all sectors of the economy and for households. The average value of lost load for Austrian households and non-household consumers in the case of a power cut of 1h on a summer workday morning was calculated to be 17.1€ per kWh of electricity not supplied.

The long-run and causal analysis of energy, growth, openness and financial development on carbon emissions in Turkey

- Energy Economics---2013---Ilhan Ozturk, Ali Acaravci

The aim of this paper is to examine the causal relationship between financial development, trade, economic growth, energy consumption and carbon emissions in Turkey for the 1960–2007 period. The bounds F-test for cointegration test yields evidence of a long-run relationship between per capita carbon emissions, per capita energy consumption, per capita real income, the square of per capita real income, openness and financial development. The results show that an increase in foreign trade to GDP ratio results an increase in per capita carbon emissions and financial development variable has no significant effect on per capita carbon emissions in the long-run. These results also support the validity of EKC hypothesis in the Turkish economy. It means that the level of CO₂ emissions initially increases with income, until it reaches its stabilization point, then it declines in Turkey. In addition, the paper explores causal relationship between the variables by using error-correction based Granger causality models.

Electricity intensity across Chinese provinces: New evidence on convergence and threshold effects

- Energy Economics---2013---Maria Jesus Herrias, G. Liu

Energy intensity has gone through different stages across Chinese regions. In this paper, we investigate the stochastic electricity-intensity convergence across

the Chinese provinces. Unlike previous work, this paper highlights the relevance of the level of technology of each province and takes into account the economic geography through the examination of club convergence. We perform several unit root tests that introduce structural breaks, nonlinearities and time variation, with the aim to capture the economic transformation of the Chinese economy. Results indicate that the majority of the Chinese regions have converged according to the unit-root tests in time-series analysis, indicating that technological differences diminish over time. However, this convergence pattern occurs within groups of regions, according with club convergence test. Indeed, we find a dominant club and others smaller clubs that few regions belong. However, it is observed that there are regions that still diverge. These findings support our argument that special policy attention is required for those regions displaying divergence.

Are green hopes too rosy? Employment and welfare impacts of renewable energy promotion

- Energy Economics---2013---Christoph Böhlinger, Andreas Keller, Edwin van der Werf

In view of pressing unemployment problems, policy makers across all parties jump on the prospects of renewable energy promotion as a job creation engine which can boost economic well-being. Our analytical model shows that initial labor market rigidities in theory provide some scope for such a double dividend. However, the practical outcome of renewable energy promotion might be sobering. Our computable general equilibrium analysis of subsidized electricity production from renewable energy sources (RES-E) in Germany suggests that the prospects for employment and welfare gains are quite limited and hinge crucially on the level of the subsidy rate and the financing mechanism. If RES-E subsidies are financed by labor taxes, welfare and employment effects are strictly negative for a broad range of subsidy rates. The use of an electricity tax to fund RES-E subsidies generates minor benefits for small subsidy rates but these benefits quickly turn into significant losses as the subsidy rate exceeds some

threshold value.

Energy intensity and investment ownership across Chinese provinces

- Energy Economics---2013---Maria Jesus Herre-
rias,Ana Cuadros,Vicente Orts

The main objective of this paper is to investigate whether openness and investment ownership are key factors in explaining the diffusion of energy-saving technologies in China. Compared with previous studies, the novel aspect of this work is the use of a rich dataset at provincial level, which allows the high level of regional heterogeneity to be taken into consideration. The unbalanced regional growth has been translated into differences in the need for energy resources across the vast territory of China. A detailed analysis of these issues may provide new insights into the energy situation in this country. The analysis is also disaggregated by type of energy: coal, electricity and petroleum. We estimate the models by panel-corrected standard errors, developed by Beck and Katz (1995), over the period 1985–2008. Results obtained confirm the hypothesis that both foreign and non-state investments play a leading role in the decline of energy intensity across Chinese regions, whereas there is no evidence of a positive contribution of state investment. The findings also reveal differences in energy intensity across regions, thus confirming the importance of accounting for the regional dimension when analyzing energy consumption in China.

Assessing alternative solutions to carbon leakage

- Energy Economics---2013---Alessandro Antimi-
ani,Valeria Costantini,Chiara Martini,Luca Sal-
vatici,Maria Cristina Tommasino

A modified version of the computable general equilibrium GTAP-E model is developed in order to assess the economic and carbon emission effects of alternative trade policy measures aimed at reducing carbon leakage. We compare several unilateral policy measures implemented by countries subject to an emissions level

cap. Results provide evidence of the scarce effectiveness of these policies in reducing the carbon leakage rate and, conversely, some of the trade measures that are discussed seem to be more consistent with the goal of protecting market shares of national firms in the domestic markets of abating countries. Assessing environmental and competitiveness outcomes jointly confirms that a global cooperative solution would be the most effective as well as an efficient policy option for reducing carbon leakage.

Rockets and feathers in power futures markets? Evidence from the second phase of the EU ETS

- Energy Economics---2013---Chiara Lo
Prete,Catherine Norman

This paper examines the possibility of asymmetric transmission of CO₂ prices to electricity futures prices in the second phase of the European Emission Trading Scheme. We would like to assess whether output prices tend to respond more quickly to input price increases than decreases: this phenomenon is known as “rockets and feathers” in the literature. Compared to Zachmann and von Hirschhausen (2008), who carried out a similar analysis for Germany in the first phase of the Emission Trading Scheme with data from 2005 to 2006, our study spans a longer timeframe (July 2007–June 2010), with a presumably more mature permit market, and includes three additional European countries (France, Belgium and the Netherlands). Results do not provide empirical evidence of statistically significant differences in the response of power prices to positive and negative shocks in CO₂ allowance and fuel markets.

Should a vehicle fuel economy standard be combined with an economy-wide greenhouse gas emissions constraint? Implications for energy and climate policy in the United States

- Energy Economics---2013---Valerie Karplus,Sergey
Paltsev,Mustafa Babiker,John Reilly

The United States has adopted fuel economy standards that require increases in the on-road efficiency of new

passenger vehicles, with the goal of reducing petroleum use and (more recently) greenhouse gas (GHG) emissions. Understanding the cost and effectiveness of fuel economy standards, alone and in combination with economy-wide policies that constrain GHG emissions, is essential to inform coordinated design of future climate and energy policy. We use a computable general equilibrium model, the MIT Emissions Prediction and Policy Analysis (EPPA) model, to investigate the effect of combining a fuel economy standard with an economy-wide GHG emissions constraint in the United States. First, a fuel economy standard is shown to be at least six to fourteen times less cost effective than a price instrument (fuel tax) when targeting an identical reduction in cumulative gasoline use. Second, when combined with a cap-and-trade (CAT) policy, a binding fuel economy standard increases the cost of meeting the GHG emissions constraint by forcing expensive reductions in passenger vehicle gasoline use, displacing more cost-effective abatement opportunities. Third, the impact of adding a fuel economy standard to the CAT policy depends on the availability and cost of abatement opportunities in transport—if advanced biofuels provide a cost-competitive, low carbon alternative to gasoline, the fuel economy standard does not bind and the use of low carbon fuels in passenger vehicles makes a significantly larger contribution to GHG emissions abatement relative to the case when biofuels are not available. This analysis underscores the potentially large costs of a fuel economy standard relative to alternative policies aimed at reducing petroleum use and GHG emissions. It further emphasizes the need to consider sensitivity to vehicle technology and alternative fuel availability and costs as well as economy-wide responses when forecasting the energy, environmental, and economic outcomes of policy combinations.

Speculative trading and oil price dynamic: A study of the WTI market

- Energy Economics---2013---Emmanuel Hache,Frédéric Lantz

The aim of this paper is to study the oil price dynamic in West Texas Intermediate (WTI) market in the US.

By using statistical and econometric tools, we first attempt to identify the long term relationship between WTI spot prices and the prices of futures contracts on the New York Mercantile Exchange (NYMEX). Subsequently we model the short term dynamic between these two prices and this analysis points up several breaks. On this basis, a short term Markov Switching Vectorial Error Correction model (MS-VECM) with two distinct states (standard state and crisis state) has been estimated. Finally we introduce the volumes of transactions observed on the NYMEX for the WTI contracts and we estimate the influence of the non-commercial players. We conclude that the hypothesis of an influence of non-commercial players on the probability for being in the crisis state cannot be rejected. In addition, we show that the rise in liquidity of the first financial contracts, as measured by the volume of open interest, is a key element to understand the dynamics in market prices.

Non-linearities in the dynamics of oil prices

- Energy Economics---2013---Khalid Kisswani,Salah Nusair

Examining stationarity is of particular importance and represents the first step in empirical time-series research. Non-stationarity invalidates many of the results obtained from standard techniques and, therefore, requires special treatment. Because oil prices play an important role in affecting economic variables, this paper examines the stationarity of real oil prices (Brent, Dubai, WTI and the World) over the period 1973:2–2011:2. Real oil prices are expressed in the currencies of seven Asian countries (Indonesia, Japan, Korea, Malaysia, the Philippines, Singapore and Thailand) and in the U.S. dollar. While using linear unit root tests without structural breaks shows no evidence of stationarity, allowing for breaks shows very limited evidence of stationarity. We argue that these results are attributed to the presence of nonlinearities in the behavior of oil prices. Testing for nonlinearity shows significant evidence of nonlinearity in all the cases with evidence of exponential smooth transition autoregression (ESTAR) nonlinearity-type in most cases. Ap-

plying unit root tests that account for two types of nonlinearities (smooth transition and nonlinear deterministic trends) reveals evidence of stationarity in all the cases.

Modeling and forecasting the volatility of petroleum futures prices

- Energy Economics---2013---Sang Hoon Kang, Seong-Min Yoon

We investigate volatility models and their forecasting abilities for three types of petroleum futures contracts traded on the New York Mercantile Exchange (West Texas Intermediate crude oil, heating oil #2, and unleaded gasoline) and suggest some stylized facts about the volatility of these futures markets, particularly in regard to volatility persistence (or long-memory properties). In this context, we examine the persistence of market returns and volatility simultaneously using the following ARFIMA–GARCH-class models: ARIMA–GARCH, ARFIMA–GARCH, ARFIMA–IGARCH, and ARFIMA–FIGARCH. Although the ARFIMA–FIGARCH model better captures long-memory properties of returns and volatility, the out-of-sample analysis indicates no unique model for all three types of petroleum futures contracts, suggesting that investors should be careful when measuring and forecasting the volatility (risk) of petroleum futures markets.

Gasoline prices, gasoline consumption, and new-vehicle fuel economy: Evidence for a large sample of countries

- Energy Economics---2013---Paul Burke, Shuhei Nishitaten

Countries differ considerably in terms of the price drivers pay for gasoline. This paper uses data for 132 countries for the period 1995–2008 to investigate the implications of these differences for the consumption of gasoline for road transport. To address the potential for simultaneity bias, we use both a country's oil reserves and the international crude oil price as instruments for a country's average gasoline pump price. We

obtain estimates of the long-run price elasticity of gasoline demand of between 0.2 and 0.5. Using newly available data for a sub-sample of 43 countries, we also find that higher gasoline prices induce consumers to substitute to vehicles that are more fuel-efficient, with an estimated elasticity of +0.2. Despite the small size of our elasticity estimates, there is considerable scope for low-price countries to achieve gasoline savings and vehicle fuel economy improvements via reducing gasoline subsidies and/or increasing gasoline taxes.

Downside risk and the energy hedger's horizon

- Energy Economics---2013---Thomas Conlon, John Cotter

In this paper, we explore the impact of investor time-horizon on an optimal downside hedged energy portfolio. The optimal heating oil hedge ratio is first calculated for a variety of downside risk objective functions at different time-horizons using the wavelet transform. Next, associated hedging effectiveness is contrasted for a range of risk metrics, with all metrics showing increasing hedging effectiveness at longer horizons. Moreover, decreased hedging effectiveness is demonstrated for increased levels of uncertainty at higher confidence intervals. While small differences in effectiveness are found across the different hedging objectives, time-horizon effects are found to dominate confirming the importance of the hedging horizon. The findings suggest that while downside risk measures are useful in determining an optimal futures hedge encompassing negative returns, hedging horizon and confidence intervals should also be given careful consideration by the energy hedger.

Price determination in the EU ETS market: Theory and econometric analysis with market fundamentals

- Energy Economics---2013---Piia Remes (née Aantola), Markku Ollikainen, Anne Toppinen

We investigate the price determination of the European Union emission allowance (EUA) of the European

Union emissions trading scheme (EU ETS). We postulate an uncertain permit price and risk-averse firms which have the possibility to hedge in the forward market. The firms produce final goods, abate their emissions and trade permits in the permit market. The dependence of the equilibrium permit price on exogenous variables is studied in a permit market model. We test our theoretical findings with empirical data from 2005 to 2010 in the EU ETS market. We use daily forward prices of EUA as our dependent variable. We use several econometric models with multiple stationary time series to discover that there is a strong relationship between the fundamentals, such as German electricity prices and gas and coal prices, with the price of EUA. We find that the EUA forward price depends on fundamentals, especially on the price of electricity as well as on the gas–coal difference, in a statistically significant way.

Valuing electricity transmission: The case of Alberta

- Energy Economics---2013---Joseph Doucet,Andrew Kleit,Serkan Fikirdanis

Transmission economics remains a difficult area. Market forces alone are generally felt to be insufficient for signaling investment due to appropriability problems and the challenges of “parallel (loop) flow.” Further, there is no generally recognized method of estimating the value of transmission expansion. Here we extend the approach of Kleit and Reitzes (2008) to the nearly isolated electricity grid of Alberta, essentially eliminating the problems of parallel flow. With this model, we are able to determine the value of electricity flows to and from Alberta, as well as the transactions costs associated with those flows. We are also able to value the impact of transmission expansion in Alberta. We apply this model to a project currently being developed, the Montana–Alberta Tie Line (MATL). Depending on the relevant elasticity of supply, we find that the MATL owners will be able to appropriate between 80% and 96% of the societal value of their new transmission capacity. This high level of appropriability is in contrast to the conclusions of most of the literature in this

area, suggesting that market forces may in some instances be effective in providing incentives for optimal transmission investment.

The role of storage in a competitive electricity market and the effects of climate change

- Energy Economics---2013---Lew Evans,Graeme Guthrie,Andrea Lu

This paper uses a new model of a competitive electricity market to investigate the role of storage in markets dominated by hydro generation. Competition among generators leads to an endogenous shadow price of stored water, which facilitates the efficient intra-day and inter-season substitution of fuel. Overall welfare depends on storage capacity, the cost structure of non-hydro generators, and the characteristics of water inflows. If climate change reduces the long-run average level of inflows or leads to the introduction of a carbon tax then overall welfare will fall and the profitability of generators will rise. The welfare benefits from additional storage capacity will increase if climate change makes long-term inflows less predictable or leads to the introduction of a carbon tax. They will decrease if average inflows fall or the predictable seasonal cycle in inflows becomes less pronounced.

Company’s affordability of increased energy costs due to climate policies: A survey by sector in China

- Energy Economics---2013---Xianbing Liu,Can Wang,Weishi Zhang,Sunhee Suk,Kinichi Sudo

This paper estimates the affordability of Chinese companies on energy cost increases due to the introduction of market-based climate policies. The data were collected from 170 respondents mainly from iron and steel, cement and chemical industries, using a multiple-bounded discrete choice (MBDC) format. Estimations indicate that a mean of 8.8% in energy cost increase would be acceptable for all the samples. The chemical companies express a slightly higher affordability, with the mean of acceptable ratios of energy cost increases being 9.9%, while the cement companies show slightly

lower affordability with a mean of 7.7%. Econometric analysis confirms that the market competition degree has a significant but negative relationship with the affordability while the company's size is significantly and positively associated with the affordability. Calculations indicate that the mean of affordable energy cost increases roughly equals a carbon price of 83.7 CNY/t-CO₂ (about 12 USD/t-CO₂) for chemical companies and around 40 CNY/t-CO₂ (about 6 USD/t-CO₂) for iron and steel and cement sectors. This result provides a meaningful referendum for the development of carbon tax and the establishment of a domestic carbon emissions trading scheme in China, especially from the perspective of surveyed industries.

Valuing the carbon exposure of European utilities. The role of fuel mix, permit allocation and replacement investments

- Energy Economics---2013---Nicolas Koch,Alexander Bassen

This paper assesses the carbon exposure of European electric utilities covered by the EU Emissions Trading System (EU ETS). First, we rely on an asset pricing model to empirically determine the effect of carbon price risks on firm-specific cost of capital for a sample of 20 European utility stocks during the period 2005–2010. Second, we employ a discounted cash flow framework to simulate carbon-adjusted equity values for three selected utilities and their investment strategies from 2009 to 2020. We show that company-specific carbon risks are asymmetrically distributed to a few utility firms: While for the great majority of power producers carbon price movements are not a relevant risk factor, we find that utilities with an extremely high-emitting fuel mix bear significant risk premiums for carbon which translate to higher cost of capital and a loss of equity value. In contrast, we find no evidence that low-emitting utilities benefit from reduced capital costs. We further reveal that, in addition to the firm's fuel mix, permit allocation rules and replacement investment decisions in terms of fuel technology choice are the driving forces behind the carbon exposure of the utilities. The carbon-related loss of equity value is

substantially reduced by implementing an investment strategy directed towards a carbon-free generation mix. The derogations from full permit auctioning in Eastern European member states provide insurance against carbon risks of utilities.

Environmental policy and the energy efficiency of vertically differentiated consumer products

- Energy Economics---2013---Magdalena Brzeskot,Alexander Haupt

We analyse optimal environmental policies in a market that is vertically differentiated in terms of the energy efficiency of products. Considering energy taxes, subsidies to firms for investment in more eco-friendly products, and product standards, we are particularly interested in how distributional goals in addition to environmental goals shape the choice of policy instruments. We find that an industry-friendly government levies an energy tax to supplement a lax product standard, but shies away from subsidies to firms. By contrast, a consumer-friendly government relies heavily on a strict product standard and additionally implements a moderate subsidy to firms, but avoids energy taxes.

Analyzing the impact of futures trading on spot price volatility: Evidence from the spot electricity market in France and Germany

- Energy Economics---2013---Fotis G. Kalantzis,Nikolaos Milonas

This paper examines the impact of the introduction of electricity futures on the spot-price volatility of the French (Powernext) and German (EEX) electricity markets, as well as the degree of their price correlation over the period 2002–2011. Our working hypotheses were tested based on a bivariate VECM-GARCH model. The results indicate that the introduction of futures contracts in the French electricity market, as well as the launch of the joint futures market in these countries in 2009, has decreased spot price volatility. However, this effect was not as explicit for the German market, due to data specificities. Other interesting results are: the German market dominates and leads the long run price

relationship; the impact of cooling needs on demand is greater than the impact of heating needs; there is a substantial systematic pattern of electricity prices and their respective volatilities during weekdays and holidays. Overall, results are supportive of policy making at the European Commission regarding electricity market integration.

The causal relationship between energy use and economic growth in Switzerland

- Energy Economics---2013---Andrea Baranzini,Sylvain Weber,Markus Bareit,Nicole Mathys

This paper investigates the relationships between energy consumption and economic growth in Switzerland over the period 1950–2010. We apply bounds testing techniques to different energy types separately. Robustness tests are performed by including additional variables and restricting the analysis to the period after 1970. The results show that there exist robust long-run relationships going from real GDP toward heating oil and electricity consumption. The relationship between heating oil and GDP is in fact bidirectional, although weaker from heating oil toward GDP than in the reverse direction. When investigating the period 1970–2010 only, the estimate of the long-run income elasticity of electricity consumption loses statistical significance and that for heating oil becomes negative. Those results imply a possible decoupling between GDP growth and energy consumption, so that energy conservation policies are not necessarily expected to have a negative impact on Swiss economic growth.

Modeling EU allowances and oil market interdependence. Implications for portfolio management

- Energy Economics---2013---Juan Reboredo

This paper examines the dependence structure between European Union allowances (EUAs) and crude oil markets during the second commitment period of the European Union Emissions Trading Scheme and the implications for portfolio management. Using different

copula models, our findings suggest positive average dependence and extreme symmetric independence that is consistent with interdependence and no contagion effects between the EUA and crude oil markets. The implication of this result for EUA-oil portfolios points to the existence of diversification benefits, hedging effectiveness, and value-at-risk reductions. The EUA market is therefore an attractive market for investors in terms of diversifying market risk and reducing downside risk in crude oil markets.

Efficient mechanisms for access to storage when competition in gas markets is imperfect

- Energy Economics---2013---Alberto Cava-
liere,Valentina Giust,Mario Maggi

Scarce storage capacity and distortions in access to storage can lead to market foreclosure in liberalized gas markets. We consider rules currently adopted in Europe for storage allocation, and discuss efficient rationing mechanisms as based on the value of storage, when other flexibility inputs are partially available. We initially analyze productive efficiency issues, without explicitly considering vertical restraints. We then assume imperfect competition in the downstream market for gas supplies, given the availability of storage capacity upstream, and analyze strategic behavior in a two-stage model. In this framework we compare regulated storage tariffs — coupled with a centralized rationing mechanism — with storage auctions. Finally, we consider the allocation of storage that arises from welfare maximization by a benevolent social planner. We find that it is usually optimal to maximize the amount of storage capacity allocated to new entrants in liberalized gas markets. Storage auctions deviate from the optimal mechanism, but still afford greater efficiency than do rules that allocate storage capacity independently of its value. Furthermore, storage allocation appears to be a powerful mechanism with which to improve competition and efficiency in gas markets.

Speculative bubbles in recent oil price dynamics: Evidence from a Bayesian Markov-switching state-space approach

- Energy Economics---2013---Marc Lammerding, Patrick Stephan, Mark Trede, Bernd Wilfling

Motivated by repeated spikes and crashes during previous decades we investigate whether the heavily financialized market for crude oil has been driven by speculative bubbles. In our theoretical modeling we draw on the convenience yield approach in order to approximate the fundamental value of the oil price. We separate the oil price fundamental from the bubble component by expressing a standard present-value oil price model in state-space form. We then introduce two Markov-regimes into the state-space representation in order to distinguish between two distinct phases in the bubble process, namely one in which the oil price bubble is a stable process and one in which the bubble explodes. We estimate the entire Markov-switching state-space specification using an econometrically robust Bayesian Markov-Chain-Monte-Carlo (MCMC) methodology. Based on inferential techniques designed for statistically separating both Markov-regimes in the bubble process from each other, we find robust evidence for the existence of speculative bubbles in recent oil price dynamics.

On the dynamics of gasoline market integration in the United States: Evidence from a pair-wise approach

- Energy Economics---2013---Mark Holmes, Jesus Otero, Theodore Panagiotidis

This paper employs a pair-wise approach to examine regional integration in the US gasoline market. Using gasoline price data at the state level over a period of more than two decades, we find strong support for the view that the law of one price holds in regional markets, as more than 80% of bivariate price differentials turn out to be stationary. Furthermore, we uncover evidence that the speed at which prices converge to the long-run equilibrium depends upon the distance between states. Asymmetries are also present in this relationship. Our

findings suggest that the more similar are states with respect to taxation, gas stations and refining capacity, the faster is the speed of adjustment towards the long-run equilibrium.

Examining the cost efficiency of Chinese hydroelectric companies using a finite mixture model

- Energy Economics---2013---Carlos Barros, Zhongfei Chen, Shunsuke Managi, Olinda Sequeira Antunes

This paper evaluates the operational activities of Chinese hydroelectric power companies over the period 2000–2010 using a finite mixture model that controls for unobserved heterogeneity. In so doing, a stochastic frontier latent class model, which allows for the existence of different technologies, is adopted to estimate cost frontiers. This procedure not only enables us to identify different groups among the hydro-power companies analysed, but also permits the analysis of their cost efficiency. The main result is that three groups are identified in the sample, each equipped with different technologies, suggesting that distinct business strategies need to be adapted to the characteristics of China's hydro-power companies. Some managerial implications are developed.

An information diffusion-based model of oil futures price

- Energy Economics---2013---Ziran Li, Jiajing Sun, Shouyang Wang

Inspired by the increasing evidence of financialization/speculation in commodity pricing, this paper constitutes a first attempt to build an information diffusion-based asset pricing framework for the oil futures market. With gradual information dissemination, slowly decaying uncertainty about the asset's future fundamentals generates persistent conditional volatility and a drift in asset return. Volatility-based proxies for information flows are proposed to examine empirically the asset pricing implications. The results confirm a significant intertemporal relationship between return

on the price of oil futures, information diffusion and volatility components. An important implication of our study is that the slow diffusion of information generates predictability in price dynamics. A forecasting model is then constructed and tested in relation to our theory. It is found that the lagged series of the pricing factors possess significant predicting power for returns.

Risk spillovers in oil-related CDS, stock and credit markets

- Energy Economics---2013---Shawkat Ham-moudeh,Tengdong Liu,Chia-Lin Chang,Michael McAleer

This paper examines risk transmission and migration among six US measures of credit and market risk during the full period 2004–2011 period and the 2009–2011 recovery subperiod, with a focus on four sectors related to the highly volatile oil price. There are more long-run equilibrium risk relationships and short-run causal relationships among the four oil-related Credit Default Swaps (CDS) indexes, the (expected equity volatility) VIX index and the (swaption expected volatility) SMOVE index for the full period than for the recovery subperiod. The auto sector CDS spread is the most error-correcting in the long run and also leads in the risk discovery process in the short run. On the other hand, the CDS spread of the highly regulated, natural monopoly utility sector does not error correct. The four oil-related CDS spread indexes are responsive to VIX in the short- and long-run, while no index is sensitive to SMOVE which, in turn, unilaterally assembles risk migration from VIX. The 2007–2008 Great Recession seems to have led to “localization” and less migration of credit and market risk in the oil-related sectors.

Convergence in per capita energy use among OECD countries

- Energy Economics---2013---Ming Meng,James Payne,Junsoo Lee

Unlike previous studies which mainly focus on the integration properties of energy consumption and pro-

duction, this study examines the convergence of per capita energy use among 25 OECD countries over the period 1960 to 2010. In particular, newly developed LM and RALS-LM unit root tests with allowance for two endogenously determined structural breaks are employed. The results indicate significant support for per capita energy use convergence among OECD countries.

Do oil prices respond to real interest rates?

- Energy Economics---2013---Vipin Arora,Matthew Tanner

We show that the robustness of an inverse relationship between the real interest rate and real oil price depends crucially on how the real interest rate is calculated, and the time-frame of the sample. Consistent with earlier studies, we find that the oil price falls with an unexpected rise in either U.S. or international ex-ante real interest rates. When the ex-post real interest rate is used, the oil price only falls with rises to short-term rates (3months or less). Additionally, the response of the oil price to long-term ex-ante real interest rates must include the period through the mid-2000s for the inverse relationship to appear. In contrast, the oil price consistently falls with unexpected rises in short-term real interest rates throughout the entire sample. We draw two conclusions from the results. The first is that the oil price is consistently responsive to short-term U.S. and international real interest rates, underlying the importance of storage. Second, oil prices have become more responsive to long-term real interest rates over time.

Efficient storage capacity in power systems with thermal and renewable generation

- Energy Economics---2013---Bjarne Steffen,Christoph Weber

Power systems with high shares of wind and solar power have to balance their intermittent nature. Pumped-hydro storage plants can provide the required flexibility, while thermal backup plants offer an alternative. This paper proposes a capacity planning model to describe

the efficient technology portfolio. Drawing on a residual load duration curve, we derive the efficient storage capacity and discuss its dependence on cost parameters, as well as the effect of periods with renewable generation in excess of load. A case study for Germany applies the model and highlights the impact of CO₂ prices on storage efficiency.

Price and welfare effects of emission quota allocation

- Energy Economics---2013---Rolf Golombek,Sverre Kittelsen,Knut Einar Rosendahl

We analyze how different ways of allocating emission quotas may influence the electricity market. Using a large-scale numerical model of the Western European energy market with heterogeneous electricity producers, we show that different allocation mechanisms can have very different effects on the electricity market, even if the total emission target is fixed. This is particularly the case if output-based allocation (OBA) of quotas is used. Gas power production is then substantially higher than if quotas are grandfathered. Moreover, the welfare costs of attaining a fixed emission target are significantly higher. The numerical results for OBA are supported by a theoretical analysis, which offers some new results.

Fair electricity transfer price and unit capacity selection for microgrids

- Energy Economics---2013---Di Zhang,Nouri J. Samsatli,Adam D. Hawkes,Dan J.L. Brett,Nilay Shah,Lazaros G. Papageorgiou

Microgrids are defined as an area of electricity distribution network that can operate autonomously from the rest of the network. In order to achieve the best economic outcomes, the participants in a microgrid can benefit from cooperation in microgrid design and operation. In this paper, a mathematical programming formulation is presented for fair, optimised cost distribution amongst participants in a general microgrid. The proposed formulation is based on the Game-theory Nash bargaining solution approach for finding optimal

multi-partner cost levels subject to given upper bounds on the equivalent annual costs. The microgrid planning problem concerning the fair electricity transfer price and unit capacity selection is first formulated as a mixed integer non-linear programming model. Then, a separable programming approach is applied to reform the resulting mixed integer non-linear programming model to a mixed integer linear programming form. The model is applied to a case study with a microgrid involving five participants.

Causality-in-mean and causality-in-variance within the international steam coal market

- Energy Economics---2013---Monika Papież,Sławomir Śmiech

The purpose of this paper is to investigate the integration of the steam coal market. The analysis of dependencies between mean rates of return of prices on the steam coal market and volatility spillover was conducted using weekly data from the period 04.01.2002 to 30.12.2011. The prices of the world's largest exporters and importers on the Pacific and Atlantic markets were chosen to analyse the dependencies. The methodology was based on the tests from Cheung and Ng (1996) and Hong (2001), which allow for the analysis of Granger causality both in mean and in variance. The analyses indicate that the dependence between participants is not the same. The strongest links were observed between the pairs of participants from the same market (that is, either the Atlantic market or the Pacific market), and the price of Australian coal turned out to be the most important factor in shaping other prices on the Pacific market. On the Atlantic market, the coal prices in the Amsterdam-Rotterdam-Antwerp (ARA) ports and the Richards Bay port had the greatest influence on coal prices and were the Granger cause of prices in the Pacific region.

Clean fuel-saving technology adoption in urban Ethiopia

- Energy Economics---2013---Abebe D. Beyene,Steven Koch

The heavy dependence and inefficient utilization of biomass resources have contributed to the depletion of forest resources in Ethiopia, while the use of traditional cooking technology has also been linked to indoor air pollution and poor health. In response, the government and other institutions have pushed for the adoption of new cooking technologies, with limited success. This research examines the reasons underpinning the lack of widespread adoption, via duration analysis, correlating the speed of adoption of Mirte and Lakech cook stoves – two examples of new cooking technologies – in urban Ethiopia to socioeconomic factors. According to the duration analysis, adoption rates have steadily increased over time, while economic factors, such as product price, household income and household wealth, are, for the most part, important determinants of adoption behavior. There is also evidence that the availability of substitute technologies tends to hinder adoption, and that there are large regional differences in adoption rates, suggesting the need for a more detailed regional analysis of adoption decisions.

Fitting semiparametric Markov regime-switching models to electricity spot prices

- Energy Economics---2013---Michael Eichler,D. Türk

Recently regime-switching models have become the standard tool for modeling electricity prices. These models capture the main properties of electricity spot prices well but estimation of the model parameters requires computer intensive methods. Moreover, the distribution of the price spikes must be fully specified although the high volatility of the spikes makes it difficult to check such distributional assumptions. Consequently, there are a number of competing proposals for the distribution in the spike regime. As an alternative, we propose a semiparametric Markov regime-switching model that leaves the distribution under the spike regime unspecified. We show that the model parameters can be estimated by employing robust statistical techniques. This presents an alternative to the existing estimation methods that are based on computer intensive numerical maximization

of the likelihood function. The model in combination with the estimation framework is easier to estimate, needs less computation time and distributional assumptions. To show its advantages we compare the proposed model with a well-established Markov regime-switching model in a simulation study. Furthermore, we apply the model to log-prices for the Australian electricity market. The results are in accordance with the results from the simulation study, indicating that the proposed model might be advantageous whenever the distribution of the spike process is not sufficiently known. The results are thus encouraging and suggest the use of our approach when modeling electricity prices and pricing derivatives.

Valuing modular nuclear power plants in finite time decision horizon

- Energy Economics---2013---Shashi Jain,Ferry Roelofs,Cornelis W. Oosterlee

Small and medium sized reactors, SMRs, (according to IAEA, ‘small’ refers to reactors with power less than 300MWe, and ‘medium’ with power less than 700MWe) are considered as an attractive option for investment in nuclear power plants. SMRs may benefit from flexibility of investment, reduced upfront expenditure, enhanced safety, and easy integration with small sized grids. Large reactors on the other hand have been an attractive option due to the economy of scale. In this paper we focus on the economic impact of flexibility due to modular construction of SMRs. We demonstrate, using real option analysis, the value of sequential modular SMRs. Numerical results under different considerations of decision time, uncertainty in electricity prices, and constraints on the construction of units, are reported for a single large unit and for modular SMRs.

Energy consumption and economic growth: Evidence from the economic community of West African States (ECOWAS)

- Energy Economics---2013---Nadia S. Ouedraogo

Access to modern energy is believed to be a prerequisite

for sustainable development, poverty alleviation and the achievement of the Millennium Development Goals.

Residential electricity demand in Spain: New empirical evidence using aggregate data

- Energy Economics---2013---Leticia Blázquez,Nina Boogen,Massimo Filippini

This paper presents an empirical analysis on residential demand for electricity. This analysis has been performed using aggregate panel data at the province level for 47 Spanish provinces for the period from 2000 to 2008. For this purpose, we estimated a log-log demand equation for electricity consumption using a dynamic partial adjustment approach. This dynamic demand function has been estimated using a two-step system GMM estimator proposed by Blundell and Bond (1998). The purpose of this empirical analysis is to highlight some of the characteristics of Spanish residential electricity demand. Particular attention has been paid to the influence of price, income, and weather conditions on electricity demand. The estimated short and long-run own price elasticities are negative, as expected, but lower than 1. Furthermore, weather variables have a significant impact on electricity demand.

Volatility spillover between oil and agricultural commodity markets

- Energy Economics---2013---Saban Nazli-oglu,Cumhur Erdem,Ugur Soytaş

This study examines volatility transmission between oil and selected agricultural commodity prices (wheat, corn, soybeans, and sugar). We apply the newly developed causality in variance test and impulse response functions to daily data from 01 January 1986 to 21 March 2011. In order to identify the impact of the food price crisis, the data are divided into two sub-periods: the pre-crisis period (01 January 1986 to 31 December 2005) and the post-crisis period (01 January 2006–21 March 2011). The variance causality test shows that while there is no risk transmission between oil and agricultural commodity markets in the pre-crisis period, oil market volatility spills on the agricultural markets

—with the exception of sugar—in the post-crisis period. The impulse response analysis also indicates that a shock to oil price volatility is transmitted to agricultural markets only in the post-crisis period. This paper thereby shows that the dynamics of volatility transmission changes significantly following the food price crisis. After the crisis, risk transmission emerges as another dimension of the dynamic interrelationships between energy and agricultural markets.

Impacts of biodiesel on the Brazilian fuel market

- Energy Economics---2013---Daniel Silva Junior

This paper investigates market effects of the Brazilian biodiesel law, which made the use of biodiesel, blended with petroleum diesel, mandatory in Brazil. The study estimates the demand curve for diesel fuel (biodiesel and petroleum diesel) and the industry supply curve of biodiesel. These two pieces of information have been used in a static analysis to draw scenarios with different biodiesel mandates. The results show that the current proportion of biodiesel in the diesel mixture (5%) increases consumers' price by 1.7% and decreases the consumption by 1.5% compared to the scenario without biodiesel. Also, an increase in the biodiesel percentage to 10% would raise the price by 3.5% and reduce the consumption by 3%.

Effects and mechanism of influence of China's resource tax reform: A regional perspective

- Energy Economics---2013---Zengkai Zhang,Guo, Ju'e,Dong Qian,Yong Xue,Luping Cai

China's resource tax reform, beginning with Xinjiang as a pilot area in June 2010, marked a new stage in the progression of China's resource tax system. Based on the 2007 social accounting matrix (SAM) for Xinjiang, constructed by ourselves, this paper takes a regional perspective on China's resource tax reform to quantitatively calculate its degree of influence and qualitatively analyze its mechanism of influence by adopting an energy computable general equilibrium (CGE) model and a SAM price model. The results show that the main significance of the reform lies in

bolstering local government finances rather than energy conservation or carbon reduction. This is because revenue will be transferred from resource enterprises and the central government to the local government, while simultaneously the low tax rate, narrow tax scope and unreasonable price mechanism will combine to prevent the reform from reaching its environmental goals. Promoting resource price mechanism reform and deepening resource tax reform will be two key elements of China's future energy strategies. Because resource enterprises will bear the increased burden caused by the reform, the degree of sectoral price increases will be limited; therefore, the fear that resource tax reform will push up inflation is unnecessary and should not be a barrier to reform.

Energy consumption and economic growth: Parametric and non-parametric causality testing for the case of Greece

- Energy Economics---2013---Theologos Dergiades,Georgios Martinopoulos,Lefteris Tsoulfidis

The objective of this paper is to contribute towards the understanding of the linear and non-linear causal linkages between energy consumption and economic activity, making use of annual time series data of Greece for the period 1960–2008. Two are the salient features of our study: first, the total energy consumption has been adjusted for qualitative differences among its constituent components through the thermodynamics of energy conversion. In doing so, we rule out the possibility of a misleading inference with respect to causality due to aggregation bias. Second, the investigation of the causal linkage between economic growth and the adjusted for quality total energy consumption is conducted within a non-linear context. Our empirical results reveal significant unidirectional both linear and non-linear causal linkages running from total useful energy to economic growth. These findings may provide valuable information for the contemplation of more effective energy policies with respect to both the consumption of energy and environmental protection.

The (de)merits of minimum-variance hedging: Application to the crack spread

- Energy Economics---2013---Carol Alexander,Marcel Prokopczuk,Anannit Sumawong

We study the empirical performance of the classical minimum-variance hedging strategy, comparing several econometric models for estimating hedge ratios of crude oil, gasoline and heating oil crack spreads. Given the great variability and large jumps in both spot and futures prices, considerable care is required when processing the relevant data and accounting for the costs of maintaining and re-balancing the hedge position. We find that the variance reduction produced by all models is statistically and economically indistinguishable from the one-for-one “naïve” hedge. However, minimum-variance hedging models, especially those based on GARCH, generate much greater margin and transaction costs than the naïve hedge. Therefore we encourage hedgers to use a naïve hedging strategy on the crack spread bundles now offered by the exchange; this strategy is the cheapest and easiest to implement. Our conclusion contradicts the majority of the existing literature, which favours the implementation of GARCH-based hedging strategies.

The energy–GDP nexus; addressing an old question with new methods

- Energy Economics---2013---Robin Coers,Mark Sanders

This paper reassesses the causal relationship between per capita energy use and gross domestic product, while controlling for capital and labour (productivity) inputs in a panel of 30 OECD countries over the past 40years. The paper uses panel unit root and cointegration testing and specifies an appropriate vector error correction model to analyse the nexus between income and energy use. In doing so we contribute to an old debate using modern tools that shed a new light. There is some evidence that over the very short-run bidirectional causality exists. Our results also show a strong unidirectional causality running from capital formation and GDP to energy usage. In the long run the reverse

causality, found in recent work, is lost. We then show that we can reproduce these earlier results in our data if we reproduce a slightly misspecified model for the Engle–Granger two-step procedure used in these earlier papers. Our findings thus imply that results are very sensitive to model misspecification and careful testing of specifications is required. Our results have some strong policy implications. They suggest that policies aimed at reducing energy usage or promoting energy efficiency are not likely to have a detrimental effect on economic growth, except over the very short run.

A PROMETHEE-GDSS for oil and gas pipeline planning in the Caspian Sea basin

- Energy Economics---2013---Madjid Tavana,Majid Behzadian,Mohsen Pirdashti,Hasan Pirdashti

The demand for oil and natural gas has severely challenged the world supply. The Caspian Sea basin holds large quantities of both oil and natural gas. Pipelines are needed to transport the oil and natural gas from this landlocked region over long distances within countries and across borders to meet this increasing demand. The evaluation of alternative export routes in the Caspian Sea basin is a complex multicriteria problem with conflicting objectives. We present a Group Decision Support System (GDSS) for the evaluation of alternative pipeline routes in this region. The proposed system decomposes the route selection process into manageable steps. The system combines Strength, Weakness, Opportunity and Threat (SWOT) analysis with the Delphi method to capture the decision makers' (DMs') beliefs. A group Preference Ranking Organization Method for Enrichment Evaluation (PROMETHEE) model is used to integrate these beliefs with subjective judgments and identify the most attractive pipeline route. The Geometrical Analysis for Interactive Assistance (GAIA) plane is used to further analyze the alternative routes and arrive at a group solution consistent with managerial goals and objectives.

Smart meter devices and the effect of feedback on residential electricity consumption: Evidence from a natural experiment in Northern Ireland

- Energy Economics---2013---Will Gans,Anna Alberini,Alberto Longo

Using a unique set of data and exploiting a large-scale natural experiment, we estimate the effect of real-time usage information on residential electricity consumption in Northern Ireland. Starting in April 2002, the utility replaced prepayment meters with advanced meters that allow the consumer to track usage in real-time. We rely on this event, account for the endogeneity of price and payment plan with consumption through a plan selection correction term, and find that the provision of information is associated with a decline in electricity consumption of 11–17%. We find that the reduction is robust to different specifications, selection-bias correction methods and subsamples of the original data. The advanced metering program delivers reasonably cost-effective reductions in carbon dioxide emissions, even under the most conservative usage reduction scenarios.

Is economic growth good or bad for the environment? Empirical evidence from Korea

- Energy Economics---2013---Jungho Baek,Hyun Kim

The effects of economic growth on the environment in Korea, for a given level of energy consumption, and fossil fuels and nuclear energy in electricity production, are examined in a dynamic cointegration framework. To that end, the autoregressive distributed lag (ARDL) approach is used. We find empirical evidence supporting the existence of the environmental Kuznets curve (EKC) hypothesis for Korea; that is, economic growth indeed plays a favorable role in influencing environmental outcomes. It is also found that, in both the short- and long-run, nuclear energy has a beneficial effect on environmental quality, whereas fossil fuels in electricity production and energy consumption have a detrimental effect on the environment.

China's overseas investment in the energy/resources sector: Its scale, drivers, challenges and implications

- Energy Economics---2013---Xiaomei Tan

Since 2005, China has greatly enhanced its presence in the global landscape of outward foreign direct investment (OFDI). The total volume of China's OFDI has exceeded \$200billion in the past five years. The number will further rise as China looks for outlets to spend its \$3trillion in foreign exchange reserves. China's emergence as a global direct investor entails a number of consequences, which are yet to be understood. This study seeks to shed light on how corporate China extends its reaches overseas, what are the policy drivers and who are the key decision makers, from the perspective of the energy/resources sector. The goal is to better understand how to reap the financial benefits of corporate China's marching into the global marketplace.

Past as Prologue? Understanding energy use in post-2002 China

- Energy Economics---2013---Fredrich Kahrl,David Roland-Holst,David Zilberman

From 2002 to 2009, China's energy use nearly doubled, making it the world's largest emitter of carbon dioxide more than a decade ahead of forecasts. Why did energy use in China rise so rapidly after 2002? Using index decomposition analysis, we find that the vast majority of growth in energy consumption in China over the 2000s was due to GDP growth, with a small but important amount due to structural change as a result of China's emergence as a net metals exporter. Changing prices and data anomalies make energy intensity and structural change appear to be more important drivers of energy consumption than they actually were; the infamous reversal in energy intensity in China from 2002 to 2004 may simply be an artifact of difficulties in accurately deflating value added. About half of the growth in energy consumption in China from 2002 to 2007 was driven by heavy industry. Using structural decomposition analysis, we find that growth in

heavy industrial output was due primarily to growth in construction and equipment investment, with a small amount due to an increase in net metal exports. In tandem, these two findings suggest that the primary driver of energy consumption in China after 2002 was an acceleration of the country's investment-dominated model of GDP growth. Without rebalancing the economy toward consumption, there are limits to what improvements in energy conversion efficiency and end use energy efficiency can achieve in moderating growth in China's energy use.

A stochastic fuel switching model for electricity prices

- Energy Economics---2013---Georg Zachmann

This paper develops and applies a novel electricity price model. We reproduce the merit order of a thermal-dominated electricity system by establishing a non-linear dependency of wholesale electricity prices on the prices of fuels (coal and natural gas) and of CO₂ emission allowances. The coefficients are estimated using a Markov Switching Regression.

Free EUAs and fuel switching

- Energy Economics---2013---Paolo Falbo,Daniele Felletti,Silvana Stefani

This paper focuses on the impact of EUAs on the optimal policy of a competitive electricity producer. The effect of grandfathering is consistently shown to introduce significant distortions to the system. It is theoretically shown that there is a threshold value of carbon price so that, for prices above this, the EUA becomes an incentive for reduced production rather than a penalty for inefficient producers. These theoretical results are supported by the data of one producer from Italy and one from Germany. Furthermore, the empirical evidence concludes that the high level of free allowances may generate a shift in production from less to more polluting technologies.

The case of negative day-ahead electricity prices

- Energy Economics---2013---Enzo Fanone,Andrea Gamba,Marcel Prokopczuk

In recent years, Germany has significantly increased its share of electricity produced from renewable sources, which is mainly due to the Renewable Energy Act (EEG). The EEG substantially impacts the dynamics of intra-day electricity prices by increasing the likelihood of negative prices. In this paper, we present a non-Gaussian process to model German intra-day electricity prices and propose an estimation procedure for this model. Most importantly, our model is able to generate extreme positive and negative spikes. A simulation study demonstrates the ability of our model to capture the characteristics of the data.

A Mixed Integer Linear Programming model of a zonal electricity market with a dominant producer

- Energy Economics---2013---Maria Teresa Vespucci,Mario Innorta,Guido Cervigni

We consider a liberalized electricity market, divided in zones interconnected by capacitated transmission links, where a large dimensional power producer operates. We introduce a model for determining the optimal bidding strategies of the large dimensional producer, so as to maximize his own market share, while guaranteeing an annual profit target and satisfying technical constraints. The model determines the optimal medium-term resource scheduling and yields the hourly zonal electricity prices, as it includes constraints representing the Market Clearing process. In order to compute the global solution, the complementarity conditions are formulated as mixed integer linear constraints and the revenue terms are expressed by piece-wise linear functions. The model can be used for analyzing the behavior of market prices in electricity markets where a large dimensional producer can exert market power. It can also be used by investors as a simulation tool for evaluating both the impact on the market and the profitability of investment decisions in the zonal electricity

market. A case study related to the Italian electricity market is discussed.

Exogenous oil shocks, fiscal policies and sector reallocations in oil producing countries

- Energy Economics---2013---Alessandro Cologni,Matteo Manera

Previous literature has suggested that different mechanisms of transmission of exogenous oil shocks are responsible for the negative effects on the economic performances of oil exporting countries. This paper aims at providing further evidence on the role of sectoral reallocation between private and public sectors in explaining the impact of shocks to oil revenues on the economic growth rates of major oil producing countries (namely the GCC – Gulf Corporation Council – countries). The effects of oil shocks and expansionary fiscal policy on the business cycle of oil producing countries are examined. The possibility to distinguish between various components of public sector spending policy (that is, purchases of consumption goods, investments in productive activities and compensation for public employees) is, in particular, allowed for. A real business cycle (RBC) model is calibrated to fit the data on an “average” oil producing country. Results from the simulation of the theoretical model suggest that the possibility that the expansion of the size of the government (due, in particular, to the increase in the number of employees) can explain a large fraction of the negative effects of shocks to oil revenues on the private sector of the economy. However, since the growth in size of the public sector more than compensate for the reduction in size of the private sector, an increase in oil revenues has the effect to boost total output.

Modeling and valuing make-up clauses in gas swing contracts

- Energy Economics---2013---Enrico Edoli,Stefano Fiorenzani,Samuele Ravelli,Tiziano Vargiolu

In the last 10years, thanks to the worldwide energy liberalization process, the birth of competitive gas markets and the recent financial crisis, traditional long term

swing contracts in Europe have been supplemented in a significant way by make-up clauses which allow postponing the withdrawal of gas to future years when it could be more profitable. This introduces more complexity in the pricing and optimal management of swing contracts. This paper is devoted to a proper quantitative modelization of one type of make-up clause in a gas swing contract. More in detail, we succeed in building an algorithm to price and optimally manage the make-up gas allocation among the years and the gas taking in the swing subperiods within the years: we prove that this problem has a quadratic complexity with respect to the number of years. The algorithm can be adapted to different instances of make-up clauses as well as to some forms of carry-forward clauses. Then, as an example, we show the algorithm at work on a 3-year contract and we present a sensitivity analysis of the price and of the make-up policy with respect to various parameters relative both to the price dynamics and to the swing contract. To the authors' knowledge, this is the first time that such a quantitative treatment of make-up clauses appears in literature.

Combining day-ahead forecasts for British electricity prices

- Energy Economics---2013---Silvano Bordinon,Derek W. Bunn,Francesco Lisi,Fany Nan

This paper considers how well the approach of combining forecasts extends to the context of electricity prices. With the increasing popularity of regime switching and time-varying parameter models for predicting power prices, the multi model and evolutionary considerations that usually support the combining of simpler time series methods may be less applicable when the individual models incorporate these features. We address this question with a backtesting analysis on British day-ahead prices. Furthermore, given the volatility of power prices and concerns about accurate forecasting under extreme price excursions, we evaluate the results using various error metrics including expected shortfall. The comparisons are furthermore carefully simulated to consider model selection uncertainty in order to

realistically test the value of combining as an ex ante policy. Overall, our results support combining for both accurate operational planning and risk management.

The role of Asia in mitigating climate change: Results from the Asia modeling exercise

- Energy Economics---2012---Katherine Calvin,Leon Clarke,Volker Krey,Geoffrey Blanford,Kejun Jiang,Mikiko Kainuma,Elmar Kriegler,Gunnar Luderer,P.R. Shukla

In 2010, Asia accounted for 60% of global population, 39% of Gross World Product, 44% of global energy consumption and nearly half of the world's energy system CO2 emissions. Thus, Asia is an important region to consider in any discussion of climate change or climate change mitigation. This paper explores the role of Asia in mitigating climate change, by comparing the results of 23 energy-economy and integrated assessment models. We focus our analysis on seven key areas: base year data, future energy use and emissions absent climate policy, the effect of urban and rural development on future energy use and emissions, the role of technology in emissions mitigation, regional emissions mitigation, and national climate policies.

What are the starting points? Evaluating base-year assumptions in the Asian Modeling Exercise

- Energy Economics---2012---Vaibhav Chaturvedi,Stephanie Waldhoff,Leon Clarke,Shinichiro Fujimori

A common feature of model inter-comparison efforts is that the base year numbers for important parameters such as population and GDP can differ substantially across models. This paper explores the sources and implications of this variation in Asian countries across the models participating in the Asian Modeling Exercise (AME). Because the models do not all have a common base year, each team was required to provide data for 2005 for comparison purposes. This paper compares the year 2005 information for different models, noting

the degree of variation in important parameters, including population, GDP, primary energy, electricity, and CO₂ emissions. It then explores the difference in these key parameters across different sources of base-year information. The analysis confirms that the sources provide different values for many key parameters. This variation across data sources and additional reasons why models might provide different base-year numbers, including differences in regional definitions, differences in model base year, and differences in GDP transformation methodologies, are then discussed in the context of the AME scenarios. Finally, the paper explores the implications of base-year variation on long-term model results.

Urban and rural energy use and carbon dioxide emissions in Asia

- Energy Economics---2012---Volker Krey,O'Neill, Brian C.,Bas van Ruijven,Vaibhav Chaturvedi,Vassilis Daioglou,Jiyong Eom,Leiwen Jiang,Yu Nagai,Shonali Pachauri,Xiaolin Ren

The process of urbanization has been shown to be important for economic development, environmental impacts and human wellbeing, particularly in developing countries. In this paper we compare structure, data sources and scenario results of four integrated assessment models that are capable of analyzing different aspects of urbanization. The comparison focuses on residential sector energy use and related CO₂ emissions based on a set of urbanization scenarios for China and India. Important insights from this model comparison include that (i) total fossil fuel and industrial CO₂ emissions at the regional level are not very sensitive to alternative rates of urbanization and are largely dependent on the linkage between urbanization and economic growth via differentiated labor productivity in urban and rural areas, (ii) alternative urbanization pathways may yield different results for the share of solid fuels in residential energy use, thereby affecting the number of people relying on these fuels and the associated adverse health impacts, and (iii) alternative economic growth scenarios can only be assessed for their welfare implications if urban and rural household

are distinguished, even though that distinction does not always strongly affect aggregate outcomes which is often due to two effects that compensate each other in total. It can be concluded that urbanization and heterogeneity of households and consumers are clearly relevant for distributional effects and associated health and social impacts.

Baseline projections of energy and emissions in Asia

- Energy Economics---2012---Geoffrey J. Blanford,Steven K. Rose,Massimo Tavoni

This paper analyzes the projected development of energy systems in the Asia region in the hypothetical absence of future carbon policies. Baseline scenarios prepared by participating teams in the Asia Modeling Exercise are used to generate a comprehensive assessment of the key drivers of CO₂ emissions for the next several decades, especially for China and India. We find a very wide range of projected emissions paths across the models and identify per capita income and energy intensity as the two major factors responsible for the variation. While the range of assumptions for growth in the former is roughly consistent with historical experience in other Asian economies, models foresee faster reductions in the latter with respect to those observed in neighboring countries at similar stages of economic development. On the other hand, there is a considerable agreement on the evolution of the energy technology mix, which is assumed to continue to be dominated by fossil fuels in the foreseeable future.

Regional energy system variation in global models: Results from the Asian Modeling Exercise scenarios

- Energy Economics---2012---Leon Clarke,Volker Krey,John Weyant,Vaibhav Chaturvedi

This paper explores the variation in Asian energy systems in the energy-economic and integrated assessment models participating in the Asian Modeling Exercise (AME). Consistent with previous studies, there is substantial variation in energy system configurations

across the AME scenarios, a reflection of the inherent uncertainty in how countries might undertake climate mitigation and associated energy system decisions. The paper also explores the degree to which scenarios from individual models retain regional differences in energy system configurations over time. The scenarios are mixed in this regard. Some models tend to converge toward common energy systems that focus on the utilization of a common set of options across regions, while others retain strong differences among regions. A review of modeling approaches indicates that the participating models are constructed to represent many, but not all, of the real-world forces leading to regional variation. The models do not have the capability to represent some of the most important social and political factors that influence energy technology decision making, raising important questions about how decision makers should interpret regional variations across models, particularly over the medium to long term.

Comparing model results to national climate policy goals: Results from the Asia modeling exercise

- Energy Economics---2012---Katherine Calvin,Allen Fawcett,Jiang Kejun

While the world has yet to adopt a single unified policy to limit climate change, many countries and regions have adopted energy and climate policies that have implications for global emissions. In this paper, we discuss a few key policies and how they are included in a set of 23 energy and integrated assessment models that participated in the Asia Modeling Exercise. We also compare results from these models for a small set of stylized scenarios to the pledges made as part of the Copenhagen Accord and the goals stated by the Major Economies Forum. We find that the targets outlined by the United States, the European Union, Japan, and Korea require significant policy action in most of the models analyzed. For most of the models in the study, however, the goals outlined by India are met without any climate policy. The stringency of climate policy required to meet China’s Copenhagen pledges varies across models and accounting methodologies.

Framing and modeling of a low carbon society: An overview

- Energy Economics---2012---Mikiko Kainuma,Priyadarshi R. Shukla,Kejun Jiang

Asian Modeling Exercise (AME) studies show feasible GHG emissions pathways consistent with the 2degrees centigrade global stabilization target. The aim of the low carbon society subgroup is to propose frameworks, modeling methodologies, and workable roadmaps that will transform in-situ socioeconomic development to a sustainable low carbon society. This paper overviews LCS modeling studies and presents the LCS modeling frameworks and approaches used by the country modeling teams from Japan, China, India, Korea, and Nepal. The LCS modeling is soft-linked to global targets through regional emission constraints derived from the global stabilization targets. The disaggregated, yet soft-linked, assessments provide opportunities to articulate scenarios that include context-specific inputs, and thereby explicitly consider benefits and deliver more realistic and implementable roadmaps. We find that LCS modeling exercises are still at a relatively early stage in terms of modeling space, and need methodological enhancements. However, this approach offers considerable promise in a world where major emerging economies are undergoing rapid transformation, national and regional interests everywhere still precede global interests, and implementation of the carbon market remains fragmentary. Significant opportunities therefore exist for co-benefits to be gained, opportunities that could be the key drivers of short-term actions vital to the realization of the low carbon transition.

Exploring the future role of Asia utilizing a Scenario Matrix Architecture and Shared Socio-economic Pathways

- Energy Economics---2012---Jiyong Eom,Kate Calvin,Leon Clarke,Jae Edmonds,Sonny Kim,Robert Kopp,Page Kyle,Patrick Luckow,Richard Moss,Pralit Patel,Marshall Wise

We explore the implications that alternative pathways

for human population and economic development have for the role of Asia in reference no-climate-policy scenarios and scenarios in which climate forcing is limited. We consider three different pathways of socioeconomic development, which we refer to as Shared Socio-economic Pathways (SSPs) and four different levels of limitation on climate forcing, which we refer to as Shared Climate Policy Assumptions (SPAs). SSPs are differentiated by population and economic growth assumptions, while SPAs are differentiated on the level of radiative forcing in the year 2100. Regardless of the scenarios we examined Asia plays a central role in shaping the world's future with nearly half of the world's people and more than half of the world's economic activity and energy consumption. The future of Asia and the world are dramatically different across the various combinations of SSPs and SPAs. High population worlds place significant stress on Asian resources and ecosystems. In high population SSPs the poorest members of the population face high energy and food prices and the more stringent the level of emissions mitigation, the more stress poor populations experience, though the more stringent the emissions mitigation, the larger the area of unmanaged ecosystems that are preserved.

The effect of urbanization on energy use in India and China in the iPETS model

- Energy Economics---2012---O'Neill, Brian C., Xiaolin Ren, Leiwen Jiang, Michael Dalton

Urbanization is one of the major demographic and economic trends occurring in developing countries, with important consequences for development, energy use, and well being. Yet it is only beginning to be explicitly incorporated in long-term scenario analyses of energy and emissions. We assess the implications of a plausible range of urbanization pathways for energy use and carbon emissions in India and China, using the integrated Population-Economy-Technology-Science (iPETS) model, a computable general equilibrium (CGE) model of the global economy that captures heterogeneity in household types within world regions and into which we have introduced income effects on household consumption preferences. We find

that changes in urbanization have a somewhat less than proportional effect on aggregate emissions and energy use. A decomposition analysis demonstrates that this effect is due primarily to an economic growth effect driven by the increased labor supply associated with faster urbanization. The influence of income on household consumption is strong, and indicates a potentially rapid transition away from traditional fuel use and toward modern fuels such as electricity and natural gas. Results also indicate important directions for future work, including the implications of alternative types and driving forces of urbanization over time, a better understanding of possible changes in consumption preferences associated with income growth and the urbanization process, and modeling strategies that can produce disaggregated household consumption outcomes within a CGE framework.

GHG emission scenarios in Asia and the world: The key technologies for significant reduction

- Energy Economics---2012---Osamu Akashi, Yasuaki Hijioka, Toshihiko Masui, Tatsuya Hanaoka, Mikiko Kainuma

In this paper, we explore GHG emission scenarios up to 2050 in Asia and the world as part of the Asian Modeling Exercise and assess technology options for meeting a 2.6W/m² radiative forcing target using AIM/Enduse[Global] and AIM/Impact[Policy]. Global GHG emissions in 2050 are required to be reduced by 72% relative to a reference scenario, which corresponds to a 57% reduction from the 2005 level, in order to meet the above target. Energy intensity improvement contributes a lot to curbing CO₂ emission in the short-term. Meanwhile, carbon intensity reduction and CO₂ capture play a large role for further emission reduction in the mid to long-term. The top five key technologies in terms of reduction amount are CCS, solar power generation, wind power generation, biomass power generation and biofuel, which, in total, account for about 60% of global GHG emissions reduction in 2050. We implement additional model runs, each of which enforced limited availability of one of the key technology. The result shows that the 2.6W/m² target up to 2050

is achievable even if availability of any one of the key technologies is limited to half the level achieved in the default simulation. However, if the use of CCS or biomass is limited, the cumulative GHG abatement cost until 2050 increases considerably. Therefore CCS and biomass have a vital role in curbing costs to achieve significant emission reductions.

Decomposing the impact of alternative technology sets on future carbon emissions growth

- Energy Economics---2012---Karen Fisher-Vanden,Kathryn Schu,Ian Sue Wing,Katherine Calvin

What are the drivers of future global carbon dioxide (CO₂) emissions growth and how would the availability of key energy supply technologies change their relative importance? In this paper, we apply a novel index number decomposition technique to the results of a multi-region, multi-sector computable general equilibrium model to quantify the influence of five factors on the growth of future carbon emissions: (1) growth in global economic activity; (2) shifts in the regional composition of gross world product; (3) shifts in the sectoral composition of regions' GDP; (4) changes in sectors' energy-output ratios; and (5) changes in the CO₂ intensity of energy sources. We elucidate how the relative importance of these factors changes in response to the imposition of a global carbon tax and alternative assumptions about the future availability of key energy supply technologies. Rising global economic activity and shifts in regional composition put upward pressure on emissions while changes in energy and emission intensity and the sectoral output mix have attenuating effects. A global emission tax that increases over time slows economic expansion and shifts the fuel mix, with the most pronounced impacts on China, India, and Russia. Limited availability of carbon capture and storage, nuclear, and hydroelectric generation all lead to upward shifts in the long-run marginal abatement cost curve, causing some countries to choose to pay the tax rather than abate.

Climate mitigation under an uncertain technology future: A TIAM-World analysis

- Energy Economics---2012---Maryse Labriet,Amit Kanudia,Richard Loulou

This paper explores the impacts of long-term technology and climate uncertainties on the optimal evolution of the World energy system. Stochastic programming with the TIAM-World model is used for a parametric analysis of hedging strategies, varying the probabilities associated to each of two contrasted technology outlooks. The parametric analysis constitutes an original supplement to the computation of hedging strategies by identifying technologies that are robust under a broad range of probabilities of the two technology outlooks. Natural gas appears to be one of the most appealing robust options in an uncertain technological context, especially in China, given its relatively low emissions and the low capital cost of associated technologies. Natural gas and some other options are in fact considered as “super-hedging” actions, penetrating more in the hedging solution than in any of the deterministic scenarios. Nuclear power and CCS use are less robust: they depend much more on either the level of the climate target or the probabilities of the technology outlooks. The analysis also shows that technological uncertainty has a greater impact under milder climate targets than under more severe ones. Future research might consider a larger set of possible technology outlooks, as well as specific analyses focused on key characteristics of low-carbon technologies.

Asia's role in mitigating climate change: A technology and sector specific analysis with ReMIND-R

- Energy Economics---2012---Gunnar Luderer,Robert C. Pietzcker,Elmar Kriegler,Markus Haller,Nico Bauer

We use the ReMIND-R model to analyze the role of Asia in the context of a global effort to mitigate climate change. We introduce a novel method of secondary energy based mitigation shares, which allows us to

quantify the economic mitigation potential of technologies in different regions and final energy carriers.

Assessment of GHG emission reduction pathways in a society without carbon capture and nuclear technologies

- Energy Economics---2012---Azusa Okagawa,Toshihiko Masui,Osamu Akashi,Yasuaki Hijioka,Kenichi Matsumoto,Mikiko Kainuma

Every possible technology is pursued in order to achieve strict radiative forcing targets. Nuclear energy and Carbon Capture Storage (CCS) are regarded as important mitigation options. However, harsh criticisms have been directed at Japanese nuclear energy policy after the Fukushima nuclear accident, and the Japanese government will be required to re-evaluate not only its energy policy, but also the GHG reduction target itself. Like nuclear energy, CCS might not be regarded as a suitable option for GHG mitigation because its long-term safety has not been revealed. In this paper we analyze the energy policy response to an absence of nuclear energy and CCS, especially focusing on Japan, China and India. We find that the appropriate energy strategies against the unproven technologies differ between regions due to the uneven pre-existing nuclear energy, CCS potential and renewable energy potential, and the resource endowments and the levels of economic development. We also find that the strict mitigation target can be achieved even if nuclear energy and CCS are not available. In such a case, however, significant enhancement of renewable energy is needed, as well as particular fossil fuel alternatives based on region-specific availabilities and costs.

Development and deployment of clean electricity technologies in Asia: A multi-scenario analysis using GTEM

- Energy Economics---2012---Raymond Mi,Helal Ahammad,Nina Hitchins,Edwina Heyhoe

Carbon capture and storage (CCS) and emerging renewable energy technologies including wind, solar, geothermal and biomass are commonly considered as

possible solutions for the electricity sector transitioning to low-carbon future. However, developing and deploying clean electricity technologies is not a cost-free exercise and it will draw resources from other technologies and production sectors. In this paper four mitigation scenarios with identical emissions pathways but with varying degrees of uptake of clean electricity technologies including CCS and emerging renewable energy technologies, are simulated and their welfare implications are analysed using ABARES' Global Trade and Environment Model (GTEM). To capture the range of costs and speeds of developing and deploying clean electricity technologies, technological profiles within electricity and other production sectors are determined endogenously within GTEM allowing a fast growth in one technology at the expense of other technologies. With this induced technology innovation modelling and the specific scenarios, the results presented in this paper suggest that, among Asia's three biggest economies, China may benefit from devoting resources to further developing and deploying CCS and emerging renewable energy technologies while Japan and India may gain from devoting resources to certain conventional clean energy technologies. The modelling results also suggest that coal and gas imports into Asia under the mitigation scenarios will be influenced by, among other things, the size of the carbon price, the extent of fossil fuel dependencies, and, in the case of coal, the relativities of emissions intensities of mining across economies.

The impact of residential, commercial, and transport energy demand uncertainties in Asia on climate change mitigation

- Energy Economics---2012---Tiina Koljonen,Antti Lehtilä

Energy consumption in residential, commercial and transport sectors have been growing rapidly in the non-OECD Asian countries over the last decades, and the trend is expected to continue over the coming decades as well. However, the per capita projections for energy demand in these particular sectors often seem to be very low compared to the OECD average until 2050, and it is clear that the scenario assessments

of final energy demands in these sectors include large uncertainties. In this paper, a sensitivity analysis have been carried out to study the impact of higher rates of energy demand growths in the non-OECD Asia on global mitigation costs. The long term energy and emission scenarios for China, India and South-East Asia have been contributed as a part of Asian Modeling Exercise (AME). The scenarios presented have been modeled by using a global TIMES-VTT energy system model, which is based on the IEA-ETSAP TIMES energy system modeling framework and the global ETSAP-TIAM model. Our scenario results indicate that the impacts of accelerated energy demand in the non-OECD Asia has a relatively small impact on the global marginal costs of greenhouse gas abatement. However, with the accelerated demand projections, the average per capita greenhouse gas emissions in the OECD were decreased while China, India, and South-East Asia increased their per capita greenhouse gas emissions. This indicates that the costs of the greenhouse gas abatement would especially increase in the OECD region, if developing Asian countries increase their final energy consumption more rapidly than expected.

An assessment of the potentials of nuclear power and carbon capture and storage in the long-term global warming mitigation options based on Asian Modeling Exercise scenarios

- Energy Economics---2012---Shunsuke Mori

This paper presents an evaluation of global warming mitigation options based on scenarios from the Asian Modeling Exercise. Using an extended version of the integrated assessment model MARIA-23 (Multiregional Approach for Resource and Industry Allocation), we analyze nuclear fuel recycling options, carbon capture and storage technologies (CCS), and biomass utilization. To assess the potential implications of decreased social acceptance of nuclear power in the wake of the Fukushima nuclear accident, additional scenarios including a nuclear power expansion limitation, are analyzed. We also evaluate MARIA-23 model simulation estimates of long-term contributions and interrelation-

ships among nuclear power, biomass, and CCS. Finally, potential costs of nuclear limitation under carbon control policies are assessed.

The benefit from reduced energy import bills and the importance of energy prices in GHG reduction scenarios

- Energy Economics---2012---Paul Dowling, Peter Russ

The POLES energy model has been used to assess Asia's role in combating climate change and the benefits it stands to gain. This paper focuses on the role of major Asian economies in the global effort to reduce greenhouse gas emissions and the benefits to their economies from reduced energy import bills. The costs of reaching ambitious emission reduction targets are offset by significant ancillary benefits, such as reduced energy import bills. Lower energy prices account for a share of the import bill reductions.

A developing Asia emission trading scheme (Asia ETS)

- Energy Economics---2012---Emanuele Massetti, Massimo Tavoni

This paper provides a model assessment of the role of developing Asia in the context of climate change policies. We diagnose the potential response of Asian economies to the imposition of various climate policies, showing that if we were to equally price carbon across the world roughly half of the abatement would occur in developing Asia. We show that such autarkic measures would be consistent with the policy targets put forward by the Major Economies Forum but would not necessarily be equitable. We thus propose a fragmented cap-and-trade scheme with a specific regional market for developing Asia, the Asian Emission Trading Scheme (Asia ETS). We assess the role of the Asia ETS on the macro-economy and international transfers vis-à-vis the standard case of global trading. Our results indicate that creating two large trading markets would result in small global efficiency losses, while

at the same time generating more reasonable regional incentives and transfers.

The role of China in mitigating climate change

- Energy Economics---2012---Sergey Paltsev, Jennifer Morris, Yongxia Cai, Valerie Karplus, Henry Jacoby

We explore short- and long-term implications of several energy scenarios of China's role in efforts to mitigate global climate risk. The focus is on the impacts on China's energy system and GDP growth, and on global climate indicators such as greenhouse gas concentrations, radiative forcing, and global temperature change. We employ the MIT Integrated Global System Model (IGSM) framework and its economic component, the MIT Emissions Prediction and Policy Analysis (EPPA) model. We demonstrate that China's commitments for 2020, made during the UN climate meetings in Copenhagen and Cancun, are reachable at very modest cost. Alternative actions by China in the next 10 years do not yield any substantial changes in GHG concentrations or temperature due to inertia in the climate system. Consideration of the longer-term climate implications of the Copenhagen-type of commitments requires an assumption about policies after 2020, and the effects differ drastically depending on the case. Meeting a 2°C target is problematic unless radical GHG emission reductions are assumed in the short-term. Participation or non-participation of China in global climate architecture can lead by 2100 to a 200–280ppm difference in atmospheric GHG concentration, which can result in a 1.1°C to 1.3°C change by the end of the century. We conclude that it is essential to engage China in GHG emissions mitigation policies, and alternative actions lead to substantial differences in climate, energy, and economic outcomes. Potential channels for engaging China can be air pollution control and involvement in sectoral trading with established emissions trading systems in developed countries.

Economic analysis of a low carbon path to 2050: A case for China, India and Japan

- Energy Economics---2012---Bert Saveyn, Leonidas Paroussos, Juan-Carlos Ciscar

This article studies the economic implications that different global GHG emission mitigation policies may have in the major Asian economies, namely, China, India, and Japan. The analysis covers the period 2010–2050 and is performed by means of a recursive dynamic computable general equilibrium model (GEM-E3). Four scenarios are investigated: the three standard AME scenarios, and a fourth scenario with a GHG emission reduction path compatible with the 2°C target, reducing global GHG emissions in 2050 by 50%, relative to 2005. The scenarios are compared with the already adopted and announced policies of the respective countries, in the context of the Copenhagen pledges for 2020 and their long-term objectives in 2050. We further discuss the role of energy efficiency measures and zero-carbon power technologies in order to reach the long-term 2°C target. We find that postponing significant emission reductions may not accrue an economic benefit over time whereas it may increase some risks by possibly overstressing the reliance on zero-carbon technologies.

Implications of greenhouse gas emission mitigation scenarios for the main Asian regions

- Energy Economics---2012---Bas van Ruijven, Detlef P. van Vuuren, Jasper van Vliet, Angelica Mendoza Beltran, Sebastiaan Deetman, Michel G.J. den Elzen

In order to limit global mean temperature increase, long-term greenhouse gas emissions need to be reduced. This paper discusses the implications of greenhouse gas emission reductions for major Asian regions (China, India, Indonesia, South-East Asia, Japan and Korea) based on results from the IMAGE modelling framework. Energy use in regions and economic sectors is affected differently by ambitious climate policies. We find that the potential for emission reduction varies widely between regions. With respect to technology

choices in the power sector, we find major application of CO₂ storage in Indonesia and India, whereas Korea and India apply more solar and wind. Projections for Japan include a (debatable) large share of nuclear power. China and, India, and South-East Asia, show a diverse technology choice in the power sector. For the industry sector, we find that the recent rapid growth in China limits the potential for emission reduction in the next decades, assuming that recently built coal-based industry facilities are in use for the next decades. For the residential sector, the model results show that fewer households switch from traditional fuels to modern fuels in GHG mitigation scenarios. With respect to co-benefits, we find lower imports of fossil energy in mitigation scenarios and a clear reduction of air pollutant emissions.

Synergies in the Asian energy system: Climate change, energy security, energy access and air pollution

- Energy Economics---2012---Oscar van Vliet,Volker Krey,David McCollum,Shonali Pachauri,Yu Nagai,Shilpa Rao,Keywan Riahi

We use the MESSAGE model to examine multiple dimensions of sustainable development for three Asian regions in a set of scenarios developed for the Asian Modelling Exercise. Using climate change mitigation as a starting point for the analysis, we focus on the interaction of climate and energy with technology choice, energy security, energy access, and air pollution, which often have higher policy priority than climate change.

Assessment of Copenhagen pledges with long-term implications

- Energy Economics---2012---Kenichi Wada,Fuminori Sano,Keigo Akimoto,Takashi Homma

This study first evaluates the pledges under the Copenhagen Accord using the DNE21+ model. Our estimates for the 2020 pledges fall collectively within the range of 46,700–49,100Mt CO₂-eq. Our study also finds the

efforts arising from the current 2020 pledges have wide-ranging implications in terms of mitigation costs and types of actions. Based on this analysis, we seek to place the Copenhagen pledges in a long-term context, putting focus on costs and feasibility. We set up a “Carbon Prices Convergence Scenario,” assuming that all countries start from the Copenhagen commitments and gradually undertake their own individual efforts in accordance with the convergence of carbon prices toward a uniform price in 2050. Despite soaring carbon prices in most countries, total costs as share of GDP show modest increase, ranging mostly between 0% and 0.4%. We also find that there does not seem to be much difference in the degree of burden between developed and major developing countries under this scenario. Since the challenge of climate change will require significant reductions in GHG emissions in the coming decades, we need to make long lasting efforts, getting on the right track toward the ultimate goal of stabilizing GHGs.

Low carbon and clean energy scenarios for India: Analysis of targets approach

- Energy Economics---2012---Priyadarshi R. Shukla,Vaibhav Chaturvedi

Low carbon energy technologies are of increasing importance to India for reducing emissions and diversifying its energy supply mix. Using GCAM, an integrated assessment model, this paper analyzes a targets approach for pushing solar, wind, and nuclear technologies in the Indian electricity generation sector from 2005 to 2095. Targets for these technologies have been constructed on the basis of Indian government documents, policy announcements, and expert opinions. Different targets have been set for the reference scenario and the carbon price scenario. In the reference scenario, wind and nuclear technologies exceed respective targets in the long run without any subsidy push, while solar energy requires subsidy push throughout the century in order to meet its high targets. In the short run, nuclear energy also requires significant subsidy, including a much higher initial subsidy relative to solar power, which is a result of its higher targets. Under a carbon price

scenario, the carbon price drives the penetration of these technologies. Still, subsidy is required — especially in the short run when the carbon price is low. We also found that pushing solar, wind, and nuclear technologies leads to a decrease in share of CCS under the carbon price scenario and biomass under both the reference and carbon price scenarios. This is because low carbon technologies compete among themselves and substitute each other, thereby enhancing the need for subsidy or carbon price, highlighting that proposed targets are not set at efficient levels. In light of contemporary debate on external costs of nuclear energy, we also assess the sensitivity of the results to nuclear technology cost. We find that higher cost significantly decreases the share of nuclear power under both the reference and carbon price scenarios.

Combining carbon tax and R&D subsidy for climate change mitigation

- Energy Economics---2012---Jong-Soo Lim,Yong-Gun Kim

R&D industry is introduced into a CGE model (KEI-Linkages) as a means to mimic the endogenous technological progress in the Korean economy. We found that providing across-the-board subsidy on R&D expenditure may lead to an increase in the carbon intensity, as well as the real GDP for the Korean economy. However, when R&D subsidies are combined with a carbon tax, real GDP can grow without increasing CO₂ emissions. Carbon tax on top of R&D subsidy represses the growth of carbon intensive industries compared to the case of stand-alone R&D subsidy policy. Furthermore, carbon intensive industries reduce carbon intensity by way of fuel mix change to cope with a higher carbon tax rate to meet the national CO₂ reduction target. The final outcome impinges on the industry structure of the economy. Therefore, a careful study of the industry structure of the economy is warranted to maximize the effectiveness of climate change policy-mix.

Benefits of low carbon development in a developing country: Case of Nepal

- Energy Economics---2012---Ram M. Shrestha,Shree Raj Shakya

This paper analyzes the direct and indirect benefits of reducing CO₂ emission during 2005 to 2100 in the case of Nepal, a low income developing country rich in hydropower resource. It discusses the effects on energy supply mix, local pollutant emissions, energy security and energy system costs of CO₂ emission reduction targets in the country by using an energy system model based on the MARKAL framework. The study considers three cases of CO₂ emission reduction targets and analyzes their benefits during the study period as compared to the reference scenario. The first two cases consist of a 20% cutback (Scenario ERT20) and 40% cutback (Scenario ERT40) (of CO₂ emission in the reference scenario). The third case considers a 40% cutback of CO₂ emission with the share of electric mass transport (EMT) in the land transport service demand increased to 30% (as compared to 20% in the reference scenario). The study shows that an implementation of Scenario ERT40 would increase the cumulative electricity generation (mainly from hydropower) by 16.5% (794 TWh), reduce the cumulative consumption of imported fuels by 42% (24,400 PJ) and increase the total energy system cost by 1.6% during 2005 to 2100 as compared to the reference scenario. Besides, there would be a reduction in the emission of local pollutants and generation of additional employment in the country. With the share of EMT increased to 30%, there would be a further reduction in local pollutant emissions, an improvement in energy security and a decrease in the energy system cost compared to that in Scenario ERT40.

The role of border carbon adjustment in unilateral climate policy: Overview of an Energy Modeling Forum study (EMF 29)

- Energy Economics---2012---Christoph Böhrringer,Edward Balistreri,Thomas F. Rutherford

Issues of emission leakage and competitiveness are at the fore of the climate policy debate in all the major economies implementing or proposing to implement substantial emission cap-and-trade programs. Unilateral climate policy cannot directly impose emission prices on foreign sources, but it can complement domestic emission pricing with border carbon adjustment to reduce leakage and increase global cost-effectiveness. While border carbon adjustment has a theoretical efficiency rationale, its practical implementation is subject to serious caveats. This article summarizes the results of an Energy Modeling Forum study (EMF 29) on the efficiency and distributional impacts of border carbon adjustment. We find that border carbon adjustment can effectively reduce leakage and ameliorate adverse impacts on energy-intensive and trade-exposed industries of unilaterally abating countries. However, the scope for global cost savings is small. The main effect of border carbon adjustment is to shift the economic burden of emission reduction to non-abating countries through implicit changes in international prices.

Estimating carbon leakage and the efficiency of border adjustments in general equilibrium — Does sectoral aggregation matter?

- Energy Economics---2012---Justin Caron

Estimates of the carbon leakage resulting from sub-global climate policies tend to be lower when using economy-wide general equilibrium models than what technology-specific and bottom-up models suggest. In order to test whether this difference is due to excessive sectoral aggregation, I exploit disaggregated data and estimate unobserved values to create a dataset with rich industrial sector detail. The bias caused by sectoral aggregation is estimated by calibrating a computable general equilibrium model to this dataset and comparing results with those generated from more aggregated data.

The value-added of sectoral disaggregation: Implications on competitive consequences of climate change policies

- Energy Economics---2012---Victoria Alexeeva-Talebi, Christoph Böhringer, Andreas Löschel, Sebastian Voigt

Global impact assessment of unilateral climate policies is commonly based on multi-sector, multi-region computable general equilibrium (CGE) models that are calibrated to consistent accounts of production, consumption, and bilateral trade flows. However, global economic databases such as GTAP treat energy-intensive and trade-exposed industries rather in aggregate, thereby missing potentially important details on the heterogeneity of these sectors. In this paper, we elaborate on the availability of data resources and methodological issues in disaggregating energy-intensive and trade-exposed sectors that receive larger attention in the public policy debate on unilateral emission regulation: non-ferrous metals, iron and steel and non-metallic minerals. Our sensitivity analysis revolves around three types of unobserved heterogeneity at the sub-sectoral level: trade elasticities, energy consumption and technology specifications. Drawing on the example of border tax adjustments, we find that for all given technology specifications and variation in energy shares, the biggest differences emerge from variations in Armington elasticities. Even moderate changes in Armington elasticities can alter the magnitude and the sign of the effects at the sectoral level. The implications of sub-sectoral disaggregation are not as pronounced for macroeconomic indicators and leakage as for sectoral indicators.

Alternative designs for tariffs on embodied carbon: A global cost-effectiveness analysis

- Energy Economics---2012---Christoph Böhringer, Brita Bye, Taran Fæhn, Knut Einar Rosendahl

In the absence of effective world-wide cooperation to curb global warming, import tariffs on embodied carbon have been proposed as a potential supplement to

unilateral emissions pricing. We systematically consider alternative designs for such tariffs, and analyze their effects on global welfare within a multi-region, multi-sector computable general equilibrium (CGE) model of global trade and energy. Our analysis shows that systems more likely to comply with international law yield very little in terms of carbon leakage and efficiency. Generally, the effectiveness increases substantially with complexity. However, regionalising the tariffs seems not to be worthwhile. Also, the most effective system we identify is not based on fully input-output-corrected carbon contents, but on direct plus electricity emissions, only. This reflects the more general problem of finding systems that are both feasible and well-targeted in a real global economy.

Border tax adjustments in the climate policy context: CO₂ versus broad-based GHG emission targeting

- Energy Economics---2012---Madanmohan Ghosh, Deming Luo, Muhammad Shahid Siddiqui, Yunfa Zhu

Using a multi-region, multi-sector computable general equilibrium (CGE) model, this paper compares the efficiency, distributional and emission leakage effects of border tax adjustments (BTAs) as part of unilateral climate policies that are based on carbon dioxide (CO₂)-only versus those based on all greenhouse gases (GHGs). Simulation results suggest that the broad-based GHG policies in general have lower efficiency costs and result in less re-distributive effects. BTAs bring modest efficiency gains with adverse distributional consequences. The distributional impacts are smaller under broad-based GHG policies compared to that based on CO₂ only. However, these are due to a wider variety of abatement options under multi-gas policies rather than the BTAs per se. The main difference between the two policies is distributional effects. First, CO₂-only based policies have worse impacts on fossil fuel exporters such as Russia and relatively better outcomes for oil importers such as India and China, compared to that of multi-gas policies particularly when it involves large global emission reduction.

Second, sectoral coverage under BTAs also influences the differential outcomes. For example, Brazil is worse impacted under GHG-based policies if agriculture is brought under BTAs as two-third of its emissions are non-CO₂ based and agriculture is the primary source of these emissions.

The relevance of process emissions for carbon leakage: A comparison of unilateral climate policy options with and without border carbon adjustment

- Energy Economics---2012---Birgit Bednar-Friedl, Thomas Schinko, Karl Steininger

Climate policy arrangements of partial regional coverage, as they seem to emerge from the UNFCCC process, might lead to carbon leakage and hence a broad literature has developed to quantify leakage. Most of these analyses, however, are confined to consider emissions from fuel combustion only. Yet, some of the most relevant simultaneously energy intensive and internationally trade exposed sectors are also subject to substantial emissions from industrial processes. Carbon dioxide emissions can be released in industrial processes which physically or chemically transform materials. In the steel and cement sectors, for example, these process emissions amount to about half of sector carbon dioxide emissions in many countries. We incorporate industrial process emissions based on UNFCCC data into a multi-sectoral multi-regional computable general equilibrium model and analyze the implications of a unilateral EU 20% carbon dioxide emission reduction policy on leakage and the effectiveness of border carbon adjustment in reducing leakage. By comparing the results to a model without process emissions, we find that leakage of climate policy so far has been underestimated. Leakage turns out to be higher when process emissions are correctly accounted for (38% instead of 29% for combustion emissions only). Conversely, border carbon adjustment measures are found to be roughly twice as effective to reduce leakage rates, when process emissions are correctly accounted for — as carbon adjustment rates are more directly targeted to the relevant sectors. Yet, border carbon ad-

justment measures should not be seen as a panacea as they might impede necessary technological carbon-free innovation, unless they are phased out over time.

Fossil fuel supply, leakage and the effectiveness of border measures in climate policy

- Energy Economics---2012---Stefan Boeters,Johannes Bollen

Understanding fossil fuel supply behaviour is crucial for interpreting carbon leakage and assessing the potential effectiveness of border measures in climate policy. In most computable general equilibrium models, this fossil fuel supply is derived from a constant elasticity of substitution production function, in which a natural resource is treated as a fixed factor. We show that this leads to endogenously decreasing supply elasticities and sharply increasing marginal leakage rates for large coalitions that have ambitious emissions targets, particularly when fuel exporters participate in the coalition. We propose an alternative production function that has a constant elasticity of fuel supply, which results in more stable leakage rates and a different share of trade-related leakage. The role of this model variation for the assessment of border measures in climate policy turns out to be limited. In those cases where the model versions differ most (i.e. large coalition, ambitious targets), border measures have a small effect anyway.

Subglobal carbon policy and the competitive selection of heterogeneous firms

- Energy Economics---2012---Edward Balistreri,Thomas F. Rutherford

We analyze subglobal action to mitigate climate change with a consideration of recent advances in the theory of international trade. Subglobal action impacts emissions in unconstrained countries (carbon leakage) through international trade channels. Consequently, estimates of the efficacy of subglobal action, tariffs on embodied carbon, and the distribution of policy costs will be sensitive to the assumed structure of international trade. While most climate-policy models

rely on an Armington (1969) structure of international trade, recent empirical evidence supports a new theory suggested by Melitz (2003). We find significant quantitative and qualitative differences when we consider the Melitz trade structure. These differences are important as an alternative, and arguably more plausible, representation of how trade and border adjustments interact with climate policy.

Fair, optimal or detrimental? Environmental vs. strategic use of border carbon adjustment

- Energy Economics---2012---Matthias Weitzel,Michael Hübler,Sonja Peterson

We carry out a detailed sensitivity analysis of border carbon adjustment (rates) by applying a global computable general equilibrium (CGE) GTAP7-based model. We find different incentives for the regions in the climate coalition to raise carbon-based border tax rates (BTAX) above the standard rate that mimics an equalisation of carbon prices across regions. Herein, the strategic use of BTAX (the manipulation of the terms of trade) is stronger for all coalition regions than the environmental use (the reduction of carbon emissions abroad). Higher BTAX can reduce carbon leakage but with a declining marginal effect. Furthermore, we find different incentives for regions outside the coalition to oppose high BTAX rates: Russia and the other energy exporters would oppose it, while the low-income countries would not because of benefits from the trade diversion effect. Thus, BTAX encourages the former to join the coalition, while compensating transfers are necessary to encourage the other (developing) countries including China and India.

Unilateral climate policy design: Efficiency and equity implications of alternative instruments to reduce carbon leakage

- Energy Economics---2012---Christoph Böhringer,Jared Carbone,Thomas F. Rutherford

Global cost-effectiveness of unilateral emission abatement can be seriously hampered by carbon leakage.

We assess three widely discussed proposals for leakage reduction: carbon-motivated border tax adjustments, industry exemptions from carbon regulation, and output-based allocation of emission allowances. We find that none of these measures amounts to a “magic bullet” when both efficiency and equity criteria matter. Compared to unilateral emission pricing alone, border carbon adjustments are most effective in leakage reduction and promotion of global cost-effectiveness but can markedly exacerbate regional inequality; exemptions and output-based allocation tend to avoid distributional pitfalls but are less effective in leakage reduction and global cost savings; exemptions may even decrease global cost-effectiveness of unilateral emission abatement.

Climate policy and fiscal constraints: Do tax interactions outweigh carbon leakage?

- Energy Economics---2012---Carolyn Fischer, Alan Fox

Climate policymaking faces twin challenges of carbon leakage and public sector revenue requirements. A large literature advocates the use of CO₂ pricing and recycling the revenues to lower distorting taxes as a way to minimize costs. In this paper, we explore the implications of labor tax interactions for cost-effectiveness of border adjustments and other measures to cope with leakage. We find that, for plausible values of labor supply elasticities, the cost savings from revenue recycling are significant—from 15 to 25%. The cost savings from anti-leakage measures are generally smaller, but also significant, particularly for small coalitions or more binding reduction targets. Tax interactions further enhance the cost savings from border adjustments, but make other measures like rebates or exemptions less attractive.

A look inwards: Carbon tariffs versus internal improvements in emissions-trading systems

- Energy Economics---2012---Marco Springmann

Subglobal climate policies will be the norm for some years to come. However, several options exist for im-

proving the efficiency of domestic emissions regulation. A prominent but contentious policy option for improving the external efficiency is the implementation of carbon tariffs on non-regulating regions. This is thought to reduce carbon leakage and increase domestic production, albeit at the cost of non-regulating countries. In contrast, internal efficiency improvements can be more collaborative in type. Among others, they include extending and linking of domestic emissions-trading systems. This study compares the relative economic impacts of those policy options if Annex I countries would follow one or the other. The study uses a computable-general-equilibrium model of the global world economy and develops a set of emissions-trading and carbon-tariff scenarios with various degrees of sectoral and regional coverage. For a globally effective Annex I emissions-reduction target of 20%, the results indicate that linking Annex I countries' domestic emissions-trading systems and expanding their sectoral coverage could yield greater global welfare improvements than implementing carbon tariffs on energy-intensive goods imported from non-Annex I countries. While non-Annex I countries would be significantly better off without facing carbon tariffs on their exports, Annex I countries could gain from either policy. The relative gains from linking and extending the sectoral coverage of domestic emissions-trading systems are greater for early policy implementation within a large Annex I coalition of climate-regulating countries, while late implementation within a small coalition would yield greater relative welfare gains from imposing carbon tariffs. The results suggest that, in addition to the political benefits, there exists an economic rationale for substituting the external efficiency improvements associated with implementing carbon tariffs with internal ones associated with extending Annex I countries' emissions-trading systems.

Alternative approaches for levelling carbon prices in a world with fragmented carbon markets

- Energy Economics---2012---Elisa Lanzi, Jean Chateau, Rob Dellink

When carbon markets are fragmented and carbon prices vary across regions, concerns arise that acting countries may encounter competitiveness and welfare losses and changes in production may lead to carbon leakage. Border Carbon Adjustments (BCAs) have been proposed as a response measure to address these issues. However, more cooperative response policies, such as linking carbon markets, can also reduce the burden of emission reduction in acting countries and help level carbon prices. This paper analyses the effects of BCAs and both direct and indirect linking on welfare, competitiveness and carbon leakage within a global recursive-dynamic computable general equilibrium (CGE) model. Results illustrate that an uneven carbon pricing can indeed lead to substantial competitiveness and welfare losses for acting countries as well as to carbon leakage. Of the instruments investigated in this paper, BCAs appear to be the best measure to preserve the competitiveness of acting countries as they shift part of the burden of emission reductions to non-acting countries. While BCAs are effective for acting countries, they cause severe welfare and competitiveness losses for non-acting countries. As a result, BCAs are less effective than linking in reducing global welfare losses, as linking tends to be beneficial for both acting and non-acting countries. The advantages of BCAs diminish as the carbon market is extended to more emission sources or to a wider international participation.

From “Green Growth” to sound policies: An overview

- Energy Economics---2012---Richard Schmalensee

“Green growth” is an attractive slogan with a variety of possible meanings. This essay critically examines several potential meanings of this slogan and provides a brief overview of some of the main implications of the other papers in this special issue. Taken together, these papers argue for the importance of careful analysis of energy/environmental policies, particularly ambitious ones claiming to offer huge benefits with little or no cost.

Energy and technology lessons since Rio

- Energy Economics---2012---James Edmonds, Katherine Calvin, Leon Clarke, Page Kyle, Marshall Wise

The 1992 Framework Convention on Climate Change created the basic international architecture for addressing climate change. That treaty was negotiated at a time when the research literature examining emissions mitigation and the role of energy technology was relatively limited. In the two subsequent decades a great deal has been learned. The problem of stabilizing the concentration of greenhouse gases in the atmosphere has proved far more difficult than envisioned in 1992 and the role of technology appears even more important when emissions mitigation strategies are co-developed in the context of multiple competing ends.

Investments and public finance in a green, low carbon, economy

- Energy Economics---2012---Carlo Carraro, Alice Favero, Emanuele Massetti

The paper evaluates the impacts on investments and public finance of a transition to a green, low carbon, economy induced by carbon taxation. Four global tax scenarios are examined using the integrated assessment model WITCH. Taxes are levied on all greenhouse gases (GHGs) and lead to global GHG concentrations equal to 680, 560, 500 and 460ppm CO₂-eq in 2100. Investments in the power sector increase with respect to the Reference scenario only with the two highest taxes. Investments in energy-related R&D increase in all tax scenarios, but they are a small fraction of GDP. Investments in oil upstream decline in all scenarios. As a result, total investments decline with respect to the Reference scenario. Carbon tax revenues are high in absolute terms and as share of GDP. With high carbon taxes, tax revenues follow a “carbon Laffer” curve. The model assumes that tax revenues are flawlessly recycled lump-sum into the economy. In all scenarios, the power sector becomes a net recipient of subsidies to support the absorption of GHGs. In some regions,

with high carbon taxes, subsidies to GHG removal are higher than tax revenues at the end of the century.

Financing for climate change

- Energy Economics---2012---Richard N. Cooper

This paper argues that the 2009 pledge of \$100 billion in 2020 by rich countries for mitigation and adaptation should not be used for mitigation by commercial firms in developing countries, since that would artificially create competitive advantage for such firms and provoke protectionist reactions in the rich countries where firms must bear the costs of mitigation, thereby undermining the world trading system. The costs of heating the earth's surface should be borne by all emitters, just as the price of copper and other scarce resources is paid by all users, rich or poor. That will still leave scope for rich country help in adaptation to climate change and in bringing to fruition new technologies to reduce emissions.

Clean energy: Revisiting the challenges of industrial policy

- Energy Economics---2012---Adele C. Morris,Pietro S. Nivola,Charles L. Schultze

Large public investments in clean energy technology arguably constitute an industrial policy. One rationale points to market failures that have not been corrected by other policies, most notably greenhouse gas emissions and dependence on oil. Another inspiration for clean energy policy reflects economic arguments of the 1980s. It suggests strategic government investments would increase U.S. firms' market share of a growing industry and thus help American firms and workers. This paper examines the reasoning for clean energy policy and concludes that: • While a case can be made that subsidizing clean energy might help address market failures, the case may be narrower than some assert, and turning theory into sound practice is no simple feat. • An appropriate price on greenhouse gases is an essential precondition to ensuring efficient incentives to develop and deploy cost-effective emissions-abating technologies. However, efficient prices alone

are unlikely to generate efficient levels of basic research and development by private firms. • Government investments in clean energy are unlikely to produce net increases in employment in the long run, in part because pushing home-grown technologies at taxpayers' expense offers no guarantee that the eventual products ultimately would not be manufactured somewhere else. • Spending on clean energy technologies is not well suited to fiscal stimulus.

The elusive and expensive green job

- Energy Economics---2012---Diana Furchtgott-Roth

The United States, Europe, and non-governmental international organizations are seeking to encourage the creation of green jobs and the use of non-hydropower renewable energy. This paper discusses the challenge in defining green jobs and reviews definitions across different countries, states, and NGOs. The paper describes some of the costs the United States has faced in creating jobs through programs funded by the Departments of Labor and Energy. The paper concludes by comparing the experiences of China and the United States in the use of renewable energy.

The potential role of carbon labeling in a green economy

- Energy Economics---2012---Mark Cohen,Michael P. Vandenbergh

Over the past several years, labeling schemes that focus on a wide range of environmental and social metrics have proliferated. Although little empirical evidence has been generated yet with respect to carbon footprint labels, much can be learned from our experience with similar product labels. We first review the theory and evidence on the role of product labeling in affecting consumer and firm behavior. Next, we consider the role of governments and nongovernmental organizations, concluding that international, multistakeholder organizations have a critical part to play in setting protocols and standards. We argue that it is important to consider the entire life cycle of a product being labeled and

develop an international standard for measurement and reporting. Finally, we examine the potential impact of carbon product labeling, discussing methodological and trade challenges and proposing a framework for choosing products best suited for labeling.

Reducing greenhouse gas emissions through operations and supply chain management

- Energy Economics---2012---Erica L. Plambeck

The experiences of the largest corporation in the world and those of a start-up company show how companies can profitably reduce greenhouse gas emissions in their supply chains. The operations management literature suggests additional opportunities to profitably reduce emissions in existing supply chains, and provides guidance for expanding the capacity of new “zero emission” supply chains. The potential for companies to profitably reduce emissions is substantial but (without effective climate policy) likely insufficient to avert dangerous climate change.

Greening Africa? Technologies, endowments and the latecomer effect

- Energy Economics---2012---Paul Collier,Anthony Venables

Africa is well endowed with potential for hydro and solar power, but its other endowments – shortages of capital, skills, and governance capacity – make most of the green options relatively expensive, while its abundance of hydro-carbons makes fossil fuels relatively cheap. Current power shortages make expansion of power capacity a priority. Africa’s endowments, and the consequent scarcities and relative prices, are not immutable and can be changed to bring opportunity costs in Africa closer to those in the rest of the world. The international community can support by increasing Africa’s supply of the scarce factors of capital, skills, and governance.

Green growth and the efficient use of natural resources

- Energy Economics---2012---John Reilly

The relatively new concept of “green growth” can be fruitfully connected to concepts and theories in neoclassical economics including market externalities, Ricardian and Hotelling rents, and policies that would correct externalities such as Pigovian taxes or a cap and trade system set to achieve emissions reductions consistent with cost benefit assessment. Partial equilibrium concepts have been extended to general equilibrium models, including their realization in relatively detailed empirical models that faithfully adhere to theoretical concepts of neoclassical economics. With such models we are then able to see how resource depletion and environmental degradation are affecting the economy, and how efforts to reduce the impact of these environmental and resource constraints could improve economic growth and performance. The foundation for traditional computable general equilibrium models are the National Income and Product Accounts (NIPAs), input–output (I–O) tables, and expanded Social Accounting Matrices (SAMs). The basis for extending these to include environmental and resource assets and goods are so called Integrated Economic and Environmental Social Accounts (IEESAs). While environmental effects are often considered to be “non-market,” many of the impacts of environment are often reflected in market accounts through damages that might include, for example, less labor (due to environment related health problems), reduced productivity of agroecosystems, or damage to infrastructure and other produced assets. The challenge is to make the environmental connection explicit so as to provide a guide to where changes in policies could provide benefit. However, some damages do not enter the accounts at all, and mainly this is because household labor and leisure time are generally not valued in traditional accounts. Hence the cost of illness in terms of reduced ability to contribute to household activities would be missed in the standard accounts. While the theoretical structure for expanding the accounts has been laid out in various reviews, the empirical challenge of doing so is substantial. Careful attention to expanding NIPA accounts, making it a regular part of government statistical agencies’ efforts would improve the foundation for analysis of potential “green growth” policies and

measures.

Ex post analysis of economic impacts from wind power development in U.S. counties

- Energy Economics---2012---Jason Brown,John Pender,Ryan Wiser,Eric Lantz,Ben Hoen

Wind power development has surged in recent years in the United States. Policymakers and economic development practitioners to date have typically relied upon project-level case studies or modeled input-output estimates to assess the economic development impacts from wind power, often focusing on potential local, state-wide, or national employment or earnings impacts. Building on this literature, we conduct an ex post econometric analysis of the county-level economic development impacts of wind power installations from 2000 through 2008 in a large, wind-rich region in the country. Taking into account factors influencing wind turbine location, we find an aggregate increase in county-level personal income and employment of approximately \$11,000 and 0.5 jobs per megawatt of wind power capacity installed over the sample period of 2000 to 2008. These estimates appear broadly consistent with modeled input-output results, and translate to a median increase in total county personal income and employment of 0.2% and 0.4% for counties with installed wind power over the same period.

Testing and estimating time-varying elasticities of Swiss gasoline demand

- Energy Economics---2012---David Neto

This paper is intended to test and estimate time-varying elasticities for gasoline demand in Switzerland. For this purpose, a smooth time-varying cointegrating parameters model is investigated in order to describe smooth mutations of the Swiss gasoline demand. The methodology, based on Chebyshev polynomials, is rigorously outlined. Our empirical finding states that the time-invariance assumption does not hold for long-run price and income elasticities. Furthermore they highlight that gasoline demand passed through some periods of sensitivity and non sensitivity with respect

to the price. Our empirical statements are of great importance to assess the performance of a gasoline tax as an instrument for CO₂ reduction policy. Indeed, such an instrument can contribute to reduce emissions of greenhouse gases only if the demand is not fully inelastic with respect to the price. Our results suggest that such a carbon-tax would not be always suitable since the price elasticity is found not stable over time and not always significant.

Evaluating the relative strength of product-specific factors in fuel switching and stove choice decisions in Ethiopia. A discrete choice model of household preferences for clean cooking alternatives

- Energy Economics---2012---Takeshi Takama,Stanzin Tsephel,Francis X. Johnson

Switching from conventional stoves to modern clean, safe, and efficient stoves will improve health and social welfare for the 2.7billion people worldwide that lack reliable access to modern energy services. In this paper, we critically review some key theoretical dimensions of household consumer behaviour in switching from traditional biomass cooking stoves to modern efficient stoves and fuels. We then describe the results of empirical research investigating the determinants of stove choice, focusing on the relative strength of product-specific factors across three wealth groups. A stated preference survey and discrete choice model were developed to understand household decision-making associated with cooking stove choice in Addis Ababa, Ethiopia. The study found that, with the exception of price and usage cost factors for the high wealth group, the product-specific factors that were investigated significantly affect stove and fuel choices. The relative strength of factors was assessed in terms of Marginal Willingness to Pay and provides some evidence that consumer preference for higher quality fuels and stoves tends to increase with increasing wealth.

Why do electricity prices jump? Empirical evidence from the Nordic electricity market

- Energy Economics---2012---Jörgen Hellström,Jens Lundgren,Haishan Yu

The paper empirically explores the possible causes behind electricity price jumps in the Nordic electricity market, Nord Pool. A time-series model (a mixed GARCH–EARJI jump model) capturing the common statistical features of electricity prices is used to identify price jumps. By the model, a categorical variable is defined distinguishing no, positive and negative jumps. The causes for the jumps are then explored through the use of ordered probit models in a second stage. The empirical results indicate that the structure of the market plays an important role in whether shocks in the demand and supply for electricity translate into price jumps.

Retesting the causality between energy consumption and GDP in China: Evidence from sectoral and regional analyses using dynamic panel data

- Energy Economics---2012---Chuanguo Zhang,Jiao Xu

The increasing attention on energy policy needs has provided a renewed stimulus to research the linkages between energy consumption and economic performance in China. This paper examined the causal relationship between energy consumption and economic growth in the regional and sectoral aspects by adopting provincial panel data in China from 1995 to 2008. The results indicate that economic growth causes more energy consumption in China not only at the national level but also at the regional and sectoral levels. Then the Eastern Region and the industrial sector show results quite similar to that of the whole country, in which a bidirectional causality relationship exists between energy consumption and economic growth. The implication for energy policies in China is that the Eastern Region and the industrial sector should play a leading role in the adjustment of energy consumption patterns and the transformation of the economy structure. Energy

prices have limited effects on energy consumption but do have effects on economic growth because the energy price mechanism is more government-oriented than market-oriented in China.

Internal, external and location factors influencing cofiring of biomass with coal in the U.S. northern region

- Energy Economics---2012---Francisco X. Aguilar,Michael E. Goerndt,Nianfu Song,Stephen Shifley

The use of biomass as a source of energy has been identified as a viable option to diminish reliance on fossil fuels. We parameterized the effect of selected internal (e.g. coal-fire presence), external (e.g. price and renewable energy mandates) and location (e.g. biomass availability, infrastructure) variables on the likelihood of using biomass in cofiring with coal by building a two-stage econometric model. The first stage controlled for factors driving the spatial location of coal power plants and the second stage concentrated on factors influencing cofiring. The empirical model was applied in the Northeast quadrant of the U.S. where the unit of observation was an individual county. Results of our model stress the significant effect of existing flexible coal feeding systems that permit the incorporation of biomass, transportation infrastructure and biomass availability (woody biomass in particular in the form of residues from the wood products industry). State-level renewable energy portfolio standards showed no statistically significant effect on the adoption of cofiring biomass with coal. Further developments of biomass cofiring in the U.S. northern region are most likely to take place in the Great Lakes region.

The effect of the financial sector on the evolution of oil prices: Analysis of the contribution of the futures market to the price discovery process in the WTI spot market

- Energy Economics---2012---Renan Silvério,Alexandre Szklo

The aim of this article is to empirically measure the

contribution of the futures market to the price discovery process in the spot market for benchmark crude oils, specifically that for West Texas Intermediate (WTI). For this purpose, we test the hypothesis that the recent evolution of the financial markets has affected the future oil market so as to increase its contribution to the price discovery process of the spot market. We modeled the relation between WTI spot and future prices as a cointegration relation. By using the Kalman filter technique, it was possible to obtain a time-varying measure of the contribution of future markets to the price discovery mechanism. The results show that in the case of WTI, the contribution of the futures market has been increasing, especially between 2003 and 2008 and then again after the start of 2009, evidencing the growing importance of factors particular to the financial markets in determining oil prices in recent years. During 2009, the spot prices adjusted to agents' future expectations rather than to the current supply and demand conditions.

Realized volatility and price spikes in electricity markets: The importance of observation frequency

- Energy Economics---2012---Carl J. Ullrich

This paper uses high frequency spot price data from eight wholesale electricity markets in Australia, Canada, and the United States to estimate realized volatility and the frequency of price spikes. I find similar levels of realized volatility in Australia and North America, with estimates ranging from 1500% to 2700%, much greater than estimates reported previously in the literature. In hourly data, the frequency of price spikes ranges from approximately 35% to 40% in seven of eight markets. I present evidence that increasing the lag length in the calculation of bipower variation improves jump detection in electricity prices.

The importance of energy quality in energy intensive manufacturing: Evidence from panel cointegration and panel FMOLS

- Energy Economics---2012---Brantley Liddle

This paper expands on the panel GDP–energy cointegration modeling literature; it does so by using data disaggregated along sectoral lines and adjusting energy consumption for the quality of the energy source (e.g., electricity is of higher quality than oil, which is of higher quality than coal) in order to examine the role of energy quality in the five most energy intensive manufacturing sectors (iron and steel, non-ferrous metals, non-metallic minerals, chemicals, and pulp and paper). The database was constructed by combining energy consumption (and energy price data to construct the energy quality index) from the IEA with economic data (value added, labor employed, and physical capital) from the OECD's Structural Analysis Database. In addition to finding the variables analyzed are panel I(1) and cointegrated for each sector-based panel, the long-run elasticity estimates (from panel FMOLS) indicate the importance of energy quality – primarily the shift toward the use of high quality electricity – in these energy-intensive manufacturing sectors. In each case, the elasticity for energy quality is greater than that for conventionally measured energy consumption –sometimes orders of magnitude greater. Indeed, the elasticity of conventionally measured energy consumption is insignificant to very small for three of the five sectors. Also, when using the energy quality measure, the importance of energy consumption relative to the other production factors stands out. Such results are useful for both energy–GDP cointegration/causality modelers and CGE modelers, who may need to estimate elasticities.

Forecasting spot price volatility using the short-term forward curve

- Energy Economics---2012---Erik Haugom, Carl J. Ullrich

We use high frequency real time spot prices and day-ahead forward prices from the Pennsylvania–New Jersey–Maryland wholesale electricity market to calculate, describe, and forecast spot price volatility. We introduce the concept of forward realized volatility calculated from day-ahead forward prices. Forward realized volatility improves forecasts of spot price volatility

– in the sense of higher R^2 s and significantly lower forecast errors – when compared with forecasts based solely upon historical volatility. The largest forecast improvements obtained when the change in forward realized volatility is large in magnitude. Splitting total volatility into its continuous and jump components is crucial for forecasting volatility at weekly and monthly horizons.

The changing demand for energy in rich and poor countries over 25 years

- Energy Economics---2012---James Seale,Alexis A. Solano

Country-specific income and own-price elasticities of demand for private consumption of energy are compared across time and affluence for 43 countries that participated in the 1980, 1996, and 2005 International Comparison Program based on estimates from a ten-good-demand system. Results indicate that income elasticities of demand for energy are significantly larger than unitary in 1980, are approximately unitary in 1996 but become inelastic for all 43 countries in 2005. Own-price elasticities decrease absolutely going from 1980 to 1996 to 2005 ranging from 0.8 to 1.0 in 1980, 0.7 to 0.8 in 1996, and 0.6 to 0.7 in 2005. Elasticity estimates are also calculated for the set of countries in 1996 and 2005 that do not participate in the ICP in 1980.

The case for repeatable analysis with energy economy optimization models

- Energy Economics---2012---Joseph F. DeCarolis,Kevin Hunter,Sarat Sreepathi

Energy economy optimization (EEO) models employ formal search techniques to explore the future decision space over several decades in order to deliver policy-relevant insights. EEO models are a critical tool for decision-makers who must make near-term decisions with long-term effects in the face of large future uncertainties. While the number of model-based analyses proliferates, insufficient attention is paid to transparency in model development and application.

Given the complex, data-intensive nature of EEO models and the general lack of access to source code and data, many of the assumptions underlying model-based analysis are hidden from external observers. This paper discusses the simplifications and subjective judgments involved in the model building process, which cannot be fully articulated in journal papers, reports, or model documentation. In addition, we argue that for all practical purposes, EEO model-based insights cannot be validated through comparison to real world outcomes. As a result, modelers are left without credible metrics to assess a model's ability to deliver reliable insight. We assert that EEO models should be discoverable through interrogation of publicly available source code and data. In addition, third parties should be able to run a specific model instance in order to independently verify published results. Yet a review of twelve EEO models suggests that in most cases, replication of model results is currently impossible. We provide several recommendations to help develop and sustain a software framework for repeatable model analysis.

DEA environmental assessment of coal fired power plants: Methodological comparison between radial and non-radial models

- Energy Economics---2012---Toshiyuki Sueyoshi,Mika Goto

This study discusses how to apply Data Environment Analysis (DEA) for environmental assessment. A unique feature of DEA environmental assessment is that it classifies outputs into desirable (good) and undesirable (bad) outputs because many firms often produce not only desirable outputs but also undesirable outputs as a result of their economic activities. A methodological difficulty of DEA applications is how to combine operational performance on desirable outputs and environmental performance on undesirable outputs in a unified treatment. Although previous DEA environmental studies have utilized mainly radial models and their extensions, this study uses a non-radial DEA model for the output unification because the non-radial model can unify the two types of outputs more easily than the radial models. This study incorporates three types of

output unification in DEA environmental assessment. The first unification considers both an increase and a decrease in an input vector along with a decrease in the direction vector of undesirable outputs. This type of unification measures “unified efficiency”. The second unification considers a decrease in an input vector along with a decrease in the vector of undesirable outputs. This type of unification is referred to as “natural disposability” and measures “unified efficiency under natural disposability”. The third unification considers an increase in an input vector but a decrease in the vector of undesirable outputs. This type of unification is referred to as “managerial disposability” and measures “unified efficiency under managerial disposability”. All the unifications increase the vector of desirable outputs. Using the output unification under natural and managerial disposability, this study examines methodological strengths and drawbacks of the proposed non-radial approach. Moreover, using a data set on U.S. coal fired power plants, we compare methodological strengths and drawbacks of radial and non-radial models for DEA environmental assessments. The methodological comparison is important in guiding a large energy issue because policy implications depend upon a methodology(s) used for an empirical study.

Income inequality and carbon dioxide emissions: The case of Chinese urban households

- Energy Economics---2012---Jane Golley,Xin Meng

This paper draws on Chinese survey data to investigate variations in carbon dioxide emissions across households with different income levels. Rich households generate more emissions per capita than poor households via both their direct energy consumption and their higher expenditure on goods and services that use energy as an intermediate input. An econometric analysis confirms a positive relationship between emissions and income and establishes a slightly increasing marginal propensity to emit (MPE) over the relevant income range. The redistribution of income from rich to poor households is therefore shown to reduce aggregate household emissions, suggesting that the twin

pursuits of reducing inequality and emissions can be achieved in tandem.

Cost probability analysis of reprocessing spent nuclear fuel in the US

- Energy Economics---2012---G.D. Recktenwald,M.R. Deinert

The methods by which nuclear power’s radioactive signature could be reduced typically require the reprocessing of spent nuclear fuel. However, economic assessments of the costs that are associated with doing this are subject to a high degree of uncertainty. We present a probabilistic analysis of the costs to build, operate and decommission the facilities that would be required to reprocess all US spent nuclear fuel generated over a one hundred year time frame, starting from a 2010 power production rate. The analysis suggests a total life-cycle cost of 2.11 ± 0.26 mills/kWh, with a 90% and 99% confidence that the overall cost would remain below 2.45 and 2.75 mills/kWh respectively. The most significant effects on cost come from the efficiency of the reactor fleet and the growth rate of nuclear power. The analysis shows that discounting results in life-cycle costs decreasing as recycling is delayed. However the costs to store spent fuel closely counter the effect of discounting when an intergenerational discount rate is used.

Cross-country convergence in energy and electricity consumption, 1971–2007

- Energy Economics---2012---Hassan Mohammedi,Rati Ram

Patterns of convergence in per-capita consumption of energy and electricity are studied from a large cross-country data set covering the period 1971–2007. Along with unconditional β -convergence, we use σ -convergence criterion and a simple model of conditional β -convergence. The exploration is done for the entire period and several subperiods. In addition to OLS for the global sample, β -convergence is studied for top and bottom deciles through quantile regressions. Ten points are noted. First, global convergence in energy

consumption is generally weak. Second, convergence in electricity usage is strong in most cases. Third, despite some variations, the patterns are fairly similar across the four periods. Fourth, energy convergence in both top and bottom deciles is generally weak, but there are some variations. Fifth, for electricity, convergence is noted in the top, but not in the bottom, decile. Sixth, unconditional β -convergence patterns are consistent with σ -convergence scenarios. Seventh, as is usually noted, convergence is more marked in conditional β -format than in the unconditional models. However, interpretation of conditional convergence in usage of energy or electricity is somewhat ambiguous. Eighth, weak convergence in energy usage might reflect a modestly larger increase in low-usage contexts relative to high-usage cases, and might not be of concern from the sustainability perspective. Ninth, strong convergence in electricity usage is associated with a much higher rate of global increase than the weakly-convergent energy usage. Last, the difference in convergence patterns for energy- and electricity-usage seems to merit further exploration.

Oil shocks and their impact on energy related stocks in China

- Energy Economics---2012---David Broadstock,Hong Cao,Dayong Zhang

This paper contributes to the current literature by adopting time varying conditional correlation and asset pricing models to discover how the dynamics of international oil prices affect energy related stock returns in China. After conditioning for structural instability, the results show a much stronger relation following the 2008 financial crisis. We argue that this reflects the fact that investors in the Chinese stock market, especially for energy related stocks, are more sensitive to the shocks in international crude oil market.

On the volatility–volume relationship in energy futures markets using intraday data

- Energy Economics---2012---Julien Chevallier,Benoît Sévi

This paper investigates the relationship between trading volume and price volatility in the crude oil and natural gas futures markets when using high-frequency data. By regressing various realized volatility measures (with/without jumps) on trading volume and trading frequency, our results feature a contemporaneous and largely positive relationship. Furthermore, we test whether the volatility–volume relationship is symmetric for energy futures by considering positive and negative realized semivariances. We show that (i) an asymmetric volatility–volume relationship indeed exists, (ii) trading volume and trading frequency significantly affect negative and positive realized semivariance, and (iii) the information content of negative realized semivariance is higher than for positive realized semivariance.

Structural change and convergence of energy intensity across OECD countries, 1970–2005

- Energy Economics---2012---Peter Mulder,Henri de Groot

This paper uses new and unique data derived from a consistent framework of national accounts to compute and evaluate energy intensity developments across 18 OECD countries and 50 sectors over the period 1970–2005. We find that across countries energy intensity levels tend to decrease in most Manufacturing sectors. In the Service sector, energy intensity decreases at a relatively slow rate, with diverse trends across sub-sectors. A decomposition analysis reveals that changes in the sectoral composition of the economy explain a considerable and increasing part of aggregate energy intensity dynamics. A convergence analysis reveals that only after 1995 cross-country variation in aggregate energy intensity levels clearly tends to decrease, driven by a strong and robust trend break in Manufacturing and enhanced convergence in Services. Moreover, we find evidence for the hypothesis that across sectors lagging countries are catching-up with leading countries, with rates of convergence that are on average higher in Services than in Manufacturing. Aggregate convergence patterns are almost exclusively caused by convergence of within-sector energy intensity levels,

and not by convergence of the sectoral composition of economies.

Biofuels and economic development: A computable general equilibrium analysis for Tanzania

- Energy Economics---2012---Channing Arndt,Karl Pauw,James Thurlow

Biofuels could offer new economic opportunities for low-income countries. We use a recursive dynamic computable general equilibrium model of Tanzania to evaluate different biofuels production options and estimate their impacts on growth and poverty. Our results indicate that maximizing the poverty-reducing effects of biofuels production in countries like Tanzania will require engaging and improving the productivity of smallholder farmers. Evidence shows that cassava-based ethanol production is more profitable than other feedstock options. Cassava also generates more “pro-poor” growth than sugarcane-based systems. However, if smallholder yields can be improved rather than expanding cultivated land, then both sugarcane and cassava out-grower schemes generate similar pro-poor outcomes. We conclude that, in so far as the public investments needed to establish a biofuels industry are consistent with other development needs, then producing biofuels will enhance economic development in countries like Tanzania.

Market efficiency and risk premia in short-term forward prices

- Energy Economics---2012---Erik Haugom,Carl J. Ulrich

Using recursive estimation and rolling windows over extended sample periods we examine the time-varying relationship between spot and short-term forward prices in the Pennsylvania–New Jersey–Maryland (PJM) wholesale electricity market. We examine theoretical models of forward risk premia in electricity markets and show that recent data do not provide support for existing models. The results indicate that short-

term forward prices have converged towards unbiased predictors of the subsequent spot prices.

Renewable and non-renewable energy consumption and economic growth relationship revisited: Evidence from G7 countries

- Energy Economics---2012---Can Tugcu,Ilhan Oz-turk,Alper Aslan

The aim of this study is to investigate the long-run and causal relationships between renewable and non-renewable energy consumption and economic growth by using classical and augmented production functions, and making a comparison between renewable and non-renewable energy sources in order to determine which type of energy consumption is more important for economic growth in G7 countries for 1980–2009 period. Autoregressive Distributed Lag approach to cointegration was employed for this purpose. Also, causality among energy consumption and economic growth was investigated by employing a recently developed causality test by Hatemi-J (2012). The long-run estimates showed that either renewable or non-renewable energy consumption matters for economic growth and augmented production function is more effective on explaining the considered relationship. On the other hand, although bidirectional causality is found for all countries in case of classical production function, mixed results are found for each country when the production function is augmented.

Oil prices and stock market in China: A sector analysis using panel cointegration with multiple breaks

- Energy Economics---2012---Su-Fang Li,Hui-Ming Zhu,Keming Yu

This paper investigates the relationship between oil prices and the Chinese stock market at the sector level. In a panel cointegration and Granger causality framework, the major sectors in China are studied using data collected from July 2001 to December 2010. When the effects of cross-sectional dependence and multiple structural breaks are taken into account, the panel

cointegration relationship between oil prices and stock prices is confirmed at the disaggregated sector level. The results indicate that there is some evidence of structural breaks in the interaction between oil prices and Chinese sectoral stocks. The long-run estimates suggest that the real oil price has a positive effect on sectoral stocks in the long run. The Granger causality tests demonstrate a unidirectional, short-run Granger causality relationship running from oil prices and sectoral stocks to the interest rate for 2001/07–2005/10. There is also a unidirectional, long-run Granger causality running from sectoral stocks to the interest rate for 2001/07–2005/10 and 2005/12–2007/06. However, the long-run Granger causality is bidirectional between oil prices, the interest rate and sectoral stocks for 2007/08–2008/11 and 2009/01–2010/12. Meanwhile, the short-run Granger causality is also bidirectional between the interest rate and oil prices.

Ancillary services in systems with high penetrations of renewable energy sources, the case of ramping

- Energy Economics---2012---Alberto Lamadrid,Tim Mount

Renewable Energy Sources (RES) are likely to continue the upward trend observed in the past decade. The change from dispatchable generation to an environment in which Independent System Operators (ISOs), Regional Transmission Operators (RTOs), Load Serving Entities (LSEs) and consumers dynamically respond to the conditions in the system and help to alleviate the uncertainty linked to RES requires appropriate tools to evaluate the social benefits and costs of different policies implemented. This paper presents a framework for evaluating the aforementioned effects using an engineering and economic optimization model. The proposed framework is applied to a stylized case study with operations on a test network that simulates a typical day. The objective of the case study is to compare the effects of (1) controllable demand, (2) on-site storage, and (3) upgrading transmission capacity. The different scenarios are evaluated in terms of (1) the percentage of potential wind generation spilled,

(2) the total operating cost of production, and (3) the amount of installed capacity needed to maintain operating reliability. The results show that controllable demand improves (reduces) all of the three criteria by alleviating congestion and mitigating wind variability. In contrast, the beneficial effects are smaller for RES's on-site storage, because it does not shift load to off-peak periods or reduce congestion, and for upgrading transmission, because it does not shift load to off-peak periods or mitigate wind variability.

Household energy choices and fuelwood consumption: An econometric approach using French data

- Energy Economics---2012---Stéphane Courture,Serge Garcia,Arnaud Reynaud

This study proposes an econometric analysis of household fuelwood demand in France. The choice concerning the energy used for heating is modeled, stressing the combination between one type of energy used as a main source and another one used as a back-up. This endogenous decision has an impact on fuelwood consumption and is taken into account to avoid biased estimates of price and income elasticities. The results show that the choice of energy mix is determined by the income and the socio-economic characteristics of households, and that fuelwood consumption is price-sensitive in the case where wood is the main source of energy.

The challenging economics of energy security: Ensuring energy benefits in support to sustainable development

- Energy Economics---2012---Helcio Blum,Luiz F.L. Legey

Energy is a key-resource to economic development and is required to be available continuously and in adequate amounts. Also, it is expected to be affordable and environmentally friendly. Ensuring this is a challenge, yet strategic to maintain economies running under a sustainable pattern. Energy security is neither a new concept, nor a new concern. However, because of new

issues, it requires a novel, broader approach. Such an approach should address both demand (security of supply) and supply (security of demand) sides, as well as take into account energy scarcity situations and surplus opportunities. In addition, it should allow for both private (markets) and public (policies and regulations) initiatives. This paper presents a theoretical and practical basis for the economics of energy security. Energy security is defined, in this context, as the ability of an economy to provide sufficient, affordable and environmentally sustainable energy services so as to maintain a maximum welfare state, even when issues would press it otherwise. We introduce the notion of energy security gap to represent the economy's failure to show such ability. Additionally, we also propose a framework to support the evaluation, planning and implementation of energy security in an economy. This framework relies on the concepts of resilience, adaptability and transformability (Walker et al, 2004) to prescribe indicators to assess the energy security of an economy. Furthermore, it proposes mechanisms to enhance energy security, as well as a continuous process to increasingly achieve this.

Asymmetric adjustments in the ethanol and grains markets

- Energy Economics---2012---Chia-Lin Chang,Li-Hsueh Chen,Shawkat Hammoudeh,Michael McAleer

This paper examines the long- and short-run asymmetric adjustments and pairs trades for nine pairs of spot and futures prices, itemized as three own pairs for three different bio-fuel ethanol types, three own pairs for three related agricultural products, namely corn, soybeans and sugar, and three cross pairs that included hybrids of the spot price of each of the agricultural products and an ethanol futures price. Most of the spreads' asymmetric adjustments generally occur during narrowing. The three ethanol pairs that contain the eCBOT futures with each of Chicago spot, New York Harbor spot and Western European (Rotterdam) spot show different long-run adjustments, arbitrage profitable opportunities and price risk hedging capabilities.

The asymmetric spread adjustments for the three grains are also different, with corn spread showing the strongest long-run widening adjustment, and sugar showing the weakest narrowing adjustment. Among others, the empirical analysis indicates the importance of potentially hedging the spot prices of agricultural commodities with ethanol futures contracts, which sends an important message that the ethanol futures market is capable of hedging price risk in agricultural commodity markets. The short-run asymmetric adjustments for individual prices in the nine pairs, with the exception of the corn own pair, underscore the importance of futures prices in the price discovery and hedging potential, particularly for ethanol futures.

Pass-through of wholesale price to the end user retail price in the Norwegian electricity market

- Energy Economics---2012---Faisal Mehmood Mirza,Olvar Bergland

In this paper we estimate the pass-through of wholesale electricity price to the end consumer price with variable price contracts in the Norwegian electricity market using weekly data. We find substantial asymmetry when retailers pass on the impact of price changes in the wholesale market to the retail prices as price increases are transmitted more quickly than price decreases. By examining the cumulative adjustment function of price change, we identify that some dominant retailers might be exercising market power in the retail electricity market. For an average Norwegian household with variable price contract, the cost of asymmetric price pass-through due to 2.5Øre/kWh change in the wholesale price over the complete life of pass-through in a year reaches to a high of 2.28 NOK. This cost sums up to 3.8 million NOK for all the Norwegian households on variable price contracts for one time price change. To deal with this asymmetric price setting behavior, end consumers should switch to spot price contracts and make use of "smart grid" technologies.

Prices or politics? The influence of markets and political party changes on oil and gas development in the United States

- Energy Economics---2012---Karen Maguire

This paper analyzes the influence of state and federal political party changes and market factors on the number of state oil and natural gas drilling permits issued. The findings, using a first-differenced empirical model for two samples, a 26-state sample, from 1990 to 2007, and a 19-state sample, from 1977 to 2007, indicate that the influence of political party changes is trumped by economic factors. Oil and natural gas prices are the main drivers of permitting changes, while the state and federal political party changes for the legislatures' and executive offices are consistently not significant.

Considering macroeconomic indicators in the food before fuel nexus

- Energy Economics---2012---Cheng Qiu, Gregory Colson, Cesar Escalante, Michael Wetzstein

A structural vector autoregression (SVAR) model along with a direct acyclic graph is employed to decompose how supply/demand structural shocks affect food and fuel markets. The results support the hypothesis that fundamental market forces of demand and supply are the main drivers of food price volatility. Increased biofuel production may cause short-run food price increases but not long-run price shifts. Decentralized freely operating markets will mitigate the persistence of any price shocks and restore prices to their long-run trends. The main policy implications are that oil, gasoline, and ethanol market shocks do not spillover into grain prices, which indicates no long-run food before fuel issue. In the short-run, grain prices can spike due to market shocks, so programs designed to blunt these price spikes may be warranted.

The effect of the Fukushima nuclear accident on stock prices of electric power utilities in Japan

- Energy Economics---2012---Shingo Kawashima, Fumiko Takeda

The purpose of this study is to investigate the effect of the accident at the Fukushima Daiichi nuclear power station, which is owned by Tokyo Electric Power Co. (TEPCO), on the stock prices of the other electric power utilities in Japan. Because the other utilities were not directly damaged by the Fukushima nuclear accident, their stock price responses should reflect the change in investor perceptions on risk and return associated with nuclear power generation. Our first finding is that the stock prices of utilities that own nuclear power plants declined more sharply after the accident than did the stock prices of other electric power utilities. In contrast, investors did not seem to care about the risk that may arise from the use of the same type of nuclear power reactors as those at the Fukushima Daiichi station. We also observe an increase of both systematic and total risks in the post-Fukushima period, indicating that negative market reactions are not merely caused by one-time losses but by structural changes in society and regulation that could increase the costs of operating a nuclear power plant.

The impact of regulation on pricing behavior in the Spanish electricity market (2002–2005)

- Energy Economics---2012---Aitor Ciarreta Antuñano, Maria Paz Espinosa

In this paper we measure the impact of regulatory measures which affected the Spanish electricity wholesale market between 2002 and 2005. Our approach is based on the fact that regulation changes incentives for firms and therefore their market behavior. In the absence of any regulation, firms would choose profit-maximizing prices on their residual demands so that the observed gap between optimal and actual prices provides a measure of the effect of regulation. Our results indicate that regulation has decreased wholesale prices considerably, but became less effective at the end of the sample period which explains the regulatory regime change introduced in 2006.

Strategic bidding in vertically integrated power markets with an application to the Italian electricity auctions

- Energy Economics---2012---Bruno Bosco,Lucia Parisio,Matteo Pelagatti

In this paper we apply a model of optimal bidding behavior to the Italian wholesale electricity market under three hypotheses: i) costs of generation are private knowledge, ii) firms can be vertically integrated, and iii) firms can sell part of their production in advance with bilateral contracts. We first use optimal bid functions and market data to retrieve time-varying marginal cost functions, price-cost margins and Lerner Indexes of market power for a sample of Italian companies. Then, we use estimated costs and actual equilibrium prices to evaluate the elasticity of these series to fuel price variations and estimate a possible differential impact of the dynamics of input expenditures (fuel price above all) on generation costs and final electricity prices. Our estimates suggest that the elasticities of costs and equilibrium prices with respect to oil price are virtually the same and, therefore, that the auction mechanism per se does not limit the extent to which cost increases are transferred to prices.

Price and volatility dynamics between electricity and fuel costs: Some evidence for Spain

- Energy Economics---2012---Dolores Furió,Helena Chuliá

The purpose of this study is to investigate the causal linkages between the Spanish electricity, Brent crude oil and Zeebrugge (Belgium) natural gas 1-month-ahead forward prices. Following Lütkepohl et al. (2004), we control for the presence of a structural change in the series and then we use the Johansen cointegration test and a vector error correction model (VECM) to embrace the analysis. Additionally, a multivariate generalized autoregressive conditional heteroskedastic (GARCH) model is applied to explore volatility interactions between the three markets involved in the study. Our findings reveal that Brent crude oil and Zeebrugge natural gas forward prices play a prominent role in the

Spanish electricity price formation process. Furthermore, causation, both in price and volatility, runs from Brent crude oil and natural gas forward markets to the Spanish electricity forward market. These results are of practical importance for both the wholesale and retail markets' participants as well as the regulator through the established link between the forward contracts' price and the Spanish tariff of last resort paid by more than 23million of customers.

Testing for price response asymmetries in the Spanish fuel market. New evidence from daily data

- Energy Economics---2012---Jacint Balaguer,Jordi Ripollés

In this work we use daily data to examine pattern asymmetries in the speed of transmission of international wholesale oil prices to Spanish retail fuel prices. Results are robust to two alternative specifications of an asymmetric error correction model, for which the presence of autoregressive conditional heteroskedasticity for disturbances is modeled by a GARCH(1,1) process. Evidence indicates that the short-term transmission of wholesale prices to retail prices is quite symmetric for both gasoline and diesel fuel. Nevertheless, in contrast to some of the results provided for an earlier period, we did not find asymmetries in the speed of retail price responses toward long-run equilibrium. Our evidence also suggests that the use of weekly (or lower frequency) data is one of the possible explanations for some of the seemingly contradictory results concerning this issue.

Is it in China's interest to implement an export carbon tax?

- Energy Economics---2012---Ji Feng Li,Xin Wang,Ya Xiong Zhang

Considering the dual context of China's domestic willingness to have a cleaner export structure and the widespread concern among developed countries that carbon leakage from developing countries, particularly China, could threaten their own climate policy effectiveness; this paper uses the SICGE model to investigate

the economic rationale of taxing direct CO₂ emissions of export in China. With an export carbon tax set at 200 yuan/t CO₂, three policy scenarios were studied, where the tax revenue is: undistributed; redistributed neutrally to stimulate investment; and redistributed neutrally to stimulate consumption. According to the model, the economic and climate effects of the different policy scenarios are not particularly distinguishable. The economic impacts are slightly negative while the effect on the export structure is significant: the export of major energy-intensive products decreased and the export of certain sectors (labour-intensive or with higher value-added) increased, resulting in a cut of 3.77% in total direct CO₂ emissions from exports. The revenue redistribution to stimulate consumption is shown to be the optimal scenario choice, which was confirmed by further sensitivity tests. By reviewing related WTO laws, this paper concludes that a clearly designed export carbon tax with a comparable carbon price is in China's own interest, while lessening the carbon leakage concerns of developed countries.

Towards a low-carbon economy: Coping with technological bifurcations with a carbon tax

- Energy Economics---2012---Chunjie Chi,Tiejun Ma,Bing Zhu

Technological learning is understood as an endogenous mechanism for the diffusion of advanced clean energy technologies. Technological learning is quite uncertain. Previous research showed that an optimization model with uncertain technological learning could generate technological bifurcations: various local optimal solutions of technology development strategies with very similar total costs but different environmental impacts. With a simplified energy system optimization model, this paper explores technological bifurcations and the effect of a carbon tax on the development and diffusion of new energy technologies. With a three-stage analysis, the main findings of this paper are (1) that technological learning, instead of its uncertainty, is an essential mechanism for technological bifurcations, and (2) a carbon tax can reduce carbon emission but not necessarily technological bifurcations. An implication

from these findings is that with a carbon tax, there still could be potential for other policy interventions to reduce carbon emissions without much additional cost.

The economics of planning electricity transmission to accommodate renewables: Using two-stage optimisation to evaluate flexibility and the cost of disregarding uncertainty

- Energy Economics---2012---Adriaan van der Weijde,Benjamin Hobbs

Aggressive development of renewable electricity sources will require significant expansions in transmission infrastructure. We present a stochastic two-stage optimisation model that captures the multistage nature of transmission planning under uncertainty and use it to evaluate interregional grid reinforcements in Great Britain (GB). In our model, a proactive transmission planner makes investment decisions in two time periods, each time followed by a market response. Uncertainty is represented by economic, technology, and regulatory scenarios, and first-stage investments must be made before it is known which scenario will occur. The model allows us to identify expected cost-minimising first-stage investments, as well as estimate the value of information, the cost of ignoring uncertainty, and the value of flexibility. Our results show that ignoring risk in planning transmission for renewables has quantifiable economic consequences, and that considering uncertainty can yield decisions that have lower expected costs than traditional deterministic planning methods. In the GB case, the value of information and cost of disregarding uncertainty in transmission planning were of the same order of magnitude (approximately £100M, in present worth terms). Further, the best plan under a risk-neutral decision criterion can differ from the best under risk-aversion. Finally, a traditional sensitivity analysis-based robustness analysis also yields different results than the stochastic model, although the former's expected cost is not much higher.

Distributional effects of carbon taxes: The case of Mexico

- Energy Economics---2012---Fidel Gonzalez

In this study, I develop an analytical general equilibrium model to assess the distributional effects across income groups of a carbon tax assuming that the revenue from the carbon tax is recycled in two different ways: as a manufacturing tax-cut and a food subsidy. I use this analytical model to provide intuition about the main distributional components. The model is calibrated with data from Mexico to obtain unambiguous price and quantity changes. I find that the distribution of the costs is driven by the way the revenue is recycled. In particular, the costs are distributed regressively when the revenue is recycled as a manufacturing tax cut and progressively when it is recycled as a food subsidy. Providing a food subsidy also generates higher welfare and lower carbon emissions than the manufacturing tax cut. To compare and test the robustness of the numerical findings for Mexico, I calibrate the model with data for a developed country, specifically the U.S.A. Despite differences in the magnitude of the changes in some variables, the general findings mentioned above also hold for U.S.A. data. These results suggest that, as found for the U.S.A. in recent studies, carbon taxes are not necessarily regressive. Rather, the way revenue is recycled is a major determinant of how the carbon tax costs are distributed.

Analysis of U.S. residential wood energy consumption: 1967–2009

- Energy Economics---2012---Nianfu Song, Francisco X. Aguilar, Stephen R. Shifley, Michael E. Goerndt

The residential sector consumes about 23% of the energy derived from wood (wood energy) in the U.S. An estimated error correction model with data from 1967 to 2009 suggests that residential wood energy consumption has declined by an average 3% per year in response to technological progress, urbanization, accessibility of non-wood energy, and other factors associated with a time trend such as increasing income per capita and number of houses. But the rising price of non-wood

energy has had a positive effect on the consumption and offset the downward trend effect in the last decade. Residential wood energy consumption has also been sensitive to changes in wage rate in both long-run and short-run, but the total estimated wage rate effect since 1967 is negligible. Wood energy is expected to continue to account for a small share of residential energy consumption unless public policies improve wood energy cost competitiveness relative to non-wood energy.

Volatility transmission and volatility impulse response functions in crude oil markets

- Energy Economics---2012---Xiaoye Jin, Sharon Xiaowen Lin, Michael Tamvakis

Using daily data from July 2005 to February 2011 for WTI, Dubai and Brent futures contracts, we employ a VAR-BEKK model to investigate crude oil markets integration on the second moment. We also quantify the size and persistence of these connections through the analysis of Volatility Impulse Response Functions (VIRF) for two historical shocks, namely the 2008 Financial Crisis and the BP Deepwater Horizon oil spill. We observe that Brent and Dubai crude are highly responsive to market shocks, whereas WTI crude shows the least responsiveness of the three benchmarks, which creates questions about its predominance as a benchmark crude oil. Furthermore, we fit the density of the VIRF at different forecast horizons. These fitted distributions are asymmetric, showing that the probability of observing a large impact of a shock is lower while the probability of a relatively smaller impact is much higher. Finally, we simulate the VIRF for a given probability of a random shock. The VIRF shows that only a “large” shock (derived from a smaller probability) will result in an increase in expected conditional volatilities. These results provide useful insights into the volatility transmission mechanism in crude oil markets and their associated risk estimation, and may have significant implications for various market participants and regulators.

The role of the trade channel in the propagation of oil supply shocks

- Energy Economics---2012---Alessandro Maravalle

This paper analyzes when and why idiosyncratic oil supply shocks produce large macroeconomic effects in an analytically tractable two-country general equilibrium model. We focus on a demand-driven mechanism, the trade channel, which transmits oil shocks across economies through changes in the non-oil goods terms of trade. When the trade channel is operative we have three main consequences on the transmission of oil shocks. First, the macroeconomic impact of oil shocks may be large and asymmetric across countries. Second, the magnitude of the effects is nonlinear in the size of the oil shock. Third, terms of trade movements never ensure international risk sharing after an idiosyncratic oil supply shock.

Threshold cointegration and nonlinear adjustment between CO2 and income: The Environmental Kuznets Curve in Spain, 1857–2007

- Energy Economics---2012---Vicente Esteve,Cecilio Tamarit

In this paper we model the long-run relationship between per capita CO2 and per capita income for the Spanish economy over the period 1857–2007. According to the Environmental Kuznets Curve (ECK) the relationship between the two variables has an inverted-U shape. However, previous studies for the Spanish economy only considered the existence of linear relationships. Such an approach may lack flexibility to detect the true shape of the relationship. Our empirical methodology accounts for a possible non-linear relationship through the use of threshold cointegration techniques. Our results confirm the non-linearity of the link between the two above-mentioned variables pointing to the existence of an Environmental Kuznets Curve for the Spanish case.

How market efficiency and the theory of storage link corn and ethanol markets

- Energy Economics---2012---Mindy Mallory,Scott Irwin,Dermot Hayes

This article uses the theories of market efficiency and supply of storage to develop a conceptual link between the corn and ethanol markets and explores statistical evidence for the link. We propose that a long-run no-profit condition is established in distant futures markets for ethanol, corn and natural gas and then use the theory of storage to define an inter-temporal equilibrium among these prices. The relationship shows that under certain conditions, future price expectations will influence nearby futures prices and that a short-term relationship between input and output prices will exist. We demonstrate validity of the theory using a structural price model and then by means of time-series techniques.

Forecasting energy market volatility using GARCH models: Can multivariate models beat univariate models?

- Energy Economics---2012---Yudong Wang,Chongfeng Wu

In this paper, we forecast energy market volatility using both univariate and multivariate GARCH-class models. First, we forecast volatilities of individual assets and find that multivariate models display better performance than univariate models. Second, we forecast crack spread volatility and contrast the performance of multivariate models for two underlyings, with the alternative of univariate ones for crack spreads directly. Our evidence shows that univariate models allowing for asymmetric effects display the greatest accuracy. We also discuss the hedging strategy based on multivariate models and its implications for market participants.

Cointegration and causal relationships between energy consumption and output: Assessing the evidence from Australia

- Energy Economics---2012---Md Shahiduzzaman,Khorshed Alam

In this paper, we describe our investigation of the cointegration and causal relationships between energy consumption and economic output in Australia over a period of five decades. The framework used in this paper is the single-sector aggregate production function, which is the first comprehensive approach used in an Australian study of this type to include energy, capital and labour as separate inputs of production. The empirical evidence points to a cointegration relationship between energy and output and implies that energy is an important variable in the cointegration space, as are conventional inputs capital and labour. We also find some evidence of bidirectional causality between GDP and energy use. Although the evidence of causality from energy use to GDP was relatively weak when using the thermal aggregate of energy use, once energy consumption was adjusted for energy quality, we found strong evidence of Granger causality from energy use to GDP in Australia over the investigated period. The results are robust, irrespective of the assumptions of linear trends in the cointegration models, and are applicable for different econometric approaches.

Stochastic semi-nonparametric frontier estimation of electricity distribution networks: Application of the StoNED method in the Finnish regulatory model

- Energy Economics---2012---Timo Kuosmanen

Electricity distribution network is a prime example of a natural local monopoly. In many countries, electricity distribution is regulated by the government. Many regulators apply frontier estimation techniques such as data envelopment analysis (DEA) or stochastic frontier analysis (SFA) as an integral part of their regulatory framework. While more advanced methods that combine nonparametric frontier with stochastic error term are known in the literature, in practice, regulators continue to apply simplistic methods. This paper reports the main results of the project commissioned by the Finnish regulator for further development of the cost frontier estimation in their regulatory framework. The key objectives of the project were to integrate a stochastic SFA-style noise term to the nonparametric,

axiomatic DEA-style cost frontier, and to take the heterogeneity of firms and their operating environments better into account. To achieve these objectives, a new method called stochastic nonparametric envelopment of data (StoNED) was examined. Based on the insights and experiences gained in the empirical analysis using the real data of the regulated networks, the Finnish regulator adopted the StoNED method in use from 2012 onwards.

Modeling international trends in energy efficiency

- Energy Economics---2012---David Stern

I use a stochastic production frontier to model energy efficiency trends in 85 countries over a 37-year period. Differences in energy efficiency across countries are modeled as a stochastic function of explanatory variables and I estimate the model using the cross-section of time-averaged data, so that no structure is imposed on technological change over time. Energy efficiency is measured using a new energy distance function approach. The country using the least energy per unit output, given its mix of outputs and inputs, defines the global production frontier. A country's relative energy efficiency is given by its distance from the frontier—the ratio of its actual energy use to the minimum required energy use, *ceteris paribus*. Energy efficiency is higher in countries with, *inter alia*, higher total factor productivity, undervalued currencies, and smaller fossil fuel reserves and it converges over time across countries. Globally, technological change was the most important factor counteracting the energy-use and carbon-emissions increasing effects of economic growth.

Energy efficiency policy in a non-cooperative world

- Energy Economics---2012---Philippe Barla,Stef Proost

In this paper, we explore energy efficiency policies in the presence of a global environmental problem and international cost interdependency associated with R&D

activities. We develop a simple model with two regions where the cost of an appliance in one region depends upon the level of energy efficiency in that region and the level of R&D activities by the appliance industry. In our model, the cooperative outcome can be decentralized by imposing a tax on energy. However, we show that when regions do not cooperate, they have an incentive to adopt additional instruments to increase energy efficiency. The reason is that the lack of cooperation leads to under-taxation of the environmental externality which in turn creates an incentive to try to reduce emissions produced abroad. We illustrate this phenomenon with the Californian vehicle greenhouse gas standards.

Managing the financial risks of electricity producers using options

- Energy Economics---2012---S. Pineda,A.J. Conejo

Electricity producers participating in electricity markets face risks pertaining to both selling prices and the availability of the production units. Among electricity derivatives, options represent an adequate instrument to manage these risks. In this paper, we propose a multi-stage stochastic model to determine the optimal selling strategy of a risk-averse electricity producer including options, forward contracts, and pool trading. A detailed case study highlights the advantages of an option vs. a forward contract to hedge against the financial risks related to pool prices and unexpected unit failures.

Forecasting Italian electricity zonal prices with exogenous variables

- Energy Economics---2012---Angelica Gianfreda,Luigi Grossi

In the last few years we have observed the deregulation in electricity markets and an increasing interest in price dynamics has been developed especially to consider all stylized facts shown by spot prices. Only few papers have considered the Italian Electricity Spot market since it has been deregulated recently. Therefore, this contribution is an investigation with emphasis

on price dynamics accounting for technologies, market concentration, congestions and volumes. We aim to understand how these four variables affect zonal prices since these ones combine to bring about the single national price (prezzo unico d'acquisto, PUN). Hence, understanding its features is important for drawing policy indications referred to production planning and selection of generation sources, pricing and risk-hedging problems, monitoring of market power positions and finally to motivate investment strategies in new power plants and grid interconnections. Implementing Reg-ARFIMA–GARCH models, we assess the forecasting performance of selected models showing that they perform better when these factors are considered.

Returns to scale and damages to scale on U.S. fossil fuel power plants: Radial and non-radial approaches for DEA environmental assessment

- Energy Economics---2012---Toshiyuki Sueyoshi,Mika Goto

This study proposes a new use of Data Envelopment Analysis (DEA) for environmental assessment, paying attention to a methodological bias (i.e., different methods produce different results). DEA is analytically classified into radial and non-radial approaches. The radial approach determines the level of unified (operational and environmental) efficiency by measuring an inefficiency score. The score indicates the distance of a projection from an observed performance to an efficiency frontier. In contrast, the non-radial approach determines the level of unified efficiency by measuring a total amount of slacks because each slack indicates inefficiency. To avoid the methodological bias, this study considers the use of radial and non-radial approaches. In this study, we consider a production process where all organizations produce not only desirable (good) but also undesirable (bad) outputs as a result of their business operations. To unify the two types of outputs, this study discusses the concept of disposability, which is separated into natural and managerial disposability. The natural disposability indicates negative adaptation to a regulation change on undesirable outputs. In contrast, the managerial disposability indicates corpo-

rate strategy by which a firm considers the regulation change as a new business opportunity. A firm attempts to improve its unified efficiency by utilizing new environmental technology and/or new management. This type of strategy indicates positive adaptation to the regulation change. Under the two disposability concepts, this study discusses how to measure RTS (Returns to Scale) under natural disposability and DTS (Damages to Scale: corresponding to RTS on undesirable outputs) under managerial disposability. The two scale measures are analytically discussed by the proposed radial and non-radial approaches with SCSCs or without SCSCs, where SCSCs indicate strong complementary slackness conditions. An illustrative example on U.S. fossil fuel power plants indicates a policy implication that they need to introduce new technology for environmental protection. This study also discusses a necessity of examining a methodological bias in energy studies. Empirical findings identified in this study document the practicality of the proposed approaches to measure RTS/DTS.

Gas release and transport capacity investment as instruments to foster competition in gas markets

- Energy Economics---2012---Corinne Chaton, Farid Gasmi, Marie-Laure Guillerminet, Juan-Daniel Oviedo

Motivated by policy events experienced during the last two decades by the European natural gas industry, this paper develops a simple model for analyzing the interaction between gas release and capacity investment programs as tools to improve the performance of imperfectly competitive markets. We consider a regional market in which a measure that has an incumbent release part of its gas to a marketer complements a program of investment in transport capacity dedicated to imports by the marketer, at a regulated transport charge, of competitively-priced gas. First, we examine the case where transport capacity is regulated while gas release is not, i.e., the volume of gas released is determined by the incumbent. We then analyze the effect of the “artificial” duopoly created by the regulator

when the latter regulates both gas release and transport capacity. Finally, using information on the French industry, we calibrate the basic demand and cost elements of the model and perform some simulations of these two scenarios. Besides allowing us to analyze the economic properties of these scenarios, a policy implication that comes out of the empirical analysis is that, when combined with network expansion investments, gas-release measures applied under regulatory control are indeed effective short-term policies for promoting gas-to-gas competition.

Inter-technology knowledge spillovers for energy technologies

- Energy Economics---2012---Gregory Nemet

Both anecdotal evidence and the innovation literature indicate that important advances in energy technology have made use of knowledge originating in other technological areas. This study uses the set of U.S. patents granted from 1976 to 2006 to assess the role of knowledge acquired from outside each energy patent's technological classification. It identifies the effect of external knowledge on the forward citation frequency of energy patents. The results support the claim above. Regression coefficients on citations to external prior art are positive and significant. Further, the effect of external citations is significantly larger than that of other types of citations. Conversely, citations to prior art that is technologically near have a negative effect on forward citation frequency. These results are robust across several alternative specifications and definitions of whether each flow of knowledge is external. Important energy patents have drawn heavily from external prior art categorized as chemical, electronics, and electrical; they cite very little prior art from computers, communications, and medical inventions.

Homeowners' preferences for adopting innovative residential heating systems: A discrete choice analysis for Germany

- Energy Economics---2012---Carl Michelsen, Reinhard Madlener

Space heating accounts for a large fraction of the primary energy consumption and CO₂ emissions of residential buildings in Germany. Besides targeting the insulation standard, innovative (i.e. renewable energies-based and/or energy-efficient) residential heating systems (RHS) offer the potential to reduce CO₂ emissions from space heating. Therefore, understanding the determinants of the RHS adoption decision becomes increasingly important. In this paper, we analyze the influence of preferences about RHS-specific attributes on the homeowners' adoption decision. Moreover, we control for the influence of socio-demographic, home and spatial characteristics. To this end, we specify the discrete appliance choice by a multinomial logit model and apply it to representative survey data for Germany. Our findings show that there are different drivers for the adoption of innovative RHS (partly) based on renewable energies in newly built and existing 1- and 2-family homes, and that the importance of key drivers also differs across groups of homeowners and RHS, respectively. First, we find that adopters of a gas- and oil-fired condensing boiler with solar thermal support have a strong preference for energy savings, while adopters of a heat pump or wood pellet-fired boiler prefer being more independent from fossil fuels. Second, we find that owners of existing homes have less scope for preferences in the RHS adoption decision. The decision to replace a RHS in an existing home is rather driven by socio-demographic, home and spatial characteristics. Third, our findings are quite contrary for newly built homes. Here, preferences about RHS specific attributes are found to be highly relevant, while there is less evidence for an influence of socio-demographic, home and spatial characteristics on the adoption decision.

Oil price movements and stock markets revisited: A case of sector stock price indexes in the G-7 countries

- Energy Economics---2012---Bi-Juan Lee, Chin Wei Yang, Bwo-Nung Huang

Applying sector stock prices and oil prices in 1991:01–2009:05 from the G7 countries we find oil price

shocks do not significantly impact the composite index in each country. However, stock price changes in Germany, the UK and the US were found to lead oil price changes.

Cross hedging jet-fuel price exposure

- Energy Economics---2012---Zeno Adams, Mathias Gerner

This paper investigates the cross hedging performance of several oil forwards contracts using WTI, Brent, gasoil and heating oil to manage jet-fuel spot price exposure. We apply three econometric techniques that have been widely tested and applied in the cross hedging literature on foreign exchange and stock index futures markets. Using quotes from the financial industry on forward contracts, we can show that the optimal cross hedging instrument depends on the maturity of the instrument's forwards contract. The results highlight that the standard approach in the literature to use crude oil as a cross hedge is not optimal for time horizons of three months or less. By contrast, for short hedging horizons our results indicate that gasoil forwards contracts represent the highest cross hedging efficiency for jet-fuel spot price exposure, while for maturities of more than three months, the predominance of gasoil diminishes in comparison to WTI and Brent.

A characterization of oil price behavior — Evidence from jump models

- Energy Economics---2012---Marc Gronwald

This paper is concerned with the statistical behavior of oil prices in two ways. It, firstly, applies a combined jump GARCH model in order to characterize the behavior of daily, weekly as well as monthly oil prices. Secondly, it relates its empirical results to implications of Hotelling-type resource extraction models. The empirical analysis shows that oil prices are characterized by GARCH as well as conditional jump behavior and that a considerable portion of the total variance is triggered by sudden extreme price movements. This finding implies that, first, oil price signals are not reliable and, as a consequence, both finding

optimal extraction paths and decisions regarding the transmission to alternative technologies are likely to be compromised. Second, this behavior is in stark contrast to the notion of deterministic trends in the price of oil.

The cost of providing electricity to Africa

- Energy Economics---2012---Orvika Rosnes, Haakon Vennemo

Sub-Saharan Africa lacks electricity. We estimate the cost of providing electricity to the region. To do so, we build an optimisation model that links the electricity demand to the supply and links the supply to the generation, distribution and transmission of electricity between countries. To the best of our knowledge, such a model is novel in the literature.

Pricing emission permits in the absence of abatement

- Energy Economics---2012---Beat Hintermann

If emissions are stochastic and firms are unable to control them through abatement, the cap in a permit market may be exceeded, or not be reached. I derive a binary options pricing formula that expresses the permit price as a function of the penalty for noncompliance and the probability of an exceeded cap under the assumption of no abatement. I apply my model to the EU ETS, where the rapid introduction of the market made it difficult for firms to adjust their production technology in time for the first phase. The model fits the data well, implying that the permit price may have been driven by firms hedging against stochastic emissions.

Liquidity and dirty hedging in the Nordic electricity market

- Energy Economics---2012---Dennis Frestad

Hedging involves tradeoffs in incomplete markets because the number of hedging instruments is limited. Even when an extensive set of hedging instruments is available, the ease with which these instruments can be

traded may be highly variable. This study finds systematic variations in liquidity in different segments of the Nordic electricity swap market and analyzes the potential for replacing low-liquidity, delivery-period-matched hedging instruments with more liquid, delivery-period-mismatched hedging instruments. When the costs of implementing such dirty hedging strategies are lower than those of the replaced hedging instruments and the loss of hedge effectiveness is small, dirty hedging strategies may then replace their delivery-period-matched counterparts. In this context, I analyze the dynamic out-of-sample tracking performance of selected dirty hedges. Electricity swaps with delivery in front year one and two, respectively, track electricity swaps with delivery in front year three quite well. This suggests that hedge effectiveness can be traded off for the reduced costs of implementing these dirty hedging strategies compared with those of the less liquid year-three swaps.

Evaluating the application of different pricing regimes and low carbon investments in the European electricity market

- Energy Economics---2012---Giorgia Oggioni, Yves Smeers

The EU-ETS is the first measure initiated by the EU to contribute to the decarbonization of the European energy sector. It is a cap and trade system that requires industries participating to the program to procure allowances to cover their emissions. Electricity Intensive Industries (EIIs) have complained that the system put their European plants at disadvantage compared to facilities located outside the EU. They have asked for actions to mitigate this effect; one of them is to have access to long term contracts with electricity suppliers, ideally with those operating carbon free plants. This paper presents and illustrates a method for assessing the impact of this measure on EIIs participating to the EU cap and trade system.

Oil price shocks and transportation firm asset prices

- Energy Economics---2012---Raj Aggarwal,Aigbe Akhigbe,Sunil K. Mohanty

The transportation sector is a major user of oil-based energy. Even as oil prices continue to fluctuate greatly, the impact of oil price changes on transportation firms has heretofore not been adequately examined. This paper fills this gap, documenting important new findings based on analysis of over two decades of daily data on large changes in oil prices (oil price shocks). First, while transportation firm returns are influenced negatively by oil price increases, risks are increased more by oil price declines. Second, firm characteristics are important with the market-to-book ratio being the most important firm characteristic, and ROA, firm size, and the prior run up in prices are also important in influencing oil price related returns, betas, variances, and trading volumes. Third, in the S&P transportation sub-sector, industry concentration is negatively related to returns, oil price risk, and trading volume, and asymmetrically related to returns and market betas. These new findings enhance our understanding of the asset price impact of oil price shocks and should be of much interest to scholars, corporate executives, money managers, regulators, and policy makers.

Correlations between biofuels and related commodities before and during the food crisis: A taxonomy perspective

- Energy Economics---2012---Ladislav Křišťoufek,Karel Janda,David Zilberman

In this paper, we analyze the relationships between the prices of biodiesel, ethanol and related fuels and agricultural commodities with a use of minimal spanning trees and hierarchical trees. To distinguish between short-term and medium-term effects, we construct these trees for different frequencies (weekly and monthly). We find that in short-term, both ethanol and biodiesel are very weakly connected with the other commodities. In medium-term, the biofuels network becomes more structured. The system splits into two

well separated branches — a fuels part and a food part. Biodiesel tends to the fuels branch and ethanol to the food branch. When the periods before and after the food crisis of 2007/2008 are compared, the connections are much stronger for the post-crisis period. This is the first application of this methodology on the biofuel systems.

Decomposition of the environmental inefficiency of the meta-frontier with undesirable output

- Energy Economics---2012---Ching-Ren Chiu,Je-Liang Liou,Pei-Ing Wu,Chen-Ling Fang

In this paper, we present an alternative analysis framework to evaluate the effects of technology heterogeneities and undesirable output on environmental efficiency measurement. The proposed framework combines the directional distance function and a meta-frontier analysis. It can be used to measure efficiency improvements brought about by enhanced technical management and technological advances. For demonstration purposes, we used the framework to measure the environmental efficiency in 90 countries worldwide for the 2003–2007 period. The results showed that when the meta-technology set is used as the evaluation basis, the average environmental efficiency of high competitiveness countries is greater than that of lower-middle, low, and upper-middle competitiveness countries. The upper-middle competitiveness countries perform worse than the lower-middle and low competitiveness countries because of the excessive labor force usage and carbon dioxide emissions in these countries. We also found that the environmental inefficiency of the meta-frontier for high competitiveness countries can be attributed to managerial failure in the production process, whereas that for upper-middle, lower-middle, and low competitiveness countries can be attributed to technological differences.

The effect of ethanol listing on corn prices: Evidence from spot and futures markets

- Energy Economics---2012---Riza Demirer,Ali Kutan,Fanglin Shen

The use of corn for ethanol has been the topic of heated discussions in the media and among policy makers. As part of this debate, some observers have argued that the use of corn in the production of ethanol has had adverse effects on corn prices. This paper contributes to this reviving debate by examining the impact of the listing of ethanol futures in the Chicago Board of Trade on the spot and futures prices for corn. We find a significant listing effect, indicating that the listing of ethanol has had a positive contribution to both price and volatility in the corn market, especially in the spot and the shorter maturity futures contracts, and mostly through its interaction with trading volume in the corn market. We discuss the policy implications of the findings for investors and its relevance for the ongoing debate on US energy policy. We conclude with some suggestions for future research.

Global warming and electricity demand in the rapidly growing city of Delhi: A semi-parametric variable coefficient approach

- Energy Economics---2012---Eshita Gupta

This paper estimates the climate sensitivity of electricity demand in Delhi using daily data on electricity demand and apparent temperature for the period 2000–09. The study adopts a semi-parametric variable coefficient model in order to investigate the impact of climatic factors on electricity demand. As evident from previous studies, electricity demand is a U-shaped function of temperature. We find the rising part of the temperature–electricity curve to become more pronounced over time implying an increase in cooling demand per unit increase in summer temperatures. The study therefore predicts the adverse effects of climate change on electricity demand to be asymmetrically distributed in different seasons in the future, resulting in a serious disequilibrium in the hot months.

Returns to Scale and Damages to Scale with Strong Complementary Slackness Conditions in DEA Assessment: Japanese Corporate Effort on Environment Protection

- Energy Economics---2012---Toshiyuki Sueyoshi, Mika Goto

This study proposes a use of Data Envelopment Analysis (DEA) for environmental assessment. All organizations in private and public sectors produce not only desirable (good) but also undesirable (bad) outputs as a result of their economic activities. The proposed use of DEA determines the level of unified (operational and environmental) efficiency of all the organizations. A contribution of this study is that it explores how to measure not only RTS (Returns to Scale) on desirable outputs but also a new concept regarding “DTS: Damages to Scale” (corresponding to RTS for undesirable outputs). This study discusses how to measure RTS under natural disposability and DTS under managerial disposability by DEA. The measurement of RTS and DTS is formulated by incorporating “Strong Complementary Slackness Conditions (SCSCs)”. As a result, this study can handle an occurrence of multiple reference sets and multiple projections in the RTS/DTS measurement. The incorporation of SCSCs makes it possible both to restrict DEA multipliers in a specific range without any prior information and to identify all possible efficient organizations as a reference set. Using the unique capabilities of SCSCs, this study discusses the use of DEA environmental assessment by exploring how to classify the type of RTS/DTS with SCSCs. Such analytical capabilities are essential, but not previously explored in DEA environmental assessment for energy industries. As an illustrative example, this study applies the proposed approach for the performance evaluation of Japanese manufacturing industries. This study finds that these firms need to introduce technology innovation to reduce an amount of greenhouse gases and wastes. The empirical result confirms the importance of measuring RTS/DTS in DEA environmental assessment.

Measuring contagion between energy market and stock market during financial crisis: A copula approach

- Energy Economics---2012---Xiaoqian Wen, Yu Wei, Dengshi Huang

In this paper, we apply time-varying copulas to investigate whether a contagion effect existed between energy and stock markets during the recent financial crisis. Using the WTI oil spot price, the S&P500 index, the Shanghai stock market composite index and the Shenzhen stock market component index returns, evidence was found for a significantly increasing dependence between crude oil and stock markets after the failure of Lehman Brothers, thus supporting the existence of contagion in the sense of Forbes and Rigobon's (2002) definition. Moreover, increased tail dependence and symmetry characterize all the paired markets. This indicates that significant increases in tail dependence are an actual dimension of the contagion phenomenon and that crude oil and stock prices are linked to the same degree regardless of whether markets are booming or crashing during the sample period. Finally, the contagion effect is found to be much weaker for China than the US. The empirical results have potentially important implications for risk management.

Jump spillovers in energy futures markets: Implications for diversification benefits

- Energy Economics---2012---Qingfu Liu, Anthony H. Tu

In this paper, we investigate jump spillover effects of five energy (petroleum) futures and their implications for diversification benefits. In order to identify the latent historical jumps for each of these energy futures, we use a Bayesian MCMC approach to estimate a jump-diffusion model for each. We examine the simultaneous jump intensities of pairs of energy futures and the probabilities that jumps in crude oil (and natural gas) cause jumps or usually large returns in other energy futures. In all cases, we find significant evidence that the diffusion-jump process is a better characterization for energy futures prices. We further

find that jump spillovers significantly reduce the diversification benefits of an energy futures portfolio in a tranquil (rather than crisis) period.

The Arctic: No big bonanza for the global petroleum industry

- Energy Economics---2012---Lars Lindholt, Solveig Glomsrød

Petroleum companies and Arctic states are carefully watching the sea ice withdrawal and the future access to petroleum resources in the Arctic. We raise the question if the global market for petroleum will actually keep the door open for substantial supply of oil and gas from the Arctic, a region with almost a quarter of global undiscovered petroleum resources, but at high costs and long lead times. This makes future Arctic supply highly dependent on oil and gas prices, influenced by future supply of unconventional oil and gas and also by huge amounts of conventional gas in the Middle East coming on stream. We study the oil and gas supplies from 6 Arctic regions during 2010–2050 using the FRISBEE model of global oil and gas markets, based on Arctic resource estimates from the U.S. Geological Survey.

Accounting for household heterogeneity in general equilibrium economic growth models

- Energy Economics---2012---N.B. Melnikov, O'Neill, B.C., M.G. Dalton

We describe and evaluate a new method of aggregating heterogeneous households that allows for the representation of changing demographic composition in a multi-sector economic growth model. The method is based on a utility and labor supply calibration that takes into account time variations in demographic characteristics of the population. We test the method using the Population-Environment-Technology (PET) model by comparing energy and emissions projections employing the aggregate representation of households to projections representing different household types explicitly. Results show that the difference between the two approaches in terms of total demand for energy and consumption goods is negligible for a wide range

of model parameters. Our approach allows the effects of population aging, urbanization, and other forms of compositional change on energy demand and CO₂ emissions to be estimated and compared in a computationally manageable manner using a representative household under assumptions and functional forms that are standard in economic growth models.

US residential energy demand and energy efficiency: A stochastic demand frontier approach

- Energy Economics---2012---Massimo Filippini, Lester Hunt

This paper estimates a US frontier residential aggregate energy demand function using panel data for 48 ‘states’ over the period 1995 to 2007 using stochastic frontier analysis (SFA). Utilizing an econometric energy demand model, the (in)efficiency of each state is modeled and it is argued that this represents a measure of the inefficient use of residential energy in each state (i.e. ‘waste energy’). This underlying efficiency for the US is therefore observed for each state as well as the relative efficiency across the states. Moreover, the analysis suggests that energy intensity is not necessarily a good indicator of energy efficiency, whereas by controlling for a range of economic and other factors, the measure of energy efficiency obtained via this approach is. This is a novel approach to model residential energy demand and efficiency and it is arguably particularly relevant given current US energy policy discussions related to energy efficiency.

Technical efficiency, shadow price of carbon dioxide emissions, and substitutability for energy in the Chinese manufacturing industries

- Energy Economics---2012---Myunghun Lee, Ning Zhang

China is the world’s largest CO₂ producer and energy consumer. In this paper, we calculate the maximum technically obtainable CO₂ emissions reduction from the efficient use of inputs and estimate the shadow prices of CO₂ emissions in order to assess the potential

cost savings deriving from trading emissions among industries by measuring the input distance function for 30 Chinese manufacturing industries. Our empirical results indicate that CO₂ emissions could be reduced by as much as 680 million tons in the aggregate. The shadow prices of CO₂ vary from a high of \$18.82 to a low of zero across industries, with an average of \$3.13 per ton. Additionally, the estimated indirect Morishima elasticities of substitution of capital for fossil fuels indicate that the substitutabilities of capital for oil, gas, and coal are higher than the substitutability for labor.

Estimating the marginal cost of quality improvements: The case of the UK electricity distribution companies

- Energy Economics---2012---Tooraj Jamasb, Luis Orea, Michael Pollitt

The main aim of this paper is to develop an econometric approach to the estimation of marginal costs of improving quality of service. Estimating marginal costs of quality can help energy regulators to design more effective incentive mechanisms for network utilities to achieve optimal quality levels and reduce welfare losses due to sub-optimal quality. We implement this methodology by way of applying it to the case of the UK electricity distribution networks. The proposed method allows us to measure the welfare effect of the observed quality improvements in the UK between 1995 and 2003. Our results suggest that the regulatory incentives to reduce service interruptions have not been strong enough to achieve economically efficient levels of service quality. We find that the incentives to encourage utilities to reduce network energy losses have led to performance improvement. We estimate that the observed improvements in quality during the period of the study only represented about 20% of the potential customer welfare gains, hence leaving considerable scope for further economically efficient improvements in service quality.

Non-parametric and parametric modeling of biodiesel, sunflower oil, and crude oil price relationships

- Energy Economics---2012---Islam Has-souneh,Teresa Serra,Barry Goodwin,José M. Gil

Multivariate local linear regression and parametric error correction models are applied to assess price linkages and price transmission patterns between food and energy prices in Spain. Weekly biodiesel, sunflower and crude oil prices observed from November 2006 to October 2010 are used in the empirical analysis. Results suggest the existence of a long-run, equilibrium relationship between the three prices studied. Biodiesel is the only variable that adjusts to deviations from this long-run relationship. Local linear regression techniques show that the speed of adjustment of biodiesel prices is faster when biodiesel is relatively cheap than when it is expensive. Energy prices are also found to influence sunflower oil prices through short-run price dynamics.

Rising household diesel consumption in the United States: A cause for concern? Evidence on asymmetric pricing

- Energy Economics---2012---Jack Fosten

Papers in the literature have thus far overlooked the projected increase in U.S. diesel car share when looking at asymmetries in petroleum pricing. This paper addresses this issue by comparing retail gasoline and diesel prices in order to see whether they rise faster than they fall given the price of their upstream input, crude oil. This phenomenon has been termed in the literature as “Rockets and Feathers.” We apply the threshold vector error correction model (TVECM) of Hansen and Seo (2002) which has not yet been applied in the literature. We account for the 2008 structural break to crude oil and petroleum prices by splitting the sample using evidence from the recent structural break unit root test of Kim and Perron (2009). Both markets seem to price symmetrically before the 2008 break, but we find evidence of asymmetric pricing after

2008 in diesel prices, and not in gasoline prices. Given that the diesel market is small relative to the gasoline market and therefore more open to price exploitation, the ongoing cost increases associated with the policy of switching to Ultra Low Sulphur diesel (ULSD) from 2006 to 2010 could be at the heart of this asymmetry. With this in mind, the U.S. Federal Trade Commission should monitor diesel prices as the market share grows, in order to ensure that consumers are not adversely affected.

Stochastic carbon sinks for combating carbon dioxide emissions in the EU

- Energy Economics---2012---Ing-Marie Gren,Mattias Carlsson,Katarina Eloffsson,Miriam Munnich

This paper carries out numerical calculations on the potential of carbon sinks in the EU Emissions Trading Scheme (ETS) and national commitments under conditions of stochastic carbon dioxide emissions from fossil fuels and carbon sequestration by forests. Chance constraint programming is used to analyze the role of stochastic carbon sinks for national and EU-wide compliance costs. The analytical results show that the inclusion of the carbon sink option can reduce costs for low enough marginal cost and risk discount, but also that costless carbon sinks as by-products from forestry are not part of a cost-effective solution under a high reliability concern. Cost savings are reduced due to risk discounting under a reliability concern, in particular when assigning Chebyshev's inequality as compared with a normal probability distribution. It is also shown that the supply of forest sinks on the market depends on the differences in marginal abatement cost between the trading and the non-trading sectors, and in risk discounting between achievements of the ETS cap and the national commitment. Relatively low marginal abatement cost in the non-trading sector and high risk discounting of national commitment achievements increase the supply of sinks in the market and, hence, reduces the equilibrium price. The empirical application illustrates the importance of risk discounting for the magnitude of cost savings obtained from

introducing forest carbon sinks in the EU ETS and national commitments.

Cross-country differences in the effects of oil shocks

- Energy Economics---2012---Gert Peersman, Ine Van Robays

We compare the macroeconomic consequences of several types of oil shocks across a set of industrialized countries that are structurally very diverse with respect to the role of oil and other forms of energy in the economy. The results crucially depend on the underlying source of the oil price shift. When a rise in oil prices is caused by increased global economic activity or a rise in oil-specific demand, almost all countries experience respectively a temporary increase and transitory decline of real GDP. The role of oil and other forms of energy cannot explain the differences in the effects of both shocks across countries. In contrast, this role is very important to explain asymmetries in the effects of exogenous oil supply shocks. Whereas net oil and energy-importing countries typically face a permanent fall in economic activity, the impact is insignificant or even positive in net energy-exporting countries. In addition, countries that improved their net energy-position the most over time, became less vulnerable to oil supply shocks relative to other countries.

Energy substitutability and modernization of energy-consuming technologies

- Energy Economics---2012---Natali Hritonenko, Yuri Yatsenko

The paper examines long-term strategies of capital modernization under different assumptions about embodied technological change, energy regulation, and substitutability between energy and capital. To describe modernization of physical capital, the authors use a vintage capital model with the constant elasticity of substitution between capital and energy. The models take into account (i) availability of new more energy-efficient equipment under energy-saving technical progress, (ii) possibility of buying new capital with

various combinations of energy parameters and prices, (iii) controlled scrapping of obsolete capital, and (iv) energy regulation quotas. The paper analyzes how the elasticity of substitution between capital and energy impacts the capital modernization policy. In particular, it is proven that the optimal lifetime of capital appears to be longer for a larger elasticity.

Efficiency, productivity and environmental policy: A case study of power generation in the EU

- Energy Economics---2012---Jūratė Jaraite-Kažukauskė, Corrado Di Maria

This study uses the EU public power generating sector as a case study to investigate the environmental efficiency and productivity enhancing performance of the European Union's CO₂ Emissions Trading Scheme (EU ETS) in its first phase. Using Data Envelopment Analysis methods, we measure the environmental efficiency and the productivity growth registered in public power generation across the EU over the 1996–2007 period. In the second stage of our analysis we attempt to explain changes in productivity and efficiency over time using econometric techniques. Our analysis suggests two conclusions: carbon pricing led to an increase in environmental efficiency and to a shift outwards of the technological frontier; and, the overly generous allocation of emission permits had a negative impact on both measures. These results are shown to be robust to changes in controls and specifications.

The impact of geologic variability on capacity and cost estimates for storing CO₂ in deep-saline aquifers

- Energy Economics---2012---Jordan K. Eccles, Lincoln Pratson, Richard Newell, Robert B. Jackson

While numerous studies find that deep-saline sandstone aquifers in the United States could store many decades worth of the nation's current annual CO₂ emissions, the likely cost of this storage (i.e. the cost of storage only and not capture and transport costs) has been harder to constrain. We use publicly available data

of key reservoir properties to produce geo-referenced rasters of estimated storage capacity and cost for regions within 15 deep-saline sandstone aquifers in the United States. The rasters reveal the reservoir quality of these aquifers to be so variable that the cost estimates for storage span three orders of magnitude and average >\$100/tonne CO₂. However, when the cost and corresponding capacity estimates in the rasters are assembled into a marginal abatement cost curve (MACC), we find that ~75% of the estimated storage capacity could be available for

The effects of a natural gas boom on employment and income in Colorado, Texas, and Wyoming

- Energy Economics---2012---Jeremy Weber

Improvements in technology have made it profitable to tap unconventional gas reservoirs in relatively impermeable shale and sandstone deposits, which are spread throughout the U.S., mostly in rural areas. Proponents of gas drilling point to the activity's local economic benefits yet no empirical studies have systematically documented the magnitude or distribution of economic gains. I estimate these gains for counties in Colorado, Texas, and Wyoming, three states where natural gas production expanded substantially since the late 1990s. I find that a large increase in the value of gas production caused modest increases in employment, wage and salary income, and median household income. The results suggest that each million dollars in gas production created 2.35 jobs in the county of production, which led to an annualized increase in employment that was 1.5% of the pre-boom level for the average gas boom county. Comparisons show that ex-ante estimates of the number of jobs created by developing the Fayetteville and Marcellus shale gas formations may have been too large.

A critical empirical study of three electricity spot price models

- Energy Economics---2012---Fred Espen Benth, Rüdiger Kiesel, Anna Nazarova

We conduct an empirical analysis of three recently proposed and widely used models for electricity spot price process. The first model, called the jump-diffusion model, was proposed by Cartea and Figueroa (2005), and is a one-factor mean-reversion jump-diffusion model, adjusted to incorporate the most important characteristics of electricity prices. The second model, called the threshold model, was proposed by Roncoroni (2002) and further developed by Geman and Roncoroni (2006), and is an exponential Ornstein–Uhlenbeck process driven by a Brownian motion and a state-dependent compound Poisson process. It is designed to capture both statistical and pathwise properties of electricity spot prices. The third model, called the factor model, was proposed by Benth et al. (2007). It is an additive linear model, where the price dynamics is a superposition of Ornstein–Uhlenbeck processes driven by subordinators to ensure positivity of the prices. It separates the modelling of spikes and base components. We calibrate all three models to German spot price data. Besides employing techniques similar to those used in the original papers we adopt the prediction-based estimating function technique (Sørensen, 2000) and the filtering technique (Meyer-Brandis and Tankov, 2008). We critically compare the properties and the estimation of the three models and discuss several shortcomings and possible improvements. Besides analysing the spot price behaviour, we compute forward prices and risk premia for all three models for various German forward data and identify the key forward price drivers.

Population density and efficiency in energy consumption: An empirical analysis of service establishments

- Energy Economics---2012---Masayuki Morikawa

This study, using novel establishment-level microdata from the Energy Consumption Statistics, empirically analyzes the effect of urban density on energy intensity in the service sector. According to the analysis, the efficiency of energy consumption in service establishments is higher for densely populated cities. Quantitatively, after controlling for differences among industries, en-

ergy efficiency increases by approximately 12% when the density in a municipality population doubles. This result suggests that, given a structural transformation toward the service economy, deregulation of excessive restrictions hindering urban agglomeration, and investment in infrastructure in city centers would contribute to environmentally friendly economic growth.

Biofuel supply chain design under competitive agricultural land use and feedstock market equilibrium

- Energy Economics---2012---Yun Bai,Yanfeng Ouyang,Jong-Shi Pang

The rapid expansion of the biofuel industry diverts a large amount of agricultural crops as energy feedstocks, and in turn affects farm land allocation, feedstock market equilibrium, and agricultural economic development in local areas. In this paper, we propose game-theoretic models that incorporate farmers' decisions on land use and market choice into the biofuel manufacturers' supply chain design problem. A noncooperative bi-level Stackelberg leader-follower game model and a cooperative game model are developed respectively to address possible business partnership scenarios between feedstock suppliers and biofuel manufacturers. The models determine the optimal number and locations of biorefineries, the required prices for these refineries to compete for feedstock resources, as well as farmers' land use choices between food and energy. Using corn as an example of feedstock crops, spatial market equilibrium is utilized to model the relationship between corn supply and demand, and the associated price variations in local grain markets. With linear corn demand functions, we develop a solution approach that transforms the original discrete mathematical program with equilibrium constraints (DC-MPEC) into a solvable mixed integer quadratic programming (MIQP) problem based on Karush-Kuhn-Tucker (KKT) conditions. The proposed methodology is illustrated using an empirical case study of the Illinois State. The computation results reveal interesting insights into optimal land use strategies and supply chain design for the emerging "biofuel economy".

Reverse globalization: Does high oil price volatility discourage international trade?

- Energy Economics---2012---Shiu-Sheng Chen,Kai-Wei Hsu

This paper examines whether higher oil price volatility causes a reversal in globalization. Using a large annual panel data set covering 84 countries all over the world from 1984 to 2008, we investigate the impacts of oil price fluctuations on international trade, namely exports and imports. We present strong and robust evidence that international trade flows will be lower when oil prices fluctuate significantly. We therefore conclude that oil price volatility hurts globalization.

Optimal transmission regulation of an integrated energy market

- Energy Economics---2012---Thomas Tagerås

The capacity of the transmission network determines the extent of integration of a multi-national energy market. Cross-border externalities render coordination of network capacity valuable. Is it then optimal to collect regulatory powers in the hands of a single regulator? Should a common system operator manage the entire network? I show that optimal network governance depends on (i) whether the centralized regulatory agency is able to balance the interests of the different countries; (ii) asymmetries across countries in the gains from market integration; (iii) network characteristics (substitutability versus complementarity); and (iv) the social cost of operator rent.

OPEC news announcements: Effects on oil price expectation and volatility

- Energy Economics---2012---Harald Schmidbauer,Angi Rösch

Several times a year, OPEC hosts conferences among its members to agree on further oil production policies. Prior to OPEC conferences, there is usually rampant speculation about which decision concerning world oil production levels (no change, increase, or cut) will be announced. The purpose of our investigation is to

assess the impact of OPEC announcements on expectation and volatility of daily oil price changes (returns).

Valuing fuel diversification in power generation capacity planning

- Energy Economics---2012---Malte Sunderkötter, Christoph Weber

Deterministic capacity planning problems in electricity systems can be solved by comparing technology specific long-term and short-term marginal costs. In an uncertain market environment, Mean-Variance Portfolio (MVP) theory provides a consistent framework to balance risk and return in power generation portfolios. Focusing on fuel price risks, MVP theory can be adopted to determine the welfare efficient system generation technology mix.

Reforming the power sector in transition: Do institutions matter?

- Energy Economics---2012---Rabindra Nepal, Tooraj Jamasb

This paper aims to investigate the often poorly explored link between power sector reforms and wider institutional reforms in the economy across different groups of transition countries. We use panel-data econometrics based on bias corrected dynamic fixed effect analysis (LSDVC) to assess the impact of reforms on macroeconomic and power sector outcomes. The results indicate that power sector reform is highly inter-dependent with wider reforms in other sectors of the economy. The findings indicate that failure to harmonize inter-sector reforms leads to power sector reform measures being ineffective. We conclude that the success of power sector reforms in developing countries largely depend on the extent to which they synchronize inter-sector reforms in the economy.

Causality between market liquidity and depth for energy and grains

- Energy Economics---2012---Ramazan Sari, Shawkat Hammoudeh, Chia-Lin Chang, Michael McAleer

This paper examines the roles of futures prices of crude oil, gasoline, ethanol, corn, soybeans and sugar in the energy-grain nexus. It also investigates the own- and cross-market impacts for the lagged grain trading volume and the open interest in the energy and grain markets. According to the results, the conventional view, for which the impacts are from oil to gasoline to ethanol to grains in the energy-grain nexus, does not hold well in the long run because the oil price is influenced by gasoline, soybeans and oil. Moreover, gasoline is preceded by only the oil price, and ethanol is not foreshadowed by any of the prices. However, in the short run, a two-way feedback in both directions exists in all markets. The grain trading volume effect across oil and gasoline is more pronounced in the short-run than in the long-run, satisfying both the overconfidence/disposition and the new information hypotheses across markets. The results for the ethanol open interest show that money flows out of this market in both the short- and long-run, but no results suggest across market inflows or outflows to the other grain markets.

Residential electricity consumption in Seattle

- Energy Economics---2012---Thomas Fullerton, David A. Juarez, Adam G. Walke

Recent empirical research for different regions of the United States indicates that residential electricity may be an “inferior” good whose consumption is negatively correlated with income. That is a provocative result that runs counter to what many earlier econometric studies indicate. Given that, it makes sense to examine how electricity consumption behaves in different regional service areas. Even if residential electricity is an inferior good whose usage declines as income rises, there is no guarantee that this will be the case across all service areas. This study examines residential electricity consumption for Seattle, Washington, the largest metropolitan economy in the northwestern region of the United States. Results from a dynamic error correction modeling approach indicate that residential electricity consumption reacts in statistically significant manners to changes in real price, real in-

come, and cold weather. In the short-run, residential electricity is a normal good in this metropolitan economy. In the long-run, residential electricity appears to be an inferior good in Seattle. All else equal, whenever real per capita income growth exceeds 1.2%, per capita residential electricity usage declines in Seattle.

Model based Monte Carlo pricing of energy and temperature Quanto options

- Energy Economics---2012---Massimiliano Caporin, Juliusz Preś, Hipolit Torro

Weather derivatives have become very popular tools in weather risk management in recent years. One of the elements supporting their diffusion has been the increase in volatility observed on many energy markets. Among the several available contracts, Quanto options are now becoming very popular for a simple reason: they take into account the strong correlation between energy consumption and certain weather conditions, so enabling price and weather risk to be controlled at the same time. These products are more efficient and, in many cases, significantly cheaper than simpler plain vanilla options. Unfortunately, the specific features of energy and weather time series do not enable the use of analytical formulae based on the Black-Scholes pricing approach, nor other more advanced continuous time methods that extend the Black-Scholes approach, unless under strong and unrealistic assumptions. In this study, we propose a Monte Carlo pricing framework based on a bivariate time series model. Our approach takes into account the average and variance interdependence between temperature and energy price series. Furthermore, our approach includes other relevant empirical features, such as periodic patterns in average, variance, and correlations. The model structure enables a more appropriate pricing of Quanto options compared to traditional methods.

Rational habits in gasoline demand

- Energy Economics---2012---K Scott

The dynamics of demand for energy goods such as gasoline are complicated by investment decisions and

behavioral habits. Both types of complication can be captured by a habits model, in which past consumption enters into an agent's current utility function. If the agent is forward-looking, or 'rational', then habits imply his consumption of the habit-forming good will be sensitive to his expectation of future market conditions, in particular future prices. This sensitivity implies, in turn, that traditional measures of price elasticity will underproject consumers' responsiveness to policy interventions.

International comparison of industrial CO2 emission trends and the energy efficiency paradox utilizing production-based decomposition

- Energy Economics---2012---Kyunam Kim, Yeonbae Kim

As global concern about climate change increases, the need to control and mitigate greenhouse gas emissions is likely to emerge as a worldwide policy agenda. We determined world-wide carbon dioxide (CO₂) emission trends and six underlying forces driving emissions from the industry sector with production-based decomposition from 1990 to 2006. We also conducted a cross-country analysis in order to identify each country's technical potential for improving its CO₂ intensity. Our model provides more detailed information about the influence of both production technical efficiency and technological change on CO₂ emissions and we show that the relative degree of each country's energy efficiency paradox phenomenon can be identified empirically. As a result, trends show that economic activity change has been the dominant contributor to the growth of CO₂ emissions while changes in potential energy intensity and energy mix have led to emission reduction in almost all OECD and non-OECD countries. In the impacts of production technology (i.e., technical efficiency and technological change), the study reveals mixed results but generally shows that OECD countries diffuse their production technologies more efficiently than do non-OECD countries. From emission mitigation potentials, we also identified that many OECD and non-OECD countries have demonstrated a

reduced potential for mitigation over time.

Energy consumption-GDP nexus: Heterogeneous panel causality analysis

- Energy Economics---2012---K. Ali Akkemik,Koray Göksal

Existing studies examining the Granger causality relationship between energy consumption and GDP use a panel of countries but implicitly assume that the panels are homogeneous. This paper extends the Granger causality relationship between energy consumption and GDP by taking into account panel heterogeneity. For this purpose, we use a large panel of 79 countries for the period 1980–2007. Specifically, we examine four different causal relationships: homogeneous non-causality, homogeneous causality, heterogeneous non-causality, and heterogeneous causality. The results show that roughly seven-tenths of the countries exhibit bi-directional Granger causality, two-tenths exhibit no Granger causality, and one-tenths exhibit uni-directional Granger causality.

Agent-based analysis of the impact of the imbalance pricing mechanism on market behavior in electricity balancing markets

- Energy Economics---2012---Reinier A.C. van der Veen,Alireza Abbasy,Rudi A. Hakvoort

The imbalance pricing mechanism is an important design variable within European-type electricity balancing markets that determines the incentives given to so-called Balance Responsible Parties (BRPs) to balance their electricity production and consumption portfolio. To analyze the impact of alternative imbalance pricing mechanisms on balancing market performance, an agent-based model has been built, in which the BRPs are the agents that decide autonomously in each round on their balancing strategy based on results in past rounds. Six alternative mechanisms are analyzed. It is concluded that aiming for a small long position is generally the preferable BRP strategy. Different imbalance pricing mechanisms lead to comparable system

imbalances, but single pricing results in the lowest imbalance costs for the BRPs and for the market as a whole.

Exploring renewable energy pricing with analytic network process — Comparing a developed and a developing economy

- Energy Economics---2012---Ibrahim Iskin,Tugrul Daim,Gulgun Kayakutlu,Mehmet Altuntas

Increasing use of renewable sources has a vital importance in mitigating increasing energy demand and global warming. The limited reserves and negative environmental impacts associated with fossil fuel consumption make the renewable energy sources considerable alternatives in case environmental externalities are taken into consideration. Pricing models for renewable energy alternatives are commonly based on the same fundamentals as the fossil fuels, but this approach neglects some of the characteristics that are unique to renewable energy alternatives. In order to develop more accurate pricing models these unique variables which are mostly considered as market externalities need to be integrated in the current forms of pricing models. The originality of this work is its ability to combine social, technical, environmental and economic aspects using analytic network process in order to provide a more holistic point of view on factors impacting renewable energy pricing through a comparison of two case studies. United States (U.S.) and Turkey are the two cases analyzed in this paper. U.S. represents a developed economy whereas Turkey represents a developing economy. It is expected that the results of this work would be helpful for further research in understanding the dynamics behind pricing mechanism of the renewable sources in different environments. For instance, fundamental differences in relative importance of pricing factors between two case countries have been identified as different levels of enforcement through laws and regulations, impact of geographic characteristics on site selection and job opportunities created through new investments.

Electricity Futures Prices: Indirect Storability, Expectations, and Risk Premiums

- Energy Economics---2012---Ronald Huisman, Mehtap Kilic

The goal of this paper is to examine to what extent electricity futures prices contain expected risk premiums or have power to forecast spot prices and whether this might be dependent on the type of electricity supply. We analyse futures prices from the Dutch market, a market in which power is produced with storable fossil fuels, and futures prices from the NordPool market, where electricity is mostly produced by hydropower. We show that futures prices from markets in which electricity is predominantly produced by imperfectly storable fuels such as hydro, wind and solar contain information about expected changes in the spot price of electricity, whereas futures prices from markets in which electricity is predominantly produced with perfectly storable fuels contain information about both expected price changes and time-varying risk premiums. These findings provide insight in the applicability of forward price models; one cannot apply the same model to all electricity markets. Forward models for markets with imperfect indirect storability should depend heavily on price expectations and models should include time-varying risk premiums for markets with perfect indirect storability.

Modeling extreme dependence between European electricity markets

- Energy Economics---2012---Erik Lindström, Fredrik Regland

Electricity spot prices are characterized by sudden large movements, followed a few days later by an equally large movement in the opposite direction. These phenomena are called spikes (upward movements) and drops (downward movements). Recent research has suggested that the dynamics of the electricity spot prices can be accurately described by hidden Markov Regime Switching (MRS) models. Regime switch models separate the ordinary dependence and the extreme (spike or drop) dependence. This is a crucial point

since it is the extreme dependence that is of interest when computing risks.

Returns to Scale, Damages to Scale, Marginal Rate of Transformation and Rate of Substitution in DEA Environmental Assessment

- Energy Economics---2012---Toshiyuki Sueyoshi, Mika Goto

This study discusses a new use of DEA (Data Envelopment Analysis) environmental assessment to measure MRT (Marginal Rate of Transformation) and RS (Rate of Substitution) between desirable and undesirable outputs. To discuss MRT and RS, this study first examines a concept of disposability from the perspective of corporate strategies to adapt a regulation change on undesirable outputs. The concept of disposability is separated into natural and managerial disposability. Then, this study explores the computational framework of RTS (Returns to Scale) and DTS (Damages to Scale). The type of RTS is measured within the natural disposability, while the type of DTS is measured within the managerial disposability. Considering the two types of disposability, this study discusses MRT and RS between desirable and undesirable outputs. As an illustrative example, this study applies the proposed approach to evaluate the performance of US coal-fired power plants. This study finds that the regulation policy on NO_x and SO₂ has been effective on their emission controls under US Clean Air Act (CAA). The regulation on CO₂, or a major source of the global warming and climate change, is still insufficient in the United States. Therefore, this study recommends that US federal and local governments should regulate the amount of CO₂ emission under the CAA.

Transportation and storage under a dynamic price cap regulation process

- Energy Economics---2012---Michèle Breton, Mohammed Kharbach

We study the welfare effects of Price Cap Regulation (PCR) and the strategic behavior it may induce in gas transportation networks by analyzing a stylized gas

network within the framework of a multi-period game model under three scenarios: No regulation, a dynamic setting where the price cap adjustment mechanism is not endogenized by the players, and a dynamic setting where it is endogenized by the players.

Is energy intensity important for the productivity growth of EET adopters?

- Energy Economics---2012---Kostas Kounetas, Ioannis Mourtos, Kostas Tsekouras

Energy Efficient Technologies (EET) have attracted strong interest because of their role in reducing environmental damage. Their adoption, however, remains rather low, while their impact on productivity is substantial and differentiating with respect to technological characteristics. Energy intensity, being such an obvious characteristic, could be employed to classify EET adopters thus giving rise to two heterogeneous technologies (i.e. those corresponding to firms of low and high energy consumption). Hence, this paper examines the impact of energy intensity on the productivity growth of firms adopting EET in varying time intervals through a metafrontier-based framework, while also decomposing that impact in terms of technical, efficiency and scale-efficiency changes. The analysis is complemented by examining the role of firm-specific characteristics on the productivity growth through linear regression.

Edgeworth Price Cycles and intertemporal price discrimination

- Energy Economics---2012---Michael D. Noel

In a retail gasoline market exhibiting Edgeworth Price Cycles, prices change asymmetrically with many small decreases interrupted by occasional large increases. The result is a de facto menu of prices from which consumers can choose based on exactly when they buy. This article introduces four classes of purchase timing strategies designed to systematically shift consumer purchases towards the cycle troughs. It shows in the study market of Toronto, Canada, the monetary gains to consumers from optimized timing strategies are as

high as 3.9%. Markups earned from these consumers fall up to 82%. In spite of the gains from timing strategies, surprisingly few consumers use them. Evidence is presented that a main reason is that consumers are not well informed about the cycles. Policy implications are discussed.

Market power analysis for oil pipelines facing excess demand

- Energy Economics---2012---David W. Savitski

The Federal Energy Regulatory Commission may grant market-based rates to oil pipelines in the U.S. upon a showing that they lack market power. The Commission defines market power as the ability to profitably increase price above the competitive level for a significant period. Because comparing tariffs alone is generally meaningless for identifying good transportation alternatives, the Commission tends to rely on netback price and delivered price analyses to evaluate market power. When the applicant's tariff is a poor proxy for the competitive tariff, as evidenced by significant excess demand, using the tariff biases the analysis in favor of finding market power, a reverse cellophane trap. Estimating the competitive tariff to avoid this bias is complicated by the spatial aspect of transportation. This paper suggests several ways to estimate the competitive tariff based on netback and delivered prices, or based on estimated cost, and provides an example.

Natural gas demand at the utility level: An application of dynamic elasticities

- Energy Economics---2012---Leila Dagher

Previous studies provide strong evidence that energy demand elasticities vary across regions and states, arguing in favor of conducting energy demand studies at the smallest unit of observation for which good quality data are readily available, that is the utility level. We use monthly data from the residential sector of Xcel Energy's service territory in Colorado for the period January 1994 to September 2006. Based on a very general Autoregressive Distributed Lag model this paper uses a new approach to simulate the dynamic behavior

of natural gas demand and obtain dynamic elasticities. Knowing consumers' response on a unit time basis enables one to answer a number of questions, such as, the length of time needed to reach demand stability. Responses to price and income were found to be much lower—even in the long run—than has been commonly suggested in the literature. Interestingly, we find that the long run equilibrium is reached relatively quickly, around 18 months after a change in price or income has occurred, while the literature implies a much longer period for complete adjustments to take place.

Contract theory and implications for perennial energy crop contracting

- Energy Economics---2012---Corinne Alexander, Rastislav Ivanic, Stephanie Rosch, Wallace Tyner, Steven Y. Wu, Joshua R. Yoder

This article provides an overview of modern contract theory and discusses the implications of the theory for contracting for perennial dedicated energy crops. We discuss some of the unique challenges of contracting for dedicated energy crops used for the production of advanced biofuels and survey some of the relevant concepts and research from the contract theory literature to address these challenges. We focus primarily on the “mechanism design” or “complete contracts” approach to contracting, which involves optimizing some objective function (e.g. profits, costs, etc.) with respect to contract terms, subject to important incentive constraints. The solution to these optimization problems typically highlight important tradeoffs that a contract designer needs to consider in order to maximize profits and/or minimize costs.

Where does energy R&D come from? Examining crowding out from energy R&D

- Energy Economics---2012---David Popp, Richard Newell

Recent efforts to endogenize technological change in climate policy models demonstrate the importance of accounting for the opportunity cost of climate R&D

investments. Because the social returns to R&D investments are typically higher than the social returns to other types of investment, any new climate mitigation R&D that comes at the expense of other R&D investment may dampen the overall gains from induced technological change. Unfortunately, there has been little empirical work to guide modelers as to the potential magnitude of such crowding out effects. This paper considers both the private and social opportunity costs of climate R&D. Addressing private costs, we ask whether an increase in climate R&D represents new R&D spending, or whether some (or all) of the additional climate R&D comes at the expense of other R&D. Addressing social costs, we use patent citations to compare the social value of alternative energy research to other types of R&D that may be crowded out. Beginning at the industry level, we find no evidence of crowding out across sectors—that is, increases in energy R&D do not draw R&D resources away from sectors that do not perform R&D. Given this, we proceed with a detailed look at alternative energy R&D. Linking patent data and financial data by firm, we ask whether an increase in alternative energy patents leads to a decrease in other types of patenting activity. While we find that increases in alternative energy patents do result in fewer patents of other types, the evidence suggests that this is due to profit-maximizing changes in research effort, rather than financial constraints that limit the total amount of R&D possible. Finally, we use patent citation data to compare the social value of alternative energy patents to other patents by these firms. Alternative energy patents are cited more frequently, and by a wider range of other technologies, than other patents by these firms, suggesting that their social value is higher.

Implementing the EU renewable target through green certificate markets

- Energy Economics---2012---Finn Roar Aune, Hanne Marit Dalen, Cathrine Hagem

The European Parliament has agreed on a target of a 20% share of renewables in the EU's total energy consumption by 2020. To achieve the target, the European

Council has adopted mandatory differentiated national targets for each of the member states. In this paper, we consider the use of green certificates to reach the renewable targets and we analyze the potential for cost reductions by allowing for trade in green certificates across member states. We show that differentiated national targets cannot ensure a cost-effective implementation of the overall target for the EU's renewable energy consumption. Trade in green certificates can ensure a cost-effective distribution of renewable energy production, but the national targets prevent a cost-effective distribution of energy consumption. Nevertheless, our numerical model indicates that EU-wide trade in green certificates may cut the EU's total cost of fulfilling the renewable target by as much as 70% compared with a situation with no trade. However, the design of green certificate markets may have a large impact on the distribution of costs across countries.

The price of policy risk — Empirical insights from choice experiments with European photovoltaic project developers

- Energy Economics---2012---Sonja Lüthi,Rolf Wüstenhagen

Managing the transition to a renewable energy future is an important policy priority in many countries. Solar photovoltaic (PV) technology is expected to make an essential contribution, but due to relatively high cost, its growth to date has been largely driven by public policy, notably feed-in tariffs. Feed-in tariffs have been implemented in various countries, but with widely differing outcomes in terms of installed PV capacity. Previous research indicates that the level of policy risk may be an important driver for differences in renewable energy policy effectiveness. This paper suggests that project developers who make a decision between PV investment opportunities in different countries carefully weigh feed-in tariff-induced returns against a set of policy risks, and choose the country with the most favorable risk-return profile. This model is empirically tested by a stated preference survey among European PV project developers, consisting of 1575 choice decisions by 63 investors. The findings demonstrate that

risk matters in PV policy design, and that a “price tag” can be attached to specific policy risks, such as the duration of administrative processes or uncertainty induced by an approaching capacity cap. Governments can build on these empirical results to design policies that will be effective in attracting private PV investment, while at the same time maintaining efficiency by providing an adequate compensation for policy risk.

Comparison of extended mean-reversion and time series models for electricity spot price simulation considering negative prices

- Energy Economics---2012---Dogan Keles,Massimo Genoese,Dominik Möst,Wolf Fichtner

This paper evaluates different financial price and time series models, such as mean reversion, autoregressive moving average (ARMA), integrated ARMA (ARIMA) and general autoregressive conditional heteroscedasticity (GARCH) process, usually applied for electricity price simulations. However, as these models are developed to describe the stochastic behaviour of electricity prices, they are extended by a separate data treatment for the deterministic components (trend, daily, weekly and annual cycles) of electricity spot prices. Furthermore price jumps are considered and implemented within a regime-switching model. Since 2008 market design allows for negative prices at the European Energy Exchange, which also occurred for several hours in the last years. Up to now, only a few financial and time series approaches exist, which are able to capture negative prices. This paper presents a new approach incorporating negative prices.

The Clean Development Mechanism and low carbon development: A panel data analysis

- Energy Economics---2012---Yongfu Huang,Terry Barker

The Clean Development Mechanism (CDM) of Kyoto Protocol, designed for the industrialized countries to earn emission credits by investing in greenhouse gas (GHG) emission reduction projects in developing countries, shall contribute to emission reductions and

sustainable development in the host countries. However, whether the CDM is achieving its dual goals has been questionable. This research empirically investigates the long-run impacts of CDM projects on CO₂ emission reductions for 80 eligible CDM host countries over 1993–2009. By allowing for considerable heterogeneity across countries, this research provides evidence in support of a decline in CO₂ emissions associated with CDM projects. It serves to encourage developing countries to effectively develop CDM projects towards low carbon development.

Identifying critical supply chain paths that drive changes in CO₂ emissions

- Energy Economics---2012---Yuko Oshita

To address the problem of global warming, it is important to identify the supply chain paths that drive changes in life cycle CO₂ emissions and provide both policy makers and decision makers with the information on the critical paths in order to efficiently reduce the CO₂ emissions. In this article, I extract and analyze the factors and key supply chains involved in changes in CO₂ emissions associated with Japan's overall demand from 1990 to 2000 using the Structural Path Decomposition (SPD) method applied to the 1990–1995–2000 linked Japanese environmental input–output tables at the four-digit commodity classification level. The results reveal that the volume of CO₂ emissions increased as a result of changes in the input structure of the electricity of the services sector, such as “electricity → amusement and recreation facilities → household demand”, “electricity → retail trade → household demand” and “electricity → public administration (local) → local government demand”, indicating increasing dependence of services on energy input. I also find that the final demand shift changed CO₂ emissions, for example the rise in demand for integrated circuits in exports has contributed to increasing CO₂ emissions generated from electricity, the fall in demand for frozen fish and shellfish in household demand has contributed to decreasing CO₂ emissions from marine fisheries.

Why do some emerging economies proactively accelerate the adoption of renewable energy?

- Energy Economics---2012---Ruhul Salim, Shuddhasattwa Rafiq

This article analyses the determinants of renewable energy consumption in a panel of six major emerging economies, namely Brazil, China, India, Indonesia, Philippines and Turkey that are proactively accelerating the adoption of renewable energy. Using Fully modified ordinary least square (FMOLS), Dynamic ordinary least square (DOLS), and Granger causality methods this paper finds that in the long-run, renewable energy consumption is significantly determined by income and pollutant emission in Brazil, China, India and Indonesia while mainly by income in Philippines and Turkey. Causal link between renewable energy and income; and between renewable energy and pollutant emission are found to be bidirectional in the short-run. These results suggest that the appropriateness of the efforts undertaken by emerging countries to reduce the carbon intensity by increasing the energy efficiency and substantially increasing the share of renewable in the overall energy mix.

Optimal path for China's strategic petroleum reserve: A dynamic programming analysis

- Energy Economics---2012---Y. Bai, D.Q. Zhou, P. Zhou, L.B. Zhang, Peng Zhou

This paper proposes a dynamic programming model to explore the optimal stockpiling path for China's strategic petroleum reserve before 2020. The optimal oil acquisition sizes in 2008–2020 under different scenarios are estimated. The effects of oil price, risks and elasticity value on inventory size are further investigated. It is found that the optimal stockpile acquisition strategies are mainly determined by oil price and total inventory costs. While oil supply disruption is not considered, China's optimal stockpile acquisition rate increases from 19.2 to 52million barrels from 2008 to 2020. If an oil supply disruption occurs, the oil acquisition rate will be reduced significantly. However, it may not be a good strategy to interrupt oil reserve activities in

order to minimize the total costs for the entire planning period.

Fuel switching and climate and energy policies in the European power generation sector: A generalized Leontief model

- Energy Economics---2012---Fredrik Pettersson,Patrik Söderholm,Robert Lundmark

The purpose of this paper is to analyze: (a) the role and the nature of price-induced switching behavior between fossil fuels (i.e., coal, oil, and natural gas) in the western European power sector; as well as (b) the fuel choice impacts of a number of public policies implemented in this sector during the last 20 years. The analysis is conducted within a Generalized Leontief cost function framework, and employs pooled data across eight countries over the time period 1978–2004. We present short-run own- and cross-price elasticities of fossil fuel demand, and assess the impacts of a set of government policies implemented over this time period. The empirical results show evidence of notable short-run interfuel substitution between oil and gas, and particularly in countries where fossil fuels are used extensively for both base and peak load purposes. These findings support the notion that ex post fossil fuel substitution takes place in dual- and multi-fired plants, by switching load between different single-fuel fired plants, as well as through the conversion of power plants to be able to burn alternate fuels. The results also illustrate that different public policies – i.e., removal of coal subsidies, electricity market liberalization etc. – have had profound impacts on fossil fuel choices and have in particular favored power generation gas use at the expense of coal. Finally, the paper makes use of the empirical results to simulate the fuel switching impacts of different carbon prices within the European Emissions Trading Scheme (EU ETS).

Energy content in manufacturing exports: A cross-country analysis

- Energy Economics---2012---João Amador

This article compares the energy content in manufacturing exports in a set of 30 advanced and emerging economies and examines its evolution from 1995 to 2005, combining information from the OECD input–output matrices and international trade data in 17 manufacturing sectors. In addition, the article suggests a methodology to disentangle export structure and sectoral energy efficiency effects, presenting results according to technological categories. The article concludes that Brazil, India and, mostly, China, present a high energy content in manufacturing exports, which has increased from 1995 to 2005. Conversely, many advanced economies, notably in Europe and North America, which showed energy contents below the world average in 1995, reinforced their position as exporters with relatively lower energy usage. The contribution of export structure and energy efficiency effects to explain differences in the energy content of exports draws attention to the situation of China. This country increased its relative energy usage in the exports of all technological categories of goods. This effect was reinforced by the stronger export specialization in high-tech products and hindered by a comparatively lower specialization in medium-high-tech products.

Long memory and disaggregated energy consumption: Evidence from fossils, coal and electricity retail in the U.S

- Energy Economics---2012---Nicholas Apergis,Chris Tsoumas

In this paper, the long memory properties of disaggregated fossils, coal and electricity retail consumption in the U.S. over the 1989–2009 period are examined. The presence of long memory is related to autocorrelation persistence of each series. Our results show that there is heterogeneity in the order of integration between these types of energy consumption and for the different sectors employed, which is affected by the inclusion of a break event. The order of integration was generally higher for the case of a break in the intercept than in the slope, with the latter being more plausible for all series.

Decomposition of aggregate CO2 emissions within a joint production framework

- Energy Economics---2012---Xing-Ping Zhang, Ya-Kun Tan, Qin-Liang Tan, Jiahai Yuan

We present an alternative decomposition technique to identify the factors which contribute to the change of aggregate CO2 emissions by using distance functions to model the joint production of desirable and undesirable outputs. The key feature of the proposed approach is the introduction of inputs/outputs factor efficiencies, specified as distance functions, to the decomposition model. By using the proposed approach, the components driving the change of CO2 emissions are decomposed into the contributors from nine factors specified in this paper, and several production technology related components are included. This paper applies the model to data from developing countries. For the 20 developing countries as a whole, empirical results indicate the economic (GDP) growth is the most important contributor to CO2 emission increase, while good output technical change is the most important component to CO2 emission reduction between 1995 and 2005. The empirical results also provide extensive insights into the components driving CO2 emissions for each country between 1995 and 2005.

Oil price, agricultural commodity prices, and the dollar: A panel cointegration and causality analysis

- Energy Economics---2012---Saban Nazlioglu, Ugur Soytaş

This study examines the dynamic relationship between world oil prices and twenty four world agricultural commodity prices accounting for changes in the relative strength of US dollar in a panel setting. We employ panel cointegration and Granger causality methods for a panel of twenty four agricultural products based on monthly prices ranging from January 1980 to February 2010. The empirical results provide strong evidence on the impact of world oil price changes on agricultural commodity prices. Contrary to the findings of many studies in the literature that report neutrality of

agricultural prices to oil price changes, we find strong support for the role of world oil prices on prices of several agricultural commodities. The positive impact of a weak dollar on agricultural prices is also confirmed.

Sustainable economic development and the environment: Theory and evidence

- Energy Economics---2012---Luisito Bertinelli, Eric Strobl, Benteng Zou

The relationship between growth and pollution is studied through a vintage capital model, where new technologies are more environmentally friendly. We find that once the optimal scrapping age of technologies is reached, an economy may achieve two possible cases of sustainable development, one in which pollution falls and another in which it stabilizes, or a catastrophic outcome, where environmental quality reaches its lower bound. The outcome will depend on countries' investment path and their propensity to innovate in environmentally clean technologies, both of which are likely to differ across economies. Empirical results using long time series for a number of developed and developing countries indeed confirm heterogeneous experiences in the pollution-output relationship.

Clustering in crude oil prices and the target pricing zone hypothesis

- Energy Economics---2012---Rakesh Bharati, Susan J. Crain, Vincent Kaminski

This paper studies the target pricing zone (TPZ) hypothesis for crude oil by examining price clustering in the dollar digit. It is hypothesized that price clustering occurs within an established TPZ if OPEC is able to defend the upper and lower bounds through output changes. The results show that prices strongly cluster around the dollar digit value of 9 within the TPZ sub-periods, but not outside the sub-periods. Furthermore, the degree of clustering declines when production capacity utilization is high and when production significantly exceeds quotas, consistent with OPEC's inability to defend the zone. Nine-centered clustering also results in lower contemporaneous and next-day volatility. These

results support the target pricing zone hypothesis of crude oil.

Pollution from the electric power sector in Japan and efficient pollution reduction

- Energy Economics---2012---Kyohei Matsushita, Fumihiko Yamane

Under the scheme of the Kyoto Protocol, there are plans for the efficient reduction of carbon dioxide emissions. In the electric power sector, nuclear power generation, which emits no carbon dioxide in the process of generating electricity, has come under scrutiny. However, this energy produces a new environmental issue: the disposal of radioactive waste. First, we derive shadow prices of carbon dioxide and low-level waste as marginal abatement costs in the case of the electric power sector in Japan, employing a directional output distance function. It is found that the shadow prices are US\$39 per tonne for carbon dioxide and US\$1531 per liter for low-level waste. Secondly, we calculate the indirect Morishima elasticity between carbon dioxide and low-level waste in order to identify their substitutability, and it is found that the substitution of low-level waste for carbon dioxide is easier than the reverse. This result suggests that, with the amount of generated electricity fixed, carbon dioxide can be substituted more easily by low-level waste when the relative price of carbon dioxide increases, for example, as a result of implementation of a carbon dioxide tax or an emissions trading system.

Real-Time Pricing in the Nordic Power markets

- Energy Economics---2012---Maria Kopsakangas Savolainen, Rauli Svento

In this paper we study the potential effects of Real-Time Pricing (RTP) of electricity on the need for long-run capacities in the Nordic Power markets. A characteristic of the Nordic Power market is the large variety of production technologies, of which hydro and nuclear power are capacity constrained. We analyze the impact of RTP on: the need for total, peak and midmerit capacities; total demand; prices; peak demand hours;

and economic welfare. We have also studied whether the results of RTP are sensitive to the simultaneous implementation of tradable emission permits. We find that RTP diminishes the need for total capacity even with inelastic demand. Our results show that even with modest assumptions related to RTP participation, the annual midmerit and peaker capacity efficiency savings amount to 97 million Euros, which are around 6% of their total annual investment costs. The price of the peak demand hour clearly diminishes as the share of the RTP customers increases or demand becomes more price elastic. We compare RTP and tradable emission permits as two separate instruments in reaching energy use efficiencies and show how these two instruments must be seen as complementary and not as substitutable instruments. We show how RTP and tradable emission permits have a positive correlation in promoting market access of renewable energy sources. We find that welfare effects of the implementation of RTP are positive.

The impact of power market structure on CO2 cost pass-through to electricity prices under quantity competition – A theoretical approach

- Energy Economics---2012---Jos Sijm, Yihsu Chen, Benjamin Hobbs

We present a theoretical analysis of the impact of power market structure on the pass-through rate (PTR) of CO2 emissions trading (ET) costs on electricity prices. Market structure refers in particular to the number of firms active in the market and the intensity of oligopolistic competition as measured by the conjectural variation, as well as to the functional form of the power demand and supply curves. In addition, we analyse briefly the impact of other power market-related factors on the PTR of carbon costs to electricity prices. These include in particular the impact of ET-induced changes in the merit order of power generation technologies and the impact of pursuing other market strategies besides maximising generator profit, such as maximising market shares or sales revenues of power companies. Each of these factors can have a significant impact on the rate of passing-through carbon costs to electricity

prices.

Modelling energy spot prices: Empirical evidence from NYMEX

- Energy Economics---2012---Nikos Nomikos,Kostas Andriosopoulos

This paper investigates the behaviour of spot prices in eight energy markets that trade futures contracts on NYMEX. We consider two types of models, a mean-reverting model, and a spike model with mean reversion that incorporates two different speeds of mean reversion; one for the fast mean-reverting behaviour of prices after a jump occurs, and another for the slower mean reversion rate of the diffusive part of the model. We also extend these models to incorporate time-varying volatility in their specification, modelled as a GARCH and an EGARCH process. We compare the relative goodness of fit of the different modelling variations both in sample, using Monte Carlo simulations, as well as out-of-sample, in a Value-at-Risk (VaR) setting. Our results indicate the presence of a “leverage effect” for WTI, Heating Oil and Heating Oil–WTI crack spread, whereas for the remaining energy markets we find the presence of an “inverse leverage” effect. Also, the addition of the EGARCH specification for the volatility process improves both the in-sample fit as well as the out-of-sample VaR performance for most energy markets that we examine.

On the link between forward energy prices: A nonlinear panel cointegration approach

- Energy Economics---2012---Marc Joëts,Valérie Mignon

This paper investigates the relationship between forward prices of oil, gas, coal, and electricity using a nonlinear panel cointegration framework. To this end, we consider a panel of 35 maturities and control for the economic and financial environment using equity futures prices. Estimating the cointegrating relationship, we find that oil, gas and coal forward prices are positively linked, while the negative link between oil and electricity prices is consistent with a substitution

effect between the two energy sources on the long run. Estimating panel smooth transition regression (PSTR) models, we show that the forward oil price adjustment process toward its equilibrium value is nonlinear and asymmetric, putting forward the key role played by self-sustaining dynamics and speculation phenomena.

Are “flexible” taxation mechanisms effective in stabilizing fuel prices? An evaluation considering wholesale fuel markets

- Energy Economics---2012---Marina Di Giacomo,Massimiliano Piacenza,Gilberto Turati

This paper analyses the incidence of specific taxes in fuel markets, and exploits the findings to simulate the effects of government interventions aimed at mitigating oil price fluctuations. Several reduced-form model specifications are estimated to study tax incidence, using wholesale equilibrium prices for both gasoline and motor diesel in the Italian fuel industry over the period 1996–2007 as dependent variables. We then assess the impact on fuel prices stemming from the creation of an automatic fiscal mechanism consisting of reductions in specific taxes matching the rise in oil prices. Our evidence supports the idea that “flexible” taxation mechanisms focused only on excise taxes could not be a viable policy for stabilizing the price level in fuel markets and more complex policies (based also on ad valorem taxes) are needed. Alternative interventions to control prices can be designed focusing on the market structure of these industries, where Antitrust Authority could play a significant role.

Oil price shocks and European industries

- Energy Economics---2012---Bert Scholtens,Cenk Yurtsever

We investigate the impact of oil price shocks at the industry level in the Euro area for the period 1983–2007. We use different oil price specifications and use dynamic VAR models and multivariate regression to investigate how 38 different industries respond to oil price shocks. We pay specific attention to the asymmetry of the industries’ responses regarding oil price increases and

decreases. We find that the impact of oil price shocks substantially differs along the different industries. We find that the significance of this result also differs along the various oil price specifications. The results are quite robust to the way in which we model the problem.

Modularity analysis of the Canadian natural gas sector

- Energy Economics---2012---Vlad Ivanenko

The paper describes the technological process presented as a chain of tasks that natural gas companies in Canada perform to move natural gas products from the geological formation to the final consumer. Investigating the norms the firms use to establish cooperation with clients and suppliers, it shows that the standardization of tasks facilitate arm's length interactions within the chain. The paper studies the distribution of risks in client-supplier pairs and concludes that their asymmetry in risk-taking may be indicative of relative importance that the risk takers assume within the pairs. Finally, the paper touches on the role that federal and provincial governments play in regulated segments of the chain and suggests that government-sponsored standardization may need to get reconciled with market practices.

Capital stock-labor-energy substitution and production efficiency study for China

- Energy Economics---2012---Xuanming Su, Weisheng Zhou, Nakagami, Ken'ichi, Hongbo Ren, Hailin Mu

This study estimates the elasticities of substitution for China from 1953 to 2006 by the two-level constant elasticity of substitution (CES) production function with three factor inputs: capital stock, labor and energy. A technological change rate and non-constant returns to scale are under considered. All possible combinations and two other subdivided periods are carried out respectively and their technological change rates, elasticities of substitution and returns to scale are found. This study also provides an analysis of production efficiency by using marginal productivity of

specific factor input according to the estimated results and distinguishes the marginal productivities deriving from the three different combinations. It suggests that the decision-makers of China need to consider the effects of different factor inputs on GDP growth.

Environmental pricing of externalities from different sources of electricity generation in Chile

- Energy Economics---2012---Claudia Aravena, W. George Hutchinson, Alberto Longo

The rapid increase in electricity demand in Chile means a choice must be made between major investments in renewable or non-renewable sources for additional production. Current projects to develop large dams for hydropower in Chilean Patagonia impose an environmental price by damaging the natural environment. On the other hand, the increased use of fossil fuels entails an environmental price in terms of air pollution and greenhouse gas emissions contributing to climate change. This paper studies the debate on future electricity supply in Chile by investigating the preferences of households for a variety of different sources of electricity generation such as fossil fuels, large hydropower in Chilean Patagonia and other renewable energy sources. Using Double Bounded Dichotomous Choice Contingent Valuation, a novel advanced disclosure method and internal consistency test are used to elicit the willingness to pay for less environmentally damaging sources. Policy results suggest a strong preference for renewable energy sources with higher environmental prices imposed by consumers on electricity generated from fossil fuels than from large dams in Chilean Patagonia. Policy results further suggest the possibility of introducing incentives for renewable energy developments that would be supported by consumers through green tariffs or environmental premiums. Methodological findings suggest that advanced disclosure learning overcomes the problem of internal inconsistency in SB-DB estimates.

Oil exploration and perceptions of scarcity: The fallacy of early success

- Energy Economics---2012---Kristofer Jakobs-son,Bengt Söderbergh,Simon Snowden,Chuan-Zhong Li,Kjell Aleklett

It has been suggested that oil exploration may lead to false perceptions of decreasing scarcity. We perform a simulation of the exploration process using Bayesian updating. The approach enables us to isolate the information effect on the success rate and also to quantify the subjective expectation of the total resource size. The area under exploration consists of a number of regions which may differ in their oil content. Exploration is performed with the goal to maximize the expected success rate. The resulting information about the distribution of oil and the total resource size is assumed public knowledge. A number of scenarios with variations in the dimensions of the area under exploration, the oil distribution and initial beliefs are considered. The results indicate that the information effect on the success rate is significant but brief — it might have a considerable impact on price but is an unlikely mechanism behind a long-term declining price trend. However, the information effect on expectations is gradual and persistent. Since exploration is performed in regions where the expected success rate is the highest, the historical success rate will not be representative of the area as a whole. An explorer will tend to overestimate the total resource size, thereby suggesting an alternative mechanism for false perceptions of decreasing scarcity, a mechanism that could be called the “fallacy of early success”.

A dynamic programming model of China's strategic petroleum reserve: General strategy and the effect of emergencies

- Energy Economics---2012---Gang Wu,Yi-Ming Wei,Chris Nielsen,Xi Lu,Michael B. McElroy

To protect the security of energy supply, China is building national strategic petroleum reserve (SPR). We present a dynamic programming model to determine the optimal stockpiling and drawdown strategies

for China's SPR under various scenarios, focusing on minimizing the total cost of reserves. In contrast to previous research, the oil price given in our model is exogenous on a monthly instead of annual basis, with a view to more realistic simulation of optimal strategies each year. Our model results show that in the case where stockpiling affects oil prices, a given SPR size will be achieved earlier than when stockpiling does not affect oil prices. In different emergency conditions, the optimal stockpiling and drawdown strategies of China's SPR are very different. When an emergency occurs, the shock of stockpiling on the oil price per barrel could range \$0.49–\$6.35, while the impact of drawdown on the oil price per barrel could range \$6.22 to \$0.48.

International coal trade and restrictions on coal consumption

- Energy Economics---2012---David A. Riker

Coal consumption is a major source of CO₂ emissions and other air pollutants and is therefore a focus of environmental policy. However, countries that restrict their coal consumption will likely expand their coal exports to foreign markets with fewer restrictions on consumption. The adjustment in international trade will mitigate the impact on coal industry employment but will also reverse some of the reduction in global emissions. This paper quantifies the impact of restrictions on coal consumption in the United States and several other large countries on global coal consumption, trade, and industry employment. The impact calculations are based on an econometric model of the international coal market. The parameters of the model are fitted to panel data on coal consumption and production in 53 countries.

Estimation of elasticity price of electricity with incomplete information

- Energy Economics---2012---Xavier Labandeira,Jose Labeaga,Xiral López-Otero

The sharp increase in energy prices and growing concern for environmental issues, among other things, are

behind the renewed interest in energy demand estimation. However, there is scarce academic literature that takes real situation of energy suppliers into account: high quality but incomplete data. In this paper, we propose a useful and rather simple instrument for estimating electricity demand with the incomplete and/or imperfect data currently available to suppliers. In particular, using real expenditure and consumption data on electricity, we employ a model of random effects for panel data to estimate residential and industrial electricity demand in Spain.

Efficiency-based rank assessment for electric power industry: A combined use of Data Envelopment Analysis (DEA) and DEA-Discriminant Analysis (DA)

- Energy Economics---2012---Toshiyuki Sueyoshi,Mika Goto

This study discusses a combined use of DEA (Data Environment Analysis) and DEA-DA (Discriminant Analysis) to determine the efficiency-based rank of energy firms. This type of performance evaluation is important because we often have a difficulty in accessing a large sample on energy firms to derive reliable empirical results. The proposed approach is useful in dealing with such a limited number of energy firms, often found in previous DEA studies on energy industries in the world. The proposed approach uses DEA to classify energy firms into efficient and inefficient groups based upon their efficiency scores. Then, it utilizes DEA-DA to assess their efficiency scores and ranks. In this stage, we can find an adjusted efficiency score for each energy firm. The proposed approach provides us with the following analytical capabilities, all of which cannot be found in a conventional use of DEA in assessing energy firms. First, the proposed DEA approach can avoid zero in all multipliers on efficient energy firms by incorporating SCSC (Strong Complementary Slackness Condition) so that it can handle an occurrence of multiple reference sets and multiple projections. The DEA result classifies all energy firms into efficient and inefficient groups. Second, DEA-DA, applied to the two groups, evaluates all energy firms by an industry-

wide evaluation, not depending upon a limited number of efficient energy firms in a reference set, as found in a conventional use of DEA. The analytical capability can reduce the number of efficient energy firms. Third, the proposed approach can provide their efficiency-based ranking scores. Finally, we can conduct a rank sum test based upon their ranking scores to obtain a statistical inference. As an application, this study uses the proposed approach to examine the performance of Japanese electric power industry. We find two economic implications. One of the two implications is that no major change has occurred in the operational performance of Japanese electric power industry because of Japanese sluggish economy from 2005 to 2009. The other implication indicates that there are strategic differences in the operation of Japanese electric power firms after the liberalization.

Returns to scale and damages to scale under natural and managerial disposability: Strategy, efficiency and competitiveness of petroleum firms

- Energy Economics---2012---Toshiyuki Sueyoshi,Mika Goto

Environmental assessment recently becomes a major policy issue all over the world. This study discusses how to use Data Environment Analysis (DEA) for environmental assessment for planning corporate strategy and international competitiveness. An important feature of DEA environmental assessment is that it classifies outputs into desirable (good) and undesirable (bad) outputs because all private and public entities produce not only desirable outputs but also undesirable outputs as a result of their production activities. This study proposes the two types of output unification for DEA environmental assessment by using a non-radial model. One of the two output unifications is that it considers a decrease in an input vector along with a decrease in the vector of undesirable outputs. This type of unification is referred to as “natural disposability”. The other unification considers an increase in an input vector but a decrease in the vector of undesirable outputs. This type of strategy is referred to as “managerial

disposability” . Both unifications increase the vector of desirable outputs. After developing the two concepts on disposability, this study theoretically explores how to measure Returns to Scale (RTS) under natural disposability and Damages to Scale (DTS) under managerial disposability. To document the practicality of the proposed approach, this study applies it to compare the performance of national oil firms with that of international oil companies. This study identifies four important findings on the petroleum industry. First, national oil companies outperform international oil companies in the unified efficiency under natural disposability. Second, international oil companies outperform national oil companies in the unified efficiency under managerial disposability. Third, national oil firms exhibit a mixed result on RTS, while international oil firms exhibit decreasing RTS. Finally, both national and international oil companies exhibit increasing DTS, implying that all oil firms need to decrease their operational sizes for improving their environmental performance on CO2 emission. As an alternative strategy, the result suggests that they need to introduce technology innovation (e.g. clean air technology) into their business operations. The technology based strategy has more practicality than the size reduction in their operations.

Environmental assessment by DEA radial measurement: U.S. coal-fired power plants in ISO (Independent System Operator) and RTO (Regional Transmission Organization)

- Energy Economics---2012---Toshiyuki Sueyoshi,Mika Goto

The economic concept of weak and strong disposability on undesirable outputs dominated the previous discussions on DEA (Data Envelopment Analysis) radial measurement for environmental assessment. This study reexamines the economic concept from the perspective of corporate strategies on how to adapt a regulation change on undesirable outputs. The economic concept of disposability, conventionally accepted by production economists, is replaced by natural and managerial disposability in this study. The natural

disposability implies an environmental strategy that a firm attempts to decrease an input vector to reduce a vector of undesirable outputs. Given the decreased input vector, the firm attempts to increase a vector of desirable outputs as much as possible. This type of strategy indicates negative adaptation. Meanwhile, the managerial disposability indicates an opposite strategy by increasing the input vector. This disposability expresses an environmental strategy by which a firm considers a regulation change on undesirable outputs as a new business opportunity. A firm attempts to improve its unified (operational and environmental) performance by utilizing new technology and/or new management. The strategy indicates positive adaptation. Considering the two types of disposability, this study discusses how to measure unified efficiency under natural and managerial disposability by DEA radial models. To document the practicality of the proposed DEA environmental assessment, this study applies it to compare the performance of U.S. coal-fired power plants under ISOs/RTOs (Independent System Operators/Regional Transmission Organizations) with that of the other power plants not belonging to any organization. This study identifies two empirical findings. One of the two findings is that the latter coal-fired power plants outperform the former power plants belonging to ISOs/RTOs in terms of three efficiency measures. This result indicates that ISOs and RTOs do not provide an effective coordination for coal-fired power plants at the level that can be found in the other power plants. The other finding is that there is technological improvement in the operation of coal-fired power plants.

An analysis of factors that influence the technical efficiency of Malaysian thermal power plants

- Energy Economics---2012---Kok Fong See,Timothy Coelli

The main objectives of this paper are to measure the technical efficiency levels of Malaysian thermal power plants and to investigate the degree to which various factors influence efficiency levels in these plants. Stochastic frontier analysis (SFA) methods are applied to plant-level data over an eight year period from 1998

to 2005. This is the first comprehensive analysis (to our knowledge) of technical efficiency in the Malaysian electricity generation industry using parametric method. Our empirical results indicate that ownership, plant size and fuel type have a significant influence on technical efficiency levels. We find that publicly-owned power plants obtain average technical efficiencies of 0.68, which is lower than privately-owned power plants, which achieve average technical efficiencies of 0.88. We also observe that larger power plants with more capacity and gas-fired power plants tend to be more technically efficient than other power plants. Finally, we find that plant age and peaking plant type have no statistically significant influence on the technical efficiencies of Malaysian thermal power plants.

Weak and strong disposability vs. natural and managerial disposability in DEA environmental assessment: Comparison between Japanese electric power industry and manufacturing industries

- Energy Economics---2012---Toshiyuki Sueyoshi,Mika Goto

The economic concept of weak and strong disposability has long dominated studies on DEA (Data Envelopment Analysis) environmental assessment. This study reviews the two disposability concepts from their conceptual and methodological implications. In particular, this study is interested in the concept of weak disposability because the concept is believed to have an analytical capability to measure an occurrence of “congestion”. The two economic concepts on disposability, accepted by production economists, are replaced by natural and managerial disposability in this study. The natural disposability implies an environmental strategy by which a firm attempts to decrease an input vector to reduce a vector of undesirable outputs. Given the decreased input vector, a firm attempts to increase a vector of desirable outputs as much as possible. This type of strategy indicates negative adaptation. In contrast, the managerial disposability indicates an opposite strategy by increasing the input vector. This disposability expresses an environmental strategy by

which a firm considers a regulation change as a new business opportunity. A firm attempts to improve its unified performance by utilizing new clean air technology and/or new management. The strategy indicates positive adaptation. Considering the two groups of disposability, this study compares between weak/strong disposability and natural/managerial disposability in terms of their conceptual and methodological differences, focusing upon the concept of congestion and technology innovation. Furthermore, using the concept of natural and managerial disposability, this study compares Japanese electric power firms with manufacturing firms. This study finds that the manufacturing firms outperform the electric power firms under natural disposability. An opposite result is found under managerial disposability. This empirical study also finds that the two groups of Japanese firms have attained desirable (good) congestion due to technology innovation. Based upon such empirical results, this study identifies two policy implications. One of the two implications is that the two groups of Japanese industries have attained a high level of technology innovation by a result of environmental regulation. The other is that the electric power industry operates more efficiently to reduce the CO₂ emission than the manufacturing industries.

DEA radial and non-radial models for unified efficiency under natural and managerial disposability: Theoretical extension by strong complementary slackness conditions

- Energy Economics---2012---Toshiyuki Sueyoshi,Mika Goto

This study proposes a use of Data Envelopment Analysis (DEA) for environmental assessment. All radial and non-radial models are discussed under natural and managerial disposability. The natural disposability implies corporate strategy by which a firm attempts to decrease an input vector to decrease a vector of undesirable outputs. Given the decreased input vector, a firm attempts to increase a vector of desirable outputs as much as possible. This type of strategy, supported by economists, indicates negative adaptation to a reg-

ulation change on undesirable outputs. In contrast, the managerial disposability indicates opposite strategy by increasing the input vector. This disposability expresses corporate strategy by which a firm considers the regulation change as a new business opportunity. A firm attempts to improve its performance by utilizing new environmental technology and/or new management. This type of strategy, supported by corporate strategists in U.S. business schools, indicates positive adaptation to the regulation change on undesirable outputs. Using the proposed DEA assessment, this study examines the relationship among energy consumption, economic development and environmental protection in Japanese prefectures. To theoretically extend the use of DEA for environmental assessment, this study incorporates Strong Complementary Slackness Conditions (SCSCs) into the proposed radial models. The incorporation of SCSCs has three methodological strengths. First, DEA/SCSCs can handle an occurrence of multiple reference sets and multiple projections. Second, the incorporation of SCSCs makes it possible to restrict dual variables (multiples) in a specific range without any prior information. Finally, DEA/SCSCs can bypass the conventional procedure (i.e., a radial model combined with an additive model) used for DEA radial measurement.

Permit price dynamics in the U.S. SO2 trading program: A cointegration approach

- Energy Economics---2012---Mohamed Amine Boutabba,Olivier Beaumais,Sandrine Lardic

The aim of this paper is to study empirically the determination and the dynamic behavior of the SO2 permit prices. Previous research focused on ex-post market price analysis without taking weather conditions into account. Therefore, this study attempts to fill a gap in the literature by providing new empirical evidence on the SO2 price evolution and its interactions with macroeconomic variables, microeconomic variables and climate variables. Using monthly data from January 1995 to December 2006, our estimation results indicate the existence of a long-term relationship between SO2 permit price, scrubbing costs, industrial production,

and weather conditions. In the short run, SO2 permit price is affected by scrubbing costs, energy prices, and weather conditions. Policy makers and private investors could benefit from the findings of this study that provides useful information on the characteristics of the SO2 market and may plan their strategy.

Estimating the shadow prices of SO2 and NOx for U.S. coal power plants: A convex nonparametric least squares approach

- Energy Economics---2012---Maethee Mekaroonreung,Andrew Johnson

Weak disposability between outputs and pollutants, defined as a simultaneous proportional reduction of both outputs and pollutants, assumes that pollutants are byproducts of the output generation process and that a firm can “freely dispose” of both by scaling down production levels, leaving some inputs idle. Based on the production axioms of monotonicity, convexity and weak disposability, we formulate a convex nonparametric least squares (CNLS) quadratic optimization problem to estimate a frontier production function assuming either a deterministic disturbance term consisting only of inefficiency, or a composite disturbance term composed of both inefficiency and noise. The suggested methodology extends the stochastic semi-nonparametric envelopment of data (StoNED) described in Kuosmanen and Kortelainen (2011). Applying the method to estimate the shadow prices of SO2 and NOx generated by U.S. coal power plants, we conclude that the weak disposability StoNED method provides more consistent estimates of market prices.

Renewable and non-renewable energy consumption-growth nexus: Evidence from a panel error correction model

- Energy Economics---2012---Nicholas Apergis,James Payne

Unlike previous renewable energy consumption-growth studies, this study examines the relationship between renewable and non-renewable energy consumption and

economic growth for 80 countries within a multivariate panel framework over the period 1990–2007. The Pedroni (1999, 2004) heterogeneous panel cointegration test show a long-run equilibrium relationship between real GDP, renewable energy consumption, non-renewable energy consumption, real gross fixed capital formation, and the labor force with the respective coefficient estimates positive and statistically significant. There is little difference in the elasticity estimates with respect to renewable and non-renewable energy consumption. The results from the panel error correction model reveal bidirectional causality between renewable and non-renewable energy consumption and economic growth in both the short- and long-run. Also, there is bidirectional short-run causality between renewable and non-renewable energy consumption indicative of substitutability between the two energy sources.

Income level and the energy consumption–GDP nexus: Evidence from Sub-Saharan Africa

- Energy Economics---2012---Mulugeta S. Kahsai, Chali Nondo, Peter Schaeffer, Tesfa G. Gebremedhin

This study tests the relationship between energy consumption and economic growth in Sub-Saharan Africa, using a panel co-integration approach. Country-level time series data of energy consumption and economic growth are pooled and used to estimate the model. Sub-Saharan African countries in the sample are classified into low income and middle income countries. The findings support the neutrality hypothesis in the short-run, except for middle income countries, and a strong causation running in both directions is found in the long-run. The different results for low and middle income countries provide evidence of the importance of income level in the causal relationship. This study helps to explain the interdependence of energy consumption and economic growth in Sub-Saharan Africa. Results are critical in formulating sustainable development policies that are geared to the efficient allocation of resources which are expected to increase access to energy services in the study region.

Economic growth and electricity consumption in former Soviet Republics

- Energy Economics---2012---Melike Bildirici, Fazıl Kayıkçı

This study estimates the causal relationship between electricity consumption and economic growth with annual data for the Commonwealth Independent States countries in three groups of income levels. Empirical results reveal that electricity consumption and GDP are cointegrated for all these countries. Furthermore, there is a unidirectional causality from electricity consumption to GDP for all groups in the long run. Effect of electricity consumption on the GDP is negative for the second group of countries which supports the energy conservation policies, whereas it is positive for the first and third group of countries which supports the growth hypothesis.

Wind power learning rates: A conceptual review and meta-analysis

- Energy Economics---2012---Åsa Lindman, Patrik Söderholm

In energy system models endogenous technological change can be introduced by implementing so-called technology learning rates specifying the quantitative relationship between the cumulative experience of a technology and its cost. The objectives of this paper are to: (a) provide a conceptual review of learning curve model specifications; and (b) conduct a meta-analysis of wind power learning rates. This permits an assessment of a number of important specification and data issues that influence these learning rates. The econometric analysis builds on 113 estimates of the learning-by-doing rate presented in 35 studies. The meta-analysis indicates that the choice of the geographical domain of learning, and thus the assumed presence of learning spillovers, is an important determinant of wind power learning rates. We also find that the use of extended learning curve concepts, e.g., integrating public R&D effects, appears to result in lower learning rates than those generated by so-called single-factor learning curve studies. Overall the empirical findings

suggest that future studies should pay increased attention to the issue of learning and knowledge spillovers in the renewable energy field, as well as to the interaction between technology learning and R&D efforts.

A review of uncertainties in technology experience curves

- Energy Economics---2012---Sonia Yeh,Edward S. Rubin

The use of log-linear experience curves (or learning curves) relating reductions in the unit cost of technologies to their cumulative production or installed capacity has become a common method of representing endogenous technical change in energy-economic models used for policy analysis. Yet, there are significant uncertainties in such formulations whose impact on key model results have been insufficiently examined or considered. This paper reviews the major types of uncertainty in log-linear experience curves and their effect on projected rates of cost reduction. Uncertainties are found not only in the learning rate parameter of a log-linear model, but also in the functional form that determines the shape of an experience curve. Evidence for alternative forms such as an S-shaped curve is reviewed along with case studies that demonstrate the uncertainties associated with cost increases during early commercialization of a technology—a phenomena that is widely recognized but rarely quantified or incorporated in learning models. Additional factors discussed include the effects of learning discontinuities, institutional forgetting, and the influence of social, economic and political factors. We then review other models of causality, which aim to improve modelers' ability to explain and predict the influence of other underlying processes that contribute to technology cost reductions in addition to learning. Ignoring other types of underlying mechanisms can create a false sense of precision and overestimate the true contribution of learning. Currently, however, uncertainties in such multi-factor models remain large due to the difficulties of estimating key parameters (such as private-sector R&D investments) and extending models of a specific technology to a broader suite of technologies and cost

projections. Pending the development and validation of more robust models of technological change, we suggest ways to significantly improve the characterization and reporting of current learning model uncertainties and their impacts on the results of energy-economic models to help reduce the potential for drawing inappropriate or erroneous policy conclusions.

The price of wind power in China during its expansion: Technology adoption, learning-by-doing, economies of scale, and manufacturing localization

- Energy Economics---2012---Yueming Qiu,Laura D. Anadon

Using the bidding prices of participants in China's national wind project concession programs from 2003 to 2007, this paper built up a learning curve model to estimate the joint learning from learning-by-doing and learning-by-searching, with a novel knowledge stock metric based on technology adoption in China through both domestic technology development and international technology transfer. The paper describes, for the first time, the evolution of the price of wind power in China, and provides estimates of how technology adoption, experience in building wind farm projects, wind turbine manufacturing localization, and wind farm economies of scale have influenced the price of wind power. The learning curve model presented includes several important control variables, namely, wind resource indicators and steel prices. The results indicate that joint learning from technology adoption and learning-by-doing through cumulative installed capacity, wind turbine manufacturing localization, and wind farm economies of scale comprise the three most significant factors associated with reductions in the price of wind power in China during the period under consideration. The two types of learning investigated are associated with a 4.1%–4.3% price reduction per doubling of installed capacity, providing an estimate of the evolution of the price of wind power, a technology widely used in other markets, which in China has benefited from technology leapfrogging, established supply chains, and operational experience in other countries.

Because of the change of bidding rules in 2007, our estimates can be interpreted as the lower bound of the true joint learning rates. Our model also indicates that most learning about the installation and operation of wind farms was common to the whole industry (i.e., we found little evidence for intra-firm learning). The policies that have contributed to the growth of the Chinese knowledge stock through the promotion of technology adoption are also discussed.

Drilling speed—the relevance of experience

- Energy Economics---2012---Petter Osmundsen, Kristin Roll, Ragnar Tveterås

Drilling expenses have increased sharply in recent years. The productivity of drilling operations – in terms of meters drilled per day – significantly influences exploration costs. Hence it is important to understand the factors that determine drilling productivity. In this study we analyze the effect of different types of experience or learning on offshore drilling productivity. The econometric analysis employs a large data set on exploration wells from the Norwegian Continental Shelf, covering most of its 45-year drilling history. Many other industries have a steep learning curve. A central question here is if learning effects also contribute to increased productivity in petroleum exploration drilling. Furthermore, to what extent do diseconomies associated with reservoir depletion effects and limited acreage counteract learning effects on productivity?

Improving the energy efficiency of buildings: The impact of environmental policy on technological innovation

- Energy Economics---2012---Joëlle Noailly

This paper investigates the impact of alternative environmental policy instruments on technological innovations aiming to improve energy efficiency in buildings. The empirical analysis focuses on three main types of policy instruments, namely regulatory energy standards in buildings codes, energy taxes as captured by energy prices and specific governmental energy R&D expenditures. Technological innovation is measured

using patent counts for specific technologies related to energy efficiency in buildings (e.g. insulation, high-efficiency boilers, energy-saving lightings). The estimates for seven European countries over the 1989–2004 period imply that a strengthening of 10% of the minimum insulation standards for walls would increase the likelihood to file additional patents by about 3%. In contrast, energy prices have no significant effect on the likelihood to patent. Governmental energy R&D support has a small positive significant effect on patenting activities.

Information acquisition as an American option

- Energy Economics---2012---Babak Jafarizadeh

Many information acquisition activities can be postponed within a predefined time-frame. In uncertain situations, the option to postpone the information acquisition to a later, more favorable time may create value. We discuss the value that comes from holding an option to acquire information in a time period and suggest a simulation-based numerical approach to calculate the associated value. We discuss that the value of information in a time period may be very different from the value of information in a single point in time. This value is closely linked to the uncertainty of the decision outcomes over the time period.

A utility based approach to energy hedging

- Energy Economics---2012---John Cotter, Jim Hanly

A key issue in the estimation of energy hedges is the hedgers' attitude towards risk which is encapsulated in the form of the hedgers' utility function. However, the literature typically uses only one form of utility function such as the quadratic when estimating hedges. This paper addresses this issue by estimating and applying energy market based risk aversion to commonly applied utility functions including log, exponential and quadratic, and we incorporate these in our hedging frameworks. We find significant differences in the optimal hedge strategies based on the utility function chosen.

Crude oil price forecasting: Experimental evidence from wavelet decomposition and neural network modeling

- Energy Economics---2012---Rania Jam-mazi,Chaker Aloui

Oil price prediction has usually proved to be an intractable task due to the intrinsic complexity of oil market mechanism. In addition, the recent oil shock and its consequences relaunch the debate on understanding the behavior underlying the expected oil prices. Combining the dynamic properties of multilayer back propagation neural network and the recent Harr A trous wavelet decomposition, a Hybrid model HTW-MPNN is implemented to achieve prominent prediction of crude oil price. While recent studies focus on the determination of the best forecasting model by comparing various neural architectures or applying several decomposition techniques to the ANN, the new insight of this paper is to target the issue of the transfer function selection providing robust simulations on both in sample and out of sample basis. Based on the work of Yonaba, H., Anctil, F., and Fortin, V. (2010) “Comparing Sigmoid Transfer Functions for Neural Network Multistep Ahead Stream flow forecasting” . Journal of Hydrologic Engineering, April, 275–283, we use three variants of activation function namely sigmoid, bipolar sigmoid and hyperbolic tangent in order to test the model’s flexibility. Furthermore, the forecasting robustness is checked through several levels of input–hidden nodes. Comparatively, results of HTW-MBPNN perform better than the conventional BPNN. Our conclusions add a major attribute to the previous studies corroborating the Occam razor’s principle, especially when simulations are constructed through training and testing phases simultaneously. Finally, more eligible forecasting power is found according to the wavelet oil price signal which appears to be the closest to the real anticipations of future oil price fluctuations.

Population aging and carbon emissions in OECD countries: Accounting for life-cycle and cohort effects

- Energy Economics---2012---Tobias Menz,Heinz Welsch

This paper investigates the relationship between emissions of carbon dioxide and the ongoing process of demographic transition in OECD countries. Our research is motivated by suggestions in the literature that emission-relevant consumption patterns may depend on the position in the life cycle and on the birth cohort to which people belong. We augment standard macroeconomic emission regressions by including the age and cohort composition of the population. Our estimation results on a panel of data for 26 countries, spanning the period 1960–2005, suggest that both life-cycle and cohort effects belong in a macroeconomic emission function for carbon dioxide. We find that shifts in both the age and the cohort composition have contributed to rising carbon emissions in OECD countries.

Economics of CCS for coal plants: Impact of investment costs and efficiency on market diffusion in Europe

- Energy Economics---2012---Richard Lohwasser,Reinhard Madlener

In this paper, we analyze how the development of the carbon capture and storage (CCS) technology used in coal-fired power plants affects its market diffusion. Specifically, we (1) show the significant variance in expectations about the economics of commercial-grade CCS hard coal power plants observed in the literature; (2) analyze the impact of CCS economics on electricity generation costs; and (3) investigate the expected deployment of CCS in the European power sector, depending on the variance of two main factors, efficiency and investment cost, using the bottom-up electricity sector model HECTOR. Simulation results show that investment costs strongly influence the market deployment of coal-fired CCS power plants, leading to a share of 16% in European generation capacity by 2025 with the lowest observed investment costs of 1400€/kW, but

only 2% with the highest of 3000€/kW. A variation of conversion efficiency between 37% and 44%, the minimum and maximum observed values, only leads to a 13–15% share variation of CCS-equipped power plants. These findings are robust for the Base Case with a CO₂ price of 43€/t and also for sensitivities with 30 and 20€/t CO₂, but with a lower effect, as the overall share of CCS is significantly reduced at these prices.

The determinants of household energy demand in rural Beijing: Can environmentally friendly technologies be effective?

- Energy Economics---2012---Jingchao Zhang,Koji Kotani

With the recent rapid economic growth, total energy demand in rural China has increased dramatically, and the energy structure is in the transition from non-commercial to commercial sources. Simultaneously, it is expected that households in rural areas will face energy shortages and additional environmental problems unless they have more access to renewable energy technologies. However, little is known about (i) the transition of energy use patterns and (ii) whether introduced technologies have been effective. To analyze these issues, we estimated the energy demands of rural households by using survey data taken from Beijing's ten suburban districts. The data contain information on both non-commercial and commercial energy use, key characteristics of the households and several renewable energy technologies. Our empirical analysis yielded three main results. First, the per capita income is a key factor in the per capita energy consumption. More specifically, the marginal increase (or marginal change) in per capita coal consumption strongly diminishes (or declines) as per capita income increases. Second, coal and liquefied petroleum gas (LPG) prices do not exhibit substitution effects, but an increase in these prices has strong negative effects on the use of these energy resources. Third, renewable energy technologies are identified to reduce coal consumption and to improve energy efficiency. Overall, these findings suggest a positive perspective: if the Chinese govern-

ment were to design appropriate policies associated with renewable energy technologies and related energy prices, then coal consumption can be reduced in the near future, and the substitution to cleaner energy use will accelerate. Therefore, a smooth energy transition in rural China could be made in a more environmentally sustainable manner.

Factors affecting wood energy consumption by U.S. households

- Energy Economics---2012---Nianfu Song,Francisco X. Aguilar,Stephen R. Shifley,Michael E. Goerndt

About 23% of energy derived from woody sources in the U.S. was consumed by households, of which 70% was used by households in rural areas in 2005. We investigated factors affecting household-level wood energy consumption in the four continental U.S. regions using data from the U.S. Residential Energy Consumption Survey. To account for a large number of zero observations (i.e., households that do not burn wood), left-censored Tobit models were estimated. Urban/rural location is a key determinant of level of household wood energy consumption. Wood energy consumption elasticity with respect to non-wood energy price changes was 1.55 at the U.S. level, and a much higher 2.30 among rural households. While household wood energy consumption was affected primarily by non-wood energy price in rural areas, it was influenced mainly by household size and level of income in urban areas. Elasticity of wood energy consumption with respect to income can be positive or negative depending on household urban/rural location, region and income level. Newer houses were found to use less wood energy than older ones, and greater urbanization was found to have negative effect on wood energy use. Our findings suggest that policies reducing relative wood energy cost or increasing non-wood energy prices in the residential sector will result in greater wood energy consumption in the U.S. The effect of policies may vary by region and are likely to be more effective in U.S. rural areas and in the U.S. Midwest in particular.

Estimation of elasticities for domestic energy demand in Mozambique

- Energy Economics---2012---Maria de Fátima S.R. Arthur,Craig A. Bond,Bryan Willson

In Mozambique, households consume a mix of energy sources to satisfy their needs for lighting and cooking and, for wealthier households, other domestic necessities such as refrigeration. The domestic energy mix depends on the prices of the sources and on the capability of the household to invest in the energy-consuming appliances required to satisfy those needs. Based on data from a household survey carried out in Mozambique during 2002/3 (IAF), this paper calculates the price and the income elasticities of demand for domestic energy, using an econometric method developed by Deaton. The calculations are made for all households at the national level, differentiating for urban and rural households, and for the northern households of Mozambique. In the econometric formulation, proxies for the ownership of energy appliances per household are used, allowing a simple evaluation of the effects of asset ownership on the demand for energy. Own- and cross-price elasticities for five individual domestic sources are obtained: low-grade sources such as firewood and charcoal are less elastic (elasticities of 0.41 and 0.28 respectively) than candles, kerosene and electricity (respectively 0.88, 0.79 and 0.60). Income elasticities are respectively 0.45, 0.32, 0.93, 0.84 and 0.69, placing firewood and charcoal as the less responsive to income variations and candles and kerosene as the most responsive. We also comment on the factors influencing domestic energy transition.

Urban energy transition and technology adoption: The case of Tigray, northern Ethiopia

- Energy Economics---2012---Zenebe Gebreegziabher,Alemu Mekonnen,Menale Kassie,Gunnar Köhlin,Menale Kassie Berresaw

Dependency of urban Ethiopian households on rural areas for about 85% of their fuel needs is a significant cause of deforestation and forest degradation, resulting in growing fuel scarcity and higher firewood prices.

One response to reducing the pressure on rural lands is for urban households to switch fuel sources, for example, from wood fuel to electricity, to slow deforestation and forest degradation and reduce indoor air pollution. However, such an energy transition is conditioned on the adoption of appropriate cooking appliances or stove technologies by the majority of users. This paper investigates urban energy transition and technology adoption conditions using a dataset of 350 urban households in Tigray, in northern Ethiopia. Results suggest that the transition to electricity is affected by households adopting the electric mitad cooking appliance, which in turn is influenced by the level of education and income, among other things.

Measuring the welfare effects of reducing a subsidy on a commodity using micro-models: An application to Kuwait's residential demand for electricity

- Energy Economics---2012---Mahmoud A.M. BuShehri,Michael Wohlgenant

This paper provides a conceptual and empirical approach for evaluating the direct benefits and costs that are associated with reforming the price of a subsidized commodity using a micro-model. The welfare analysis is based on two alternative scenarios, a hypothetical percentage increase in the price of the commodity and a hypothetical percentage decrease in the amount of subsidy. The latter is considered to be a simultaneous problem in which the exact price of the commodity that reduces consumption, and subsequently the subsidy to the specific target level needs to be determined first. As a case study, the paper utilizes the most recent Household Expenditure Survey in the State of Kuwait to estimate residential electricity demand for different household groups (i.e., low-, middle-, and high-income), and employs a partial equilibrium model to measure the welfare implications that may result from a reduction in the electricity subsidy rates. The empirical findings show that a small increase in the price of electricity would reduce annual consumption by 4741millionkWh and annual subsidy by US\$734 million. The results also show that the loss in consumers' welfare is ap-

proximately US\$145 million, while the financial and environmental benefits to the society ranges between US\$658 million and US\$889 million. The magnitude of these welfare gains suggests that electricity price reforms combined with a rebate scheme to compensate households for their welfare loss, offsetting any political resistance to reform, is a win-win situation.

Exploring the potential for energy conservation in French households through hybrid modeling

- Energy Economics---2012---Louis-Gaëtan Giraudet,Céline Guivarch,Philippe Quirion

Although the building sector is recognized as having major potential for energy conservation and carbon dioxide emission mitigation, conventional bottom-up and top-down models are limited in their ability to capture the complex economic and technological dynamics of the sector. This paper introduces a hybrid framework developed to assess future household energy demand in France. Res-IRF, a bottom-up module of energy consumption for space heating, has several distinctive features: (i) a clear separation between energy efficiency, i.e. investment in energy efficient technologies, and sufficiency, i.e. changes in the utilization of energy consuming durables which allows the rebound effect to be assessed; (ii) the inclusion of barriers to energy efficiency in the form of intangible costs, consumer heterogeneity parameters and the learning-by-doing process; (iii) an endogenous determination of retrofitting which represents trade-offs between retrofit quantity and quality. Subsequently, Res-IRF is linked to the IMACLIM-R computable general equilibrium model. This exercise shows that, compared to a 37% reduction in final energy demand achievable in business as usual in existing dwellings in 2050, an additional reduction of 21% could be achieved if relevant barriers to efficiency and sufficiency were overcome.

Consumer preferences for automobile energy-efficiency grades

- Energy Economics---2012---Yoonmo Koo,Chang Seob Kim,Junhee Hong,Ie-Jung Choi,Jongsu Lee

Recently, increases in energy prices have made energy conservation and efficiency improvements even more essential than in the past. However, consumers experience difficulty in obtaining reliable information regarding energy efficiency, so that many countries have implemented regulations to enforce energy-efficiency grade labeling. In this study, consumer preferences regarding energy efficiency grades are analyzed by the mixed logit and MDCEV model based on the revealed preference data of past automobile purchases. Findings show that consumers rationally apply information on energy efficiency grades when purchasing automobiles. However, they tend to show inefficiency in automobile usage patterns. This study discusses political implications of energy efficiency policies as they might impact consumer behaviors of automobile purchase and usage.

An empirical study of direct rebound effect for passenger transport in urban China

- Energy Economics---2012---H. Wang,P. Zhou,D.Q. Zhou,Peng Zhou

Transport sector accounts for about 8% of total energy consumption in China and this share will likely increase in the visible future. Improving energy efficiency has been considered as a major way for reducing transport energy use, whereas its effectiveness might be affected by the rebound effect. This paper estimates the direct rebound effect for passenger transport in urban China by using the linear approximation of the Almost Ideal Demand System model and simulation analysis. Our empirical results reveal the existence of direct rebound effect for passenger transport in urban China. A majority of the expected reduction in transport energy consumption from efficiency improvement could be offset due to the existence of rebound effect. We have further investigated the relationship between the magnitude of direct rebound effect and households' expenditure. It was found that the direct rebound effect for passenger transport tends to decline with the increase of per capita household consumption expenditure.

Heterogeneity in the rebound effect: Further evidence for Germany

- Energy Economics---2012---Manuel Frondel,Nolan Ritter,Colin Vance

Rebound effects measure the behaviorally induced offset in the reduction of energy consumption following efficiency improvements. Using both panel estimation and quantile regression methods on household travel diary data collected in Germany between 1997 and 2009, this study investigates the heterogeneity of the rebound effect in private transport. With the average rebound effect being in the range of 57% to 62%, our results are in line with a recent German study by Frondel, Peters, and Vance (2008), but are substantially larger than those obtained from other studies. Furthermore, our quantile regression results indicate that the magnitude of estimated fuel price elasticities – from which rebound effects can be derived – depends inversely on the household's driving intensity: households with low vehicle mileage exhibit fuel price elasticities, and hence rebound effects, that are significantly larger than those for households with high vehicle mileage.

Distribution charges for consumers and microgeneration considering load elasticity sensitivity

- Energy Economics---2012---Paulo E. Steele Santos,Jose W. Marangon Lima,Rafael C. Leme,Tiago G. Leite Ferreira

This paper presents an approach for calculating a tariff for electrical energy distribution systems. The methodology is similar to the standard tariff-calculation method used in Brazil. The approach combines the concepts of time-of-use tariffs and Ramsey prices. The process, initially designed for energy consumers, can be used to establish tariffs for micro-generation units. The resulting regulated distribution tariffs, for both consumer and generation units, has an hourly signal associated with long-run marginal costs. Moreover, while minimizing any loss of social benefits, the tariffs comply with the revenue reconciliation constraint. The

proposed approach is applied to a real Brazilian distribution system and compared to the current procedure used by the Brazilian Electricity Regulatory Agency.

Energy consumption, output and trade in South America

- Energy Economics---2012---Perry Sadorsky

This study uses panel cointegration regression techniques to examine the relationship between energy consumption, output and trade in a sample of 7 South American countries covering the period 1980 to 2007. Panel cointegration tests show a long-run relationship between 1) output, capital, labor, energy, and exports and 2) output, capital, labor, energy, and imports. Short-run dynamics show a bi-directional feedback relationship between energy consumption and exports, output and exports and output and imports. There is evidence of a one way short-run relationship from energy consumption to imports. In the long-run there is evidence of a causal relationship between trade (exports or imports) and energy consumption. These results have implications for energy policy and environmental policy. One important implication of these results is that environmental policies designed to reduce energy use will reduce trade. This puts environmental policy aimed at reducing energy consumption at odds with trade policy.

Explaining the (non-) causality between energy and economic growth in the U.S.—A multivariate sectoral analysis

- Energy Economics---2012---Christian Gross

The rapidly growing literature on the relationship between energy consumption and economic growth has not univocally identified the causal relationship yet. We argue that bivariate models, which analyze the causality only at the macro level, are eventually misleading, especially in cases where both variables do not cover the same scope of economic activity. After discussing appropriate pairs of variables, we investigate Granger causality between energy and growth in the U.S. for the period from 1970 to 2007 for three sectors,

industry, commercial sector, transport, as well as on the macro level. Using the recently developed ARDL bounds testing approach by Pesaran and Shin (1999) and Pesaran et al. (2001), we find evidence for unidirectional long-run Granger causality in the commercial sector from growth to energy, as well as evidence for bi-directional long-run Granger causality in the transport sector. The dependence of causality on the level of aggregation is interpreted as evidence for ‘Simpsons’ Paradox’. The choice of control variables is based on findings from the Environmental Kuznets Curve literature: we find that controlling for the increasing energy productivity of production as well as trade significantly improves the fit of the bivariate model.

The electricity consumption versus economic growth of the Polish economy

- Energy Economics---2012---Henryk Gur-gul,Łukasz Lach

The aim of this contribution is an investigation of causal interdependences between electricity consumption and GDP in Poland. Our research was conducted for total electricity consumption as well as for the industrial consumption of electricity. In order to reflect the causality between GDP and electricity consumption properly we performed our investigations in a three-dimensional framework with employment chosen as an additional variable. We used reliable quarterly data from the period Q1 2000–Q4 2009. In order to check the stability of the causalities the investigations were performed on two samples: a full sample and a pre-crisis (i.e. Q1 2000–Q3 2008) subsample. We applied both traditional methods and some recently developed econometric tools.

Energy consumption and economic growth nexus in Portugal, Italy, Greece, Spain and Turkey: An ARDL bounds test approach (1965–2009)

- Energy Economics---2012---José Fuinhas,António Marques

The paper examines the nexus between primary energy

consumption and growth in Portugal, Italy, Greece, Spain and Turkey (PIGST), with annual time series data, from 1965 to 2009. PIGST are southern European economies which have experienced several episodes that make them of particular interest to the study of periods of economic expansion and stagnation. An ARDL bounds test approach is a suitable technique to examine energy-growth nexus, within the context of countries with both sporadic shocks (outliers) and permanent shocks (structural breaks). Empirical results suggest bidirectional causality between energy and growth in both the long-run and short-run, supporting the feedback hypothesis. The results reveal themselves to be robust to panel framework. An energy conservation policy will reduce GDP growth, while a saving phenomenon is observed, since one additional unit of product requires less than one unit of energy.

Coal consumption, CO2 emission and economic growth in China: Empirical evidence and policy responses

- Energy Economics---2012---Harry Bloch,Shuddhasattwa Rafiq,Ruhul Salim

This article investigates the relationship between coal consumption and income in China using both supply-side and demand-side frameworks. Cointegration and vector error correction modeling show that there is a unidirectional causality running from coal consumption to output in both the short and long run under the supply-side analysis, while there is also a unidirectional causality running from income to coal consumption in the short and long run under the demand-side analysis. The results also reveal that there is bi-directional causality between coal consumption and pollutant emission both in the short and long run. Hence, it is very difficult for China to pursue a greenhouse gas abatement policy through reducing coal consumption. Switching to greener energy sources might be a possible alternative in the long run.

Regulation and electricity market integration: When trade introduces inefficiencies

- Energy Economics---2012---Etienne Billette de Villemeur,Pierre-Olivier Pineau

Electricity markets vary greatly across jurisdictions, in terms of regulatory institutions, cost levels and environmental impacts. Integrating such different markets can lead to significant changes. This paper considers two jurisdictions, one with a regulated monopoly selling at average cost and one with a competitive market, and compares three different institutional regimes: autarky, a mixed-market structure with trade and a fully integrated market, where electricity is sold everywhere at marginal cost. We show that, in the second regime, the regulated monopoly always exports toward the jurisdiction pricing at marginal cost, up to inducing productive inefficiencies. By contrast, a shift from the second to the third regime, i.e. “integrated deregulation” yields a decrease in overall consumption. We identify the exact conditions under which the shift from one regime to the other results in environmental gains.

The economics of storage, transmission and drought: integrating variable wind power into spatially separated electricity grids

- Energy Economics---2012---Hugh Scoriah,Amy Sopinka,Gerrit van Kooten

To mitigate the high variability of wind and make it a more viable renewable energy source, observers recommend greater integration of spatially-separated electrical grids, with high transmission lines linking load centers, scattered wind farms and hydro storage sites. In this study, we examine the economics of integrating large-scale wind energy into a grid characterized by fossil fuel thermal generation (Alberta) that is only weakly linked to one characterized by hydro-electric assets and the ability to store power behind hydro dams (British Columbia). We use a mathematical programming model to investigate the impact of increasing the capacity of the transmission link between the two disparate grids, which has not been

done previously, and thereby shedding light on the issue of greater grid integration as a means of addressing intermittent renewable power. We find that, as wind capacity increases, costs of reducing CO₂ emissions fall with increased transmission capacity between the grids, although this does not hold in all cases. Costs of reducing CO₂ emissions are lowest during periods of drought. Over all scenarios, emission reduction costs vary between \$20 and \$60/t of CO₂.

Efficiency effects of observed and unobserved heterogeneity: Evidence from Norwegian electricity distribution networks

- Energy Economics---2012---Christian Growitsch,Tooraj Jamasb,Heike Wetzel

Since the 1990s, efficiency and benchmarking analysis has increasingly been used in network utilities research and regulation. A recurrent concern is the effect of observable environmental factors that are beyond the influence of firms and unobserved factors that are not identifiable on measured cost and quality performance of firms. This paper analyses the effect of observed geographic and weather factors and unobserved heterogeneity on a set of 128 Norwegian electricity distribution utilities for the 2001–2004 period. We utilise data on 78 geographic and weather variables to identify real economic inefficiency while controlling for observed and unobserved heterogeneity. We use the Factor Analysis technique to reduce the number of environmental factors into few composite variables and to avoid the problem of multicollinearity. In order to identify firm-specific inefficiency, we then estimate a pooled version of the established stochastic frontier model of Aigner et al. (1977) and the recent true random effects model of Greene (2004; 2005a,b) without and with environmental variables. The results indicate that the observed environmental factors have a rather limited influence on the utilities' average efficiency and the efficiency rankings. Moreover, the difference between the average efficiency scores and the efficiency rankings among the pooled and the true random effects models imply that the type of SFA model used is highly influencing the efficiency estimates.

How to fit demand side management (DSM) into current Chinese electricity system reform?

- Energy Economics---2012---Yongzhen Yu

DSM is one of the best and most practical policy tools available to China for balancing environmental protection and economic growth. The new round of electricity system reform provides a good opportunity to consolidate and integrate DSM policy and expedite its development and implementation. DSM policy can be upgraded by incorporating it into the current electricity system reform. Comparing the potential acceleration of electricity price reform with the possibility of imposing a System Benefit Charge (SBC), the author argues that support for a SBC would be much easier to gather among policymakers and stakeholders in a short time and would have a much better policy effect in the current situation. The author discusses three kinds of price discrimination related to the DSM development in China: time-based electricity pricing, electricity price discrimination for industrial structure adjustment in China (Fujian Province as a case), and direct power purchases by large customers and preferential tariff policy. These can be well designed to be combined with DSM and energy efficiency policy.

Optimum policy for integration of renewable energy sources into the power generation system

- Energy Economics---2012---M. Suruz Miah,N.U. Ahmed,Monjur Chowdhury

In this paper we propose a dynamic model representing the temporal evolution of the levels of power generation (installed capacity) from two competing sources. These are renewable and conventional (fossil) sources. The percentage penetration rates of renewable and nonrenewable sources are considered as control or decision variables. We introduce an objective functional based on energy demand, production of pollution associated with usage of fossil fuels, and the cost of their systematic substitution by renewable sources. Pontryagin minimum principle is used to determine optimal control policy through minimizing energy generation from

fossil fuels while meeting the energy demand as closely as possible through gradual replacement of nonrenewable sources by renewable ones. For different choices of plan periods, optimal generation path along with the corresponding control policies are presented. These results demonstrate that modern control theory can be used effectively to formulate optimal socio-economic policies.

Power marketer pricing behavior in the California Power Exchange

- Energy Economics---2012---Tyler Hodge,Carol Dahl

Various studies have examined whether market power abuses by independent electricity generators contributed to the demise of the California Power Exchange (PX). However, the behavior of wholesale power marketers has generally been overlooked. To fill this gap, our paper focuses on the pricing behavior of five major power marketers in the California PX during 2000: Duke Energy Trading & Marketing, Reliant Energy Services, Dynegy Power Marketing, Enron Power Marketing, and Williams Energy Marketing & Trading. Our unique data set, collected by the Federal Energy Regulatory Commission during an investigation of energy market pricing manipulation, allows us to assess the level of market power using the conduct parameter pricing model. The estimated conduct parameter allows us to determine power marketer pricing behavior is competitive, Cournot, or collusive. Our results indicate that Duke Energy and Reliant were exercising market power when pricing the wholesale electricity they sold in the California PX during 2000. No statistical evidence was uncovered to show that the smaller marketers – Dynegy, Williams and, Enron – were setting prices at a level higher than those consistent with a competitive market.

A data envelopment analysis-based framework for the relative performance evaluation of competing crude oil prices' volatility forecasting models

- Energy Economics---2012---Bing Xu,Jamal Oueniche

Forecasts of crude oil prices' volatility are important inputs to many decision making processes in application areas such as macroeconomic policy making, risk management, options pricing, and portfolio management. Despite the fact that a large number of forecasting models have been designed to forecast crude oil prices' volatility, so far the relative performance evaluation of competing forecasting models remains an exercise that is unidimensional in nature. To be more specific, most studies tend to use several criteria and their measures to assess the relative performance of these models, but competing models are always ranked by performance measure; thus, leading in general to different rankings for different criteria and to a situation where one cannot make an informed decision as to which model performs best with respect to all criteria under consideration. The purpose of this paper is to propose a single ranking that takes account of several criteria using a Data Envelopment Analysis framework. Our empirical results reveal that the unidimensional rankings for different criteria might differ significantly and that the multidimensional ranking of some models could be substantially different from their unidimensional rankings, which highlights the importance of the proposed performance evaluation tool.

A metric and topological analysis of determinism in the crude oil spot market

- Energy Economics---2012---John Barkoulas,Atreya Chakraborty,Arav Ouandlous

We test whether the spot price of crude oil is determined by stochastic rules or exhibits deterministic endogenous fluctuations. In our analysis, we employ both metric (correlation dimension and Lyapunov exponents) and topological (recurrence plots) diagnostic

tools for chaotic dynamics. We find that the underlying system for crude oil spot prices (i) is of high dimensionality (no stabilization of the correlation dimension), (ii) does not exhibit sensitive dependence on initial conditions, and (iii) is not characterized by the recurrence property. Thus, the empirical evidence suggests that stochastic rather than deterministic rules are present in the system dynamics of the crude oil spot market. Recurrent plot analysis indicates that volatility clustering is an adequate, but not complete, explanation of the morphology of oil spot prices.

A critical view on temperature modelling for application in weather derivatives markets

- Energy Economics---2012---Jūratė Šaltytė Benth,Fred Espen Benth

In this paper we present a stochastic model for daily average temperature. The model contains seasonality, a low-order autoregressive component and a variance describing the heteroskedastic residuals. The model is estimated on daily average temperature records from Stockholm (Sweden). By comparing the proposed model with the popular model of Campbell and Diebold (2005), we point out some important issues to be addressed when modelling the temperature for application in weather derivatives market.

Oil price uncertainty and the Canadian economy: Evidence from a VARMA, GARCH-in-Mean, asymmetric BEKK model

- Energy Economics---2012---Sajjadur Rahman,Apostolos Serletis

In this paper we build on recent work by Elder and Serletis (2010, forthcoming) and Rahman and Serletis (forthcoming) and investigate the relationship between oil price uncertainty and the level of economic activity, using quarterly Canadian data over the period from 1974:1 to 2010:1. In doing so, we use a bivariate VARMA, GARCH-in-Mean, asymmetric BEKK model, as detailed in Engle and Kroner (1995), Grier et al. (2004), and Shields et al. (2005). We show that the conditional variance-covariance process underlying

output growth and the change in the real price of oil exhibits significant non-diagonality and asymmetry. We also present evidence that increased uncertainty about the change in the real price of oil is associated with a lower average growth rate of real economic activity in Canada, consistent with the results in Elder and Serletis (2010, forthcoming) and Rahman and Serletis (forthcoming) for the United States and Elder and Serletis (2009) for Canada. Our results are robust to alternative measures of the price of oil, alternative measures of the level of economic activity, and alternative data frequencies.

On the impacts of oil price fluctuations on European equity markets: Volatility spillover and hedging effectiveness

- Energy Economics---2012---Mohamed Arouri,Jamel Jouini,Duc Khuong Nguyen

The objective of this paper is to investigate the volatility spillovers between oil and stock markets in Europe. As not all industries are expected to be equally affected by oil price changes, we conduct our study at both the aggregate as well as sector levels. Empirically, we make use of a recently developed VAR–GARCH approach which allows for transmissions in volatilities. In addition, we analyze the optimal weights and hedge ratios for oil–stock portfolio holdings based on our results. On the whole, our findings show significant volatility spillovers between oil price and sector stock returns, and suggest that a better understanding of those links is crucial for portfolio management in the presence of oil price risk.

A nonparametric GARCH model of crude oil price return volatility

- Energy Economics---2012---Aijun Hou,Sandy Suardi

The use of parametric GARCH models to characterise crude oil price volatility is widely observed in the empirical literature. In this paper, we consider an alternative approach involving nonparametric method to model and forecast oil price return volatility. Focusing on two

crude oil markets, Brent and West Texas Intermediate (WTI), we show that the out-of-sample volatility forecast of the nonparametric GARCH model yields superior performance relative to an extensive class of parametric GARCH models. These results are supported by the use of robust loss functions and the Hansen’s (2005) superior predictive ability test. The improvement in forecasting accuracy of oil price return volatility based on the nonparametric GARCH model suggests that this method offers an attractive and viable alternative to the commonly used parametric GARCH models.

Coordinating cross-border congestion management through auctions: An experimental approach to European solutions

- Energy Economics---2012---Céline Jullien, Virginie Pignon,Stéphane Robin,Carine Staropoli

Competition among producers within an integrated electricity system is impeded by any limited transmission capacity there may be at its borders. Two alternative market mechanisms have recently been designed to organize the allocation of scarce transmission capacity at cross-border level: (i) the “implicit auction”, already used in some countries, and (ii) the “coordinated explicit auction”, proposed by the European Transmission System Operators (ETSO) but not yet implemented. The main advantage of the explicit auction is that it allows each country to keep its own power exchange running. In the European institutional context, this is seen as a factor of success of a market reform, although the explicit auction (not coordinated) is known to be less efficient than the implicit mechanism. The addition of a coordination dimension in the explicit auction is intended to solve problems of international flows. We use the experimental methodology to identify and compare in a laboratory setting the efficiency properties of these two market mechanisms, given a market structure similar to the existing one in continental Europe, i.e. a competitive oligopoly. Our main result highlights the inefficiency of the coordinated explicit auction compared to the performance of the implicit auction, measured in terms of both en-

ergy prices and transmission capacity allocation. We suggest that the poor performance of the coordinated explicit auction in the laboratory is due to the level of individual expectations about both energy and transmission prices that the mechanism demands. One solution to resolve this problem when the mechanism is implemented in the field would be to design an additional and secondary market for “used” transmission capacity.

How much should we pay for interconnecting electricity markets? A real options approach

- Energy Economics---2012---Álvaro Cartea, Carlos González-Pedraz

An interconnector is an asset that gives the owner the option to transmit electricity between two locations. In financial terms, the value of an interconnector is the same as a strip of real options written on the spread between power prices in two markets. We model the spread based on a seasonal trend, mean-reverting Gaussian process, and mean-reverting jump process and express the value of these real options in closed-form. The valuation tool is applied to five pairs of European neighboring markets to value a hypothetical one-year lease of the interconnector using different assumptions about the seasonal component of the spread, and different liquidity caps which proxy for the depth of the interconnected power markets. We derive no-arbitrage lower bounds for the value of the interconnector in terms of electricity futures contract and find that, depending on the depth of the market, the jumps in the spread can account for between 1% and 40% of the total value of the interconnector. The two markets where an interconnector would be most (resp. least) valuable are Germany and The Netherlands (resp. France and Germany). Finally, we provide rules of thumb to interpret the different interconnector values.

Investment in new power generation under uncertainty: Benefits of CHP vs. condensing plants in a copula-based analysis

- Energy Economics---2012---Günther Westner, Reinhard Madlener

In this paper, we apply a spread-based real options approach to analyze the decision-making problem of an investor who has the choice between an irreversible investment in a condensing power plant without heat utilization and a plant with combined heat-and-power (CHP) generation. Our investigation focuses on large-scale fossil-fueled generation technologies and is based on a stochastic model that uses copula functions to provide the input parameters of the real options model. We define the aggregated annual spread as assessment criteria for our investigation since it contains all relevant volatile input parameters that have an impact on the evaluation of investment decisions. We show that the specific characteristics of CHP plants, such as additional revenues from heat sales, promotion schemes, specific operational features, and a beneficial allocation of CO₂ allowances, have a significant impact on the option value and therefore on the optimal timing for investment. For the two fossil-fueled CHP technologies investigated (combined-cycle gas turbine and steam turbine), we conclude from our analysis that a high share of CHP generation reduces the risk exposure for the investor. The maximal possible CHP generation depends significantly on the local heat demand in the surroundings of the power plant. Considering this, the size of the heat sink available could gain more relevance in the future selection process of sites for new large-scale fossil power plants.

Irreversible investment, uncertainty, and ambiguity: The case of bioenergy sector

- Energy Economics---2012---Pierre-André Jouvet, Elodie Le Cadre, Caroline Orset

We analyze production and investment decisions of an agent in industrial activities that are characterized by two forms of uncertainty: demand uncertainty (in terms of number of buyers) and competitive effect uncertainty (in terms of other energy resource). We apply our model on the bioenergy industries. We compare the case of an ambiguity neutral agent with that of an ambiguity averse agent. We show that the investment decision of an agent depends on the effects of both the capital investment and the level of production on the

cost and the uncertainty the agent is confronted with. Moreover, we find that ambiguity aversion tends to decrease the agent's optimal levels of production and investment. Our numerical analysis of the French case illustrates the different effects associated with demand uncertainty and competitive effect uncertainty.

Electricity capacity investment under risk aversion: A case study of coal, gas, and concentrated solar power

- Energy Economics---2012---Lin Fan,Catherine Norman,Anthony G. Patt

The policy instrument many economists favor to reduce greenhouse gas emissions and to shift new investment towards low carbon technologies is the tradable allowance system. Experience with this instrument has been mixed, with a crucial design issue being the choice of whether to auction allowances to firms, or to grandfather them based on historical emissions. In this paper, we examine the changing incentives of investment in different technologies, when investors are risk averse and are expecting an allowance system with a certain allocation rule but do not know if the policy is going to take place in the near future. Investors also cannot fully predict future investment costs for the low-carbon technology. We apply a game theoretic model to examine the combined effects of uncertainty and risk aversion on the actions of potential investors into high and low carbon generating capacity, under both allocation rules and uncertain costs. We find that uncertainty and risk aversion do have implications towards investment incentives. We discuss policy implications of these findings.

The inevitability of capacity underinvestment in competitive electricity markets

- Energy Economics---2012---Irena Milstein,Asher Tishler

Very tight generation capacity (‘underinvestment’) in competitive electricity markets is a major concern to policymakers. Employing a model with endogenous capacity, capacity mix, operations and with uncertain

demand we show that ‘underinvestment’ is due to the rational (non-abusive) behavior of profit-seeking producers and other market participants. Instead of building new capacity that will be idle during most of the year, electricity producers let the electricity price spike (price spikes ‘substitute’ for capacity). These results hold true when each electricity producer is allowed to construct and operate only one (base or peaking) generation technology or both, although capacity mix, industry profits and consumer surplus may differ substantially between these two market structures. We also show, for both market structures, how CO2 taxes affect consumer surplus and the industry's optimal capacity, capacity mix and profits, and demonstrate that total welfare gains from the CO2 tax may be substantial. Finally, we provide the regulator with easy-to-use tools to decide which market structure is to be preferred in terms of social welfare.

A simple dynamic energy capacity model

- Energy Economics---2012---James P. Gander

I develop a simple dynamic model showing how total energy capacity is allocated to two different uses and how these uses and their corresponding energy flows are related and behave through time. The control variable of the model determines the allocation. All the variables of the model are in terms of a composite energy equivalent measured in BTU's. A key focus is on the shadow price of energy capacity and its behavior through time. Another key focus is on the behavior of the control variable that determines the allocation of overall energy capacity. The matching or linking of the model's variables to real world U.S. energy data is undertaken. In spite of some limitations of the data, the model and its behavior fit the data fairly well. Some energy policy implications are discussed.

The emergence and evolution of regional convergence clusters in China's energy markets

- Energy Economics---2012---Hengyun Ma,Les Oxley

Employing the new regression tests for Convergence,

Club Convergence and Clustering proposed by Phillips and Sul (2007), this paper models and analyses the behaviour of China's energy sectors. Energy market 'convergence clusters' are identified using new price data, and their regional spatial distributions are mapped for four major fuel types: coal, gasoline, diesel and electricity. The findings are as follows: i) as yet, there are no fully integrated national energy markets in China, as more than one convergence cluster is identified for all four fuels; ii) some regional energy markets can be regarded as 'quite mature,' as evidenced by the existence of some highly concentrated convergence clusters connected geographically; iii) some regional markets remain in a 'state of transition,' as witnessed by convergence clusters that are scattered geographically and that are growing in membership; iv) it seems that there is more regional-based integration for coal and electricity than for gasoline and diesel, as more convergent clusters were identified for coal and electricity than for gasoline and diesel; and v) overall, China still appears to be in the process of energy market integration, as demonstrated by the number and evolution of convergence clusters over time.

Will history repeat itself? Economic convergence and convergence in energy use patterns

- Energy Economics---2012---Michael Jakob, Markus Haller, Robert Marschinski

In this paper, a difference-in-differences estimator on panel data for 30 developing and 21 industrialized countries is employed over the period 1971–2005 to examine how patterns of energy use (characterized by the consumption of primary energy carriers, sectoral energy use and carbon emissions) are changing in the process of economic development. For the average developing country in our sample, the results indicate that economic catch-up has been accompanied by above-average growth of the use of most primary energy carriers, the consumption of final energy in most sectors and total CO₂ emissions. For industrialized countries, we find that economic growth is partially decoupled from energy consumption and that above average rates of economic growth were accompanied by

larger improvements in energy efficiency. These results emphasize the need to identify the relevant engines of economic growth, their implications for energy use and possibilities to achieve low-carbon growth centered on productivity and efficiency improvements rather than on capital accumulation.

The globalization of steam coal markets and the role of logistics: An empirical analysis

- Energy Economics---2012---Aleksandar Zaklan, Astrid Cullmann, Anne Neumann, Christian von Hirschhausen

In this paper, we provide a comprehensive multivariate cointegration analysis of three parts of the steam coal value chain — export, transport and import prices. The analysis is based on a rich dataset of international coal prices; in particular, we combine data on steam coal prices with freight rates, covering the period December 2001 until August 2009 at weekly frequency. We then test whether the demand and supply side components of steam coal trade are consistently integrated with one another. In addition, export and import prices as well as freight rates for individual trading routes, across regions and globally are combined. We find evidence of significant yet incomplete integration. We also find heterogeneous short-term dynamics of individual markets. Furthermore, we examine whether logistics enter coal price dynamics through transportation costs, which are mainly determined by oil prices. Our results suggest that this is generally not the case.

Price discount, inventories and the distortion of WTI benchmark

- Energy Economics---2012---Chung-Wei Kao, Jer-Yuh Wan

Applying a rolling estimation to the Hasbrouck information share model, this study investigates the changing status of WTI benchmark over time. Results show the ability of WTI in reflecting market conditions decreases sharply, and WTI's efficiency in processing information has been surpassed by Brent's since the second half

of 2004. In the short run, the WTI distortion is related to its price discount problem, but the distortion cannot be indicated by contangos. In the long run, WTI's price discount problem coexists with a positive forward curve and both have harmed the price discovery role of WTI. The rising inventories in Cushing significantly deteriorate WTI's ability in serving as a world benchmark.

Does OPEC still exist as a cartel? An empirical investigation

- Energy Economics---2012---Vincent Brémond, Emmanuel Hache, Valérie Mignon

The aim of this paper is to determine if OPEC acts as a cartel by testing whether the production decisions of the different countries are coordinated and if they have an influence on oil prices. Relying on cointegration and causality tests in both time series and panel settings, our findings show that the OPEC influence has evolved through time, following the changes in the oil pricing system. While the influence of OPEC is found to be important just after the counter-oil shock, our results show that OPEC is a price taker on the majority of the considered sub-periods. Finally, by dividing OPEC between savers and spenders, we show that it acts as a cartel mainly with a subgroup of its members.

OPEC's oil exporting strategy and macroeconomic (in)stability

- Energy Economics---2012---Luís Aguiar-Conraria, Yi Wen

Aguiar-Conraria and Wen (2008) argued that dependence on foreign oil raises the likelihood of equilibrium indeterminacy (economic instability) for oil importing countries. We argue that this relation is more subtle. The endogenous choices of prices and quantities by a cartel of oil exporters, such as the OPEC, can affect the directions of the changes in the likelihood of equilibrium indeterminacy. We show that fluctuations driven by self-fulfilling expectations under oil shocks are easier to occur if the cartel sets the price of oil, but the result is reversed if the cartel sets the quantity of

production. These results offer a potentially interesting explanation for the decline in economic volatility (i.e., the Great Moderation) in oil importing countries since the mid-1980s when the OPEC cartel changed its market strategies from setting prices to setting quantities, despite the fact that oil prices are far more volatile today than they were 30 years ago.

Cartelization in gas markets: Studying the potential for a "Gas OPEC"

- Energy Economics---2012---S.A. Gabriel, Knut Einar Rosendahl, Rudolf Egging, H.G. Avetisyan, Sauleh Siddiqui

Natural gas is increasingly important as a fuel for electric power generation as well as other uses due to its environmental advantage over other fossil fuels. Using the World Gas Model, a large-scale energy equilibrium system based on a complementarity formulation, this paper analyzes possible future gas cartels and their effects on gas markets in a number of regions across the world. In addition, scenarios related to lower transport costs and decreased unconventional gas supply in the United States are considered.

An evaluation of alternative scenarios for the Gazprom monopoly of Russian gas exports

- Energy Economics---2012---Marina Tsygankova

In June 2006, Russian federal law legalized the exclusive right of Gazprom to export natural gas to Europe, and thus thwarted efforts by the European Union to bring competition to the Russian gas industry. An understanding of the motivation of the Russian government to support this export monopoly is important if Europe wishes to reduce its dependence on Gazprom. The principal aim of this paper is to contribute to a better understanding of this important question. Our analysis employs a theoretical model and several numerical simulations of an alternative organization used for gas exports, where independent gas producers in Russia are permitted to export gas to Europe. We evaluate the effects of this alternative organization on

consumer surplus, industry profits, and Russian welfare. The results demonstrate that while export by independent producers reduces Gazprom's export profits, it may also increase the total domestic and export profits earned by the Russian gas industry. However, the results also suggest that Russian gas consumers will not benefit if independent gas producers are able to supply both the domestic and international markets.

Much ado about Hotelling: Beware the ideo of Hubbert

- Energy Economics---2012---Douglas B. Reynolds,Jungho Baek

Much economic literature analyzes the Hotelling principle. Little economic literature analyzes the Hubbert curve although much controversy surrounds it. This difference in emphasis by economists needs to be reconsidered critically, and towards that end, we attempt to look at both concepts simultaneously. We test whether a simple Hubbert curve model is a significant determinant of world oil price changes and whether one of the main determinants of the Hotelling principle—the discount rate—also affects world oil prices. An autoregressive distributed lag (ARDL) bound testing approach is used to examine the effects of a Hubbert index variable and a Hotelling discount rate variable on the world wide price of oil. Results show the discount rate, the most important Hotelling variable, has little effect on oil prices, but that the Hubbert curve model does show a large effect on oil prices. Oil is a non-renewable natural resource par excellence, yet the results suggest that the Hotelling principle is not an important determinant for oil prices, yet the Hubbert curve and the theory surrounding the Hubbert curve is an important determinant of oil prices.

Attribution of changes in Divisia real energy intensity index — An extension to index decomposition analysis

- Energy Economics---2012---Ki-Hong Choi,B.W. Ang

In this paper we extend the methodology of index

decomposition analysis (IDA) in energy studies by quantifying the contribution of individual attributes to the percent change of factors such as the real energy intensity index and structural change index. We apply the proposed method to the real energy intensity index in the multiplicative Logarithmic Mean Divisia Index (M-LMDI) approach, a major IDA technique. Since the M-LMDI is based on geometric mean type indices and chain computation, we need some appropriate method to cope with the difficulties that arise. We present a numerical illustration of the proposed method using the energy consumption and real value added data of the US manufacturing industry, and compare the results obtained by the Fisher real energy intensity index.

Structural decomposition analysis applied to energy and emissions: Some methodological developments

- Energy Economics---2012---Bin Su,B.W. Ang

The only comprehensive study comparing structural decomposition analysis (SDA) and index decomposition analysis (IDA) was conducted around 2000. There have since been new developments in both techniques in energy and emission studies. These developments have been studied systematically for IDA but similar studies for SDA are lacking. In this paper, we fill the gap by examining the new methodological developments in SDA. A new development is a shift towards using decomposition methods that are ideal. We compare four such SDA methods analytically and empirically through decomposing changes in China's CO₂ emissions. We then provide guidelines on method selection. Finally, we discuss the similarities and differences between SDA and IDA based on the latest available information.

Estimating the demand for gasoline in developing countries: Senegal

- Energy Economics---2012---Seydina Sene

This paper estimates the aggregate demand for gasoline in Senegal from 1970 to 2008. The long-term and short-term elasticities of demand with respect to gasoline

prices and income are of paramount interest in this study. In Senegal, rising food prices, unemployment and shortage of electric supply are always associated with the spiking cost of world oil prices. To understand the external shocks of world oil price and demand for gasoline in Senegal, this study tested a log linear model against the linear model of the demand-for-oil function with lagged dependent variables as an explanatory variable. Here, the linear specification of the demand for oil is rejected in this study in favor of the log linear. The natural log transformation is typical when using high frequency data and significantly reduces skewness and kurtosis. Generally in this study, I found that short run elasticity is smaller than long-run elasticity and gasoline demand is inelastic with respect to both price and income for both the short and long runs in Senegal. This is why researcher like Moosa posits that "this assertion can be rationalised on the grounds that oil is such an important commodity that does not have close substitutes at least for its uses" (1998, p. 3).

Estimating the supply and demand of gasoline using tax data

- Energy Economics---2012---David Coyle,Jason De-Backer,Richard Prisinzano

We estimate supply and demand functions for the U.S. gasoline market using information from excise tax returns provided by the IRS for the period 1990–2009. We find price and income elasticities of demand similar to those found using EIA data. We find a price elasticity of supply of 0.29, which differs from the common assumption of a perfectly inelastic short-run supply curve. By using a novel data source, the analysis provides a robustness check of aggregate studies of gasoline demand and a consistent, econometric estimate of the price elasticity of gasoline supply. The results are useful in guiding tax and regulatory policies regarding gasoline consumption.

Demand for gasoline is more price-inelastic than commonly thought

- Energy Economics---2012---Tomas Havranek,Zuzana Irsova,Karel Janda

One of the most frequently examined statistical relationships in energy economics has been the price elasticity of gasoline demand. We conduct a quantitative survey of the estimates of elasticity reported for various countries around the world. Our meta-analysis indicates that the literature suffers from publication selection bias: insignificant or positive estimates of the price elasticity are rarely reported, although implausibly large negative estimates are reported regularly. In consequence, the average published estimates of both short- and long-run elasticities are exaggerated twofold. Using mixed-effects multilevel meta-regression, we show that after correction for publication bias the average long-run elasticity reaches 0.31 and the average short-run elasticity only 0.09.

Inventories and upstream gasoline price dynamics

- Energy Economics---2012---Gerard Kuper

This paper sheds new light on the asymmetric dynamics in upstream U.S. gasoline prices. The model is based on Pindyck's inventory model of commodity price dynamics. We show that asymmetry in gasoline price dynamics is caused by changes in the net marginal convenience yield: higher costs of marketing and storage lead to rising gasoline prices, whereas a drop in these costs lowers gasoline prices. The former effect is stronger. This indicates asymmetric dynamics. We also analyze the asymmetry across the sample by analyzing recursive and rolling regressions.

Stock prices of clean energy firms, oil and carbon markets: A vector autoregressive analysis

- Energy Economics---2012---Surender Kumar,Shunsuke Managi,Akimi Matsuda

Recent discussions of energy security and climate change have attracted significant attention to clean energy. We hypothesize that rising prices of conventional energy and/or placement of a price on carbon emissions would encourage investments in clean energy firms. The data from three clean energy indices show

that oil prices and technology stock prices separately affect the stock prices of clean energy firms. However, the data fail to demonstrate a significant relationship between carbon prices and the stock prices of the firms.

Oil prices, exchange rates and emerging stock markets

- Energy Economics---2012---Syed Basher, Alfred Haug, Perry Sadorsky

While two different streams of literature exist investigating 1) the relationship between oil prices and emerging market stock prices and 2) the relationship between oil prices and exchange rates, relatively little is known about the dynamic relationship between oil prices, exchange rates and emerging market stock prices. This paper proposes and estimates a structural vector autoregression model to investigate the dynamic relationship between these variables. Impulse responses are calculated in two ways (standard and the recently developed projection based methods). The model supports stylized facts. In particular, positive shocks to oil prices tend to depress emerging market stock prices and US dollar exchange rates in the short run. The model also captures stylized facts regarding movements in oil prices. A positive oil production shock lowers oil prices while a positive shock to real economic activity increases oil prices. There is also evidence that increases in emerging market stock prices increase oil prices.

Co-movement of energy commodities revisited: Evidence from wavelet coherence analysis

- Energy Economics---2012---Lukas Vacha, Jozef Baruník

In this paper, we contribute to the literature on energy market co-movement by studying its dynamics in the time-frequency domain. The novelty of our approach lies in the application of wavelet tools to commodity market data. A major part of economic time series analysis is done in the time or frequency domain separately. Wavelet analysis combines these two fundamental approaches allowing study of the time

series in the time-frequency domain. Using this framework, we propose a new, model-free way of estimating time-varying correlations. In the empirical analysis, we connect our approach to the dynamic conditional correlation approach of Engle (2002) on the main components of the energy sector. Namely, we use crude oil, gasoline, heating oil, and natural gas on a nearest-future basis over a period of approximately 16 and 1/2 years beginning on November 1, 1993 and ending on July 21, 2010. Using wavelet coherence, we uncover interesting dynamics of correlations between energy commodities in the time-frequency space.

Correlations and volatility spillovers between oil prices and the stock prices of clean energy and technology companies

- Energy Economics---2012---Perry Sadorsky

In this paper, multivariate GARCH models are used to model conditional correlations and to analyze the volatility spillovers between oil prices and the stock prices of clean energy companies and technology companies. Four different multivariate GARCH models (BEKK, diagonal, constant conditional correlation, and dynamic conditional correlation) are compared and contrasted. The dynamic conditional correlation model is found to fit the data the best and generates results showing that the stock prices of clean energy companies correlate more highly with technology stock prices than with oil prices. On average, a \$1 long position in clean energy companies can be hedged for 20cents with a short position in the crude oil futures market.

Testing the Masters Hypothesis in commodity futures markets

- Energy Economics---2012---Scott Irwin, Dwight R. Sanders

The ‘Masters Hypothesis’ is the claim that long-only index investment was a major driver of the 2007–2008 spike in commodity futures prices and energy futures prices in particular. Index position data compiled by the CFTC are carefully compared. In the energy markets, index position estimates based on agricultural

markets are shown to contain considerable error relative to the CFTC's Index Investment Data (IID). Fama–MacBeth tests using the CFTC's quarterly IID find very little evidence that index positions influence returns or volatility in 19 commodity futures markets. Granger causality and long-horizon regression tests also show no causal links between daily returns or volatility in the crude oil and natural gas futures markets and the positions for two large energy exchange-traded index funds. Overall, the empirical results of this study offer no support for the Masters Hypothesis.

The economic value of co-movement between oil price and exchange rate using copula-based GARCH models

- Energy Economics---2012---Chih-Chiang Wu,Huimin Chung,Yu-Hsien Chang

The US dollar is used as the primary currency of international crude oil trading; as such, the recent substantial depreciation in the US dollar has resulted in a corresponding increase in crude oil prices. In addition, oil price and exchange-rate returns have been shown to be skewed and leptokurtic, and to exhibit an asymmetric or tail dependence structure. Therefore, this study proposes dynamic copula-based GARCH models to explore the dependence structure between the oil price and the US dollar exchange rate. More importantly, an asset-allocation strategy is implemented to evaluate economic value and confirm the efficiency of the copula-based GARCH models. In terms of out-of-sample forecasting performance, a dynamic strategy based on the CGARCH model with the Student-t copula exhibits greater economic benefits than static and other dynamic strategies. In addition, the positive feedback trading activities are statistically significant within the oil market, but this information does not enhance the economic benefits from the perspective of an asset-allocation decision. Finally, a more risk-averse investor generates a higher fee for switching from a static strategy to a dynamic strategy based on copula-based GARCH models.

Forecasting the conditional volatility of oil spot and futures prices with structural breaks and long memory models

- Energy Economics---2012---Mohamed Aroui,Amine Lahiani,Aldo Lévy,Duc Khuong Nguyen

This paper extends previous studies by investigating the relevance of structural breaks and long memory in modeling and forecasting the conditional volatility of oil spot and futures prices using a variety of GARCH-type models. Our results can be summarized as follows. First, we provide evidence of parameter instability in five out of nine GARCH-based conditional volatility processes for energy prices. Second, long memory is effectively present in all the series considered and a FIGARCH model seems to better fit the data, but the degree of volatility persistence diminishes significantly after adjusting for structural breaks. Finally, the out-of-sample analysis shows that volatility models accommodating instability and long memory characteristics of the data provide the best volatility forecasts for most cases.

Volatility regimes, asymmetric basis effects and forecasting performance: An empirical investigation of the WTI crude oil futures market

- Energy Economics---2012---Kuang-Liang Chang

This study employs a flexible regime-switching EGARCH model with Student-t distributed error terms to investigate whether volatility regimes and basis affect the behavior of crude oil futures returns, including the conditional mean, variance, skewness, kurtosis as well as the extent of heavy-tailedness. The study also examines whether volatility regimes and asymmetric basis effects can improve the forecasting accuracy. The main merit of the empirical model is that the basis effect is allowed to be asymmetric and to vary across volatility regimes. Empirical results suggest that the conditional mean and variance respond to the basis asymmetrically and nonlinearly, and that the responses of transition probabilities to the basis are symmetric.

Furthermore, the conditional higher moments are sensitive to the absolute value of basis, and the heavy tailed characteristic can be greatly alleviated by taking into account the asymmetric basis effects and regime switches. Finally, the regime switches and asymmetric basis effects play decisive roles in forecasting return, volatility and tail distribution.

Forecasting hourly electricity prices using ARMAX–GARCH models: An application to MISO hubs

- Energy Economics---2012---Emily Hickey,David G. Loomis,Hassan Mohammadi

The recent deregulation of the electricity industry and reliance on competitive wholesale markets has generated significant volatility in wholesale electricity prices. Given the importance of short-term price forecasts in this new environment, this paper estimates and evaluates the forecasting performance of four ARMAX–GARCH models for five MISO pricing hubs (Cinergy, First Energy, Illinois, Michigan, and Minnesota) using hourly data from June 1, 2006 to October 6, 2007. Our empirical results reveal three important patterns: (a) electricity price volatility is regional and the optimum volatility model depends in part on the hub location, the forecast horizon, and regulated versus unregulated status of the market; (b) the APARCH model performs well in hubs in deregulated states; and (c) volatility dynamics in regulated states are better captured by a simple GARCH model and thus are less complex.

Modeling and explaining the dynamics of European Union Allowance prices at high-frequency

- Energy Economics---2012---Christian Conrad,Daniel Rittler,Waldemar Rotfuß

In this paper we model the adjustment process of European Union Allowance (EUA) prices to the releases of announcements at high-frequency controlling for intraday periodicity, volatility clustering and volatility persistence. We find that the high-frequency EUA

price dynamics are very well captured by a fractionally integrated asymmetric power GARCH process. The decisions of the European Commission on second National Allocation Plans have a strong and immediate impact on EUA prices. Further, EUA prices increase in response to better than expected news on the future economic development as well as the current economic activity in Germany and the U.S.

Carbon price drivers: Phase I versus Phase II equilibrium?

- Energy Economics---2012---Anna Creti,Pierre-André Jouvét,Valérie Mignon

The aim of this paper is to investigate the determinants of the carbon price during the two phases of the European Union Emission Trading Scheme (EU ETS). More specifically, relying on daily EU allowance futures contracts, we test whether the carbon price drivers identified for Phase I still hold for Phase II and evolve toward a long-run relationship. Using cointegration techniques and accounting for the 2006 structural break in the carbon market, we show that while a cointegrating relationship exists for both phases of the EU ETS, the nature of this equilibrium relationship is different across the two subperiods, with an increasing role of fundamentals in Phase II. Deriving equilibrium values, we show that the carbon price tends to be undervalued since the end of 2009.

Integration of the global carbon markets

- Energy Economics---2012---Bruce Mizrach

This paper analyzes the market architecture and common factors of emission reduction instruments in Europe and North America. Spot and futures prices across exchanges in Europe are cointegrated, but the futures curve beyond the calendar year evolves independently. Despite narrower spreads, political uncertainties about the Clean Development Mechanism have kept EUA and CER prices from converging. RGGI allowances share a common trend with EUA, and the European markets adjust to the U.S. price trend. A \$0:10 shock

to RGGI prices leads to a one-month \$0.64 cumulative increase in EUA prices. The introduction of cap and trade legislation in the U.S. has broken a cointegrating relationship in voluntary prices. Voluntary instruments that are convertible into mandatory allowances imply less than a 20% probability of price convergence between the U.S. and Europe by 2013.

Economic structure and strategies for greenhouse gas mitigation

- Energy Economics---2012---Erin S. Minihan, Ziping Wu

Greenhouse gas (GHG) emission mitigation policy impacts the economic system directly in the short-term by altering relative prices and indirectly in the long-term by shifting the structure of the economy. There may also be adjustments to economic structure independent of policy intervention due to changes in population, consumption patterns, and global markets. The overall effectiveness of specific mitigation policy will partly depend on these indirect and exogenous changes to economic structure. This study develops a new measure linking economic development with its environmental effects. The technical cost of GHG mitigation under economic growth in an economy is calculated by combining traditional input-output (IO) analysis and a linear programming based sensitivity analysis. The approach is applied to Northern Ireland (NI), producing an isoemission matrix that maps emission-neutral expansion paths for the economy. The measurement provides an indicator of the demand for technical improvement to achieve GHG mitigation at a national or regional level. The flexibility and transparency of the approach make it useful for evaluating potential GHG mitigation strategies.

Greenhouse gas emissions, energy consumption and economic growth: A panel cointegration analysis from Canadian industrial sector perspective

- Energy Economics---2012---Mahamat Hamit-Haggar

This paper investigates the long-run and the causal relationship between greenhouse gas emissions, energy consumption and economic growth for Canadian industrial sectors over the period 1990–2007. The empirical findings suggest that in the long-run equilibrium, energy consumption has a positive and statistically significant impact on greenhouse gas emissions whereas a non-linear relationship is found between greenhouse gas emissions and economic growth, consistent with the environmental Kuznets curve. The short-run dynamics conveys that there is a unidirectional Granger causality running from energy consumption to greenhouse gas emissions; from economic growth to greenhouse gas emissions and a weak unidirectional causality running from greenhouse gas emissions to energy consumption; from economic growth to energy consumption. In the long-run however, there seems to be a weak one way causality flowing from energy consumption and economic growth to greenhouse gas emissions.

Land-based mitigation in climate stabilization

- Energy Economics---2012---Steven K. Rose, Helal Ahammad, Bas Eickhout, Brian Fisher, Atsushi Kurosawa, Shilpa Rao, Keywan Riahi, Detlef P. van Vuuren

This paper evaluates the role of land in long-run climate stabilization mitigation scenarios. The details of land modeling for common stabilization policy scenarios are, for the first time, presented, contrasted, and assessed. While we find significant differences in approaches across modeling platforms, all the approaches conclude that land based mitigation – agriculture, forestry, and biomass liquid and solid energy substitutes – could be a steady and significant part of the cost-effective portfolio of mitigation strategies; thereby, reducing stabilization cost and increasing flexibility for achieving more aggressive climate targets. However, large fossil fuel emissions reductions are still required, and there are substantial uncertainties, with little agreement about abatement magnitudes. Across the scenarios, land mitigation options contribute approximately 100 to 340GtC equivalent abatement over the century, 15 to 40% of the total required for stabi-

lization, with bio-energy providing up to 15% of total primary energy. Long-run land climate modeling is rapidly evolving with critical challenges to address. In characterizing current capability, this paper hopes to stimulate future research and the next generation of land modeling and provide a point of comparison for energy and climate policies considering bio-energy, reduced deforestation and degradation, and cost containment.

Atmospheric externalities and environmental taxation

- Energy Economics---2011---Agnar Sandmo

The paper reviews the theory of environmental taxation under first best and second best conditions. It argues that negative environmental externalities lead to reductions of the provision of public goods, while investment in abatement increases the supply of public goods. Together with optimal tax rules, the paper therefore also derives conditions for the optimal use of resources on abatement. After brief discussions of the dimensions of time and uncertainty, tax reform and the double dividend, and taxes vs. quotas, the optimal tax model is applied to the problem of global warming with a discussion of the particular incentive problems that arise in designing and implementing global climate policy.

A note on environmental policy and innovation when governments cannot commit

- Energy Economics---2011---Juan-Pablo Montero

It is widely accepted that one of the most important characteristics of an effective pollution control policy is to provide firms with credible incentives to make long-run investments in R&D that can drastically reduce pollution. Recognizing that a government may be tempted to revise its policy design after innovations become available, this note shows how the performance of two policy instruments—prices (uniform taxes) and quantities (tradeable pollution permits)—differ in such a setting. I also discuss the gains from combining either instrument with subsidies to adopting firms.

Distributional impacts of carbon pricing: A general equilibrium approach with micro-data for households

- Energy Economics---2011---Sebastian Rausch,Gilbert Metcalf,John Reilly

Many policies to limit greenhouse gas emissions have at their core efforts to put a price on carbon emissions. Carbon pricing impacts households both by raising the cost of carbon intensive products and by changing factor prices. A complete analysis requires taking both effects into account. The impact of carbon pricing is determined by heterogeneity in household spending patterns across income groups as well as heterogeneity in factor income patterns across income groups. It is also affected by precise formulation of the policy (how is the revenue from carbon pricing distributed) as well as the treatment of other government policies (e.g. the treatment of transfer payments). What is often neglected in analyses of policy is the heterogeneity of impacts across households even within income or regional groups. In this paper, we incorporate 15,588 households from the U.S. Consumer and Expenditure Survey data as individual agents in a comparative-static general equilibrium framework. These households are represented within the MIT USREP model, a detailed general equilibrium model of the U.S. economy. In particular, we categorize households by full household income (factor income as well as transfer income) and apply various measures of lifetime income to distinguish households that are temporarily low-income (e.g., retired households drawing down their financial assets) from permanently low-income households. We also provide detailed within-group distributional measures of burden impacts from various policy scenarios.

Economic analysis of the climate pledges of the Copenhagen Accord for the EU and other major countries

- Energy Economics---2011---Bert Saveyn,Denise Van Regemorter,Juan-Carlos Ciscar

This article uses the world GEM-E3 computable general equilibrium model to assess the economic conse-

quences of the climate ‘Copenhagen Accord’ . The model allows analyzing the macroeconomic costs in terms of GDP, the change in employment, as well as the impacts on production of specific energy-intensive sectors. Various 2020 climate scenarios are evaluated depending on the GHG mitigation pledges. We find that the cost for the developed countries is around 0.5% of GDP in 2020 for the more ambitious pledges, whereas the GDP effects are more heterogeneous across developing countries and Russia, reflecting the different pledges and the assumptions in the reference scenario across these countries. Further, the article explores whether there is a form of double dividend in the EU when the revenues from auctioning or taxation of GHG emissions are used to reduce the social security contributions of employees. We conclude that GDP and employment perform better compared to the free allocation of permits when more sectors are subject to auctioning or GHG taxes and the additional government revenues are used to reduce the cost of labour.

DICER: A tool for analyzing climate policies

- Energy Economics---2011---Ramon Ortiz, Alexander Golub, Oleg Lugovoy, Anil Markandya, James Wang

Modeling the economy and the planet’s climate involves a great number of variables and parameters, some of them very uncertain given the current stage of knowledge regarding technology and the science of climate. The DICER model (or DICE-Regional) is a recently constructed Integrated Assessment Model (IAM), based on the structure of the DICE family of models, which was developed as an instrument for the analysis of uncertainties in climate policy. This paper aims to describe the basic version of DICER on which future developments addressing uncertainty in climate policy analysis will be based. Our results suggest a few interesting conclusions when compared to other IAMs: (i) under a plausible set of assumptions and parameters DICER indicates that an optimal global climate policy would imply higher costs of climate change in the short run but a faster (and more expensive) decarbonization process in all regions, resulting in a faster stabilization

of the climate; (ii) lower peak temperatures that occur earlier in time; (iii) considerable sensitivity of results to key parameters such as climate sensitivity, but lower than expected sensitivity to the social discount rate.

Gradual green tax reforms

- Energy Economics---2011---Carlos de Miguel, Baltasar Manzano

Green tax reforms have become an important tool not only in protecting the environment but also in bringing about a more efficient tax system. However, reforms often imply accepting sacrifices in the short-run and bring about the risk of potential political opposition. Within this framework, the debate on whether to implement green tax reforms in one-step or gradually becomes of great interest. In this paper, we use a dynamic general equilibrium model, calibrated to the Spanish economy, to evaluate different reforms that consist in increasing energy taxes and adjusting capital taxation in a revenue-neutral framework. Our findings show that, although an environmental dividend is always granted, the existence of an efficiency dividend depends on the type of reform, its size and how gradually it is implemented. Thus, one-step reforms that produce an efficiency dividend would imply large efficiency costs in the short-run. In this case, the reform could only produce efficiency gains in the short-run if it is implemented gradually, although such gains would end up disappearing in the long-run.

An ex-post analysis of the effect of renewables and cogeneration on Spanish electricity prices

- Energy Economics---2011---Liliana Gelabert, Xavier Labandeira, Pedro Linares

Growing concerns about climate change and energy dependence are driving specific policies to support renewable or more efficient energy sources such as cogeneration in many regions, particularly in the production of electricity. These policies have a non-negligible cost, and therefore a careful assessment of their impacts seems necessary. In particular, one of the most-debated impacts is their effect on electricity prices, for which

there have been some ex-ante studies, but few ex-post studies. This article presents a full ex-post empirical analysis, by looking at use of technologies and hourly electricity prices for 2005–2009 in Spain, to study the effects that the introduction of renewable electricity and cogeneration has had on wholesale electricity prices. It is particularly interesting to perform this study in Spain where an active system of public support to renewables and cogeneration has led to a considerable expansion of these energy sources and electricity pricing is at the center of intense debate. The paper reports that a marginal increase of 1GWh of electricity production using renewables and cogeneration is associated with a reduction of almost 2€ per MWh in electricity prices (around 4% of the average price for the analyzed period).

Willingness to pay and price elasticities of demand for energy-efficient appliances: Combining the hedonic approach and demand systems

- Energy Economics---2011---Ibon Galarraga,Mikel González-Eguino,Anil Markandya

This article proposes a combined approach for estimating willingness to pay for the attributes represented by energy efficiency labels and providing reliable price elasticities of demand (own and cross) for close substitutes (e.g. those with low energy efficiency and those with higher energy efficiency). This is done by using the results of the hedonic approach together with the Quantity Based Demand System (QBDS) model. The elasticity results obtained with the latter are then compared with those simulated using the Linear Almost Ideal Demand System (LA/AIDS). The methodology is applied to the dishwasher market in Spain: it is found that 15.6% of the final price is actually paid for the energy efficiency attribute. This accounts for about €80 of the average market price. The elasticity results confirm that energy efficient appliances are more price elastic than regular ones.

Cost pass-through of the EU emissions allowances: Examining the European petroleum markets

- Energy Economics---2011---Victoria Alexeeva-Talebi

This paper explores the ability of European refineries to pass-through costs associated with the introduction of the EU Emissions Trading Scheme (EU ETS). A sequence of vector error correction models (VECM) has been estimated within a multinational setting which covers 14 EU Member States. Using weekly data at the country level, this paper finds an influence of prices for European Union Allowances (EUAs) on unleaded petrol retail prices during the trial phase of the EU ETS from 2005 to 2007. The country-specific long-run elasticities of petrol prices with respect to the EUA prices are between 0.01 and 0.09. Given that these elasticities are of the same order of magnitude as the share of carbon allowances costs in total production costs in the refining industry, the estimates are consistent with the full pass-through potential. The variance decomposition analysis shows furthermore that a significant fraction of petrol price changes in Austria, Germany, France and Spain can be explained by changes in allowances prices (between 10% and 20%).

Oil prices and the impact of the financial crisis of 2007–2009

- Energy Economics---2011---Ramaprasad Bhar,Anastasios Malliaris

Oil prices increased dramatically during 2004–2006. Industry experts initially attributed these price increases to fundamental factors such as the rise in global demand, but also because of disruptions in the supply of oil. The price increases however were so substantial that additional factors are needed to explain such dramatic changes. We propose that the decline in the value of the U.S. dollar measured both by the appreciation of the Euro and of gold prices, played an important role as oil suppliers demanded compensation for the declining value of the dollar. Using a Markov switching regime methodology we find evidence that

this hypothesis is true prior to the financial crisis, but its validity does not hold after the crisis when oil prices crashed and the dollar rallied.

Oil revenue shocks and government spending behavior in Iran

- Energy Economics---2011---Mohammad Reza Farzanegan

Oil revenues play an important role in the political economy of Iran. On average, 60% of the Iranian government revenues and 90% of export revenues originate from oil and gas resources. Current international sanctions on Iran have mainly targeted the oil production capacity of Iran and its exports to the global markets. In this study, we analyze the dynamic effects of oil shocks on different categories of the Iranian government expenditures from 1959 to 2007, using impulse response functions (IRF) and variance decomposition analysis (VDC) techniques. The main results show that Iran's military and security expenditures significantly respond to a shock in oil revenues (or oil prices), while social spending components do not show significant reactions to such shocks.

The impact of oil shocks on the Spanish economy

- Energy Economics---2011---Ana Gómez-Loscos, Antonio Montañés, María Gadea

This paper analyses the impact of oil price shocks on both the GDP growth and on inflation in the economy of Spain and its seventeen regions. The Qu and Perron (2007) and the Bai and Perron (1998, 2003a and 2003b) methods identify different periods across the sample. Evidence of a diminishing effect of oil price shocks on GDP growth and on inflation is found from the 1970s until the mid 1980s. However, in contrast with previous literature, we find a renewed effect on both these macroeconomic variables after the mid 80s. In Spain, it recovers some of its initial importance in the second half of the 1990s for GDP and between 1986 and 1994 and the 2000s for inflation. In the regions, the influence of oil price shocks on the GDP progressively

disappears while the impact on inflation decreases from 1986 onwards but becomes significant again ten years later. The most outstanding result is that oil price movements explain at least some of the recent inflation. Therefore, policy measures to control the economic impact of oil shocks should be implemented in the future.

What has driven oil prices since 2000? A structural change perspective

- Energy Economics---2011---Ying Fan, Jin-Hua Xu

This paper characterizes weekly international oil price fundamentals since 2000 by analyzing the transformation of the market mechanism based on structural change perspective. Using endogenously-determined break tests that allow for changes in both level and trend, we divide the price fluctuations in the international oil market after 2000 into three stages: “Relatively calm market” period (January 07, 2000, to March 12, 2004); the “Bubble accumulation” period (March 19, 2004, to June 06, 2008,); and the “Global economic crisis” period (June 13, 2008, to September 11, 2009). The results show the existence of structural breaks refutes the utility of investigation of the full sample period as a whole. And in different structural periods the main drivers of oil price changes and their way of influence and degree are significantly distinct. Then we demonstrate the evolving process of market mechanism since 2000. Through establishing comparative models, we also quantitatively measure the roles of speculation and episodic events in oil price fluctuations.

Consumer willingness to pay for appliances produced by Green Power Partners

- Energy Economics---2011---David O. Ward, Christopher Clark, Kimberly L. Jensen, Steven T. Yen

The U.S. Environmental Protection Agency's Green Power Partnership (GPP), has over 1200 members purchasing nearly 18 billion kilowatt hours of green power annually. One possible motivation for firms to join the

GPP is to raise their reputation for environmental quality among consumers. This research investigates the extent to which consumer preferences for a residential appliance are affected by information on whether or not the appliance manufacturer was a member of the GPP. Data for the study were obtained from a contingent choice exercise in an online survey of a national sample of adults. The results suggest that consumers are, on average, willing to pay an extra \$48.52 to \$70.95 for a refrigerator manufactured by a company that is a member of the GPP. These amounts appear to generally exceed the additional costs associated with using green power to manufacture a refrigerator and suggest that GPP could effectively be used to market consumer products.

Read the label! Energy Star appliance label awareness and uptake among U.S. consumers

- Energy Economics---2011---Anthony G. Murray,Bradford Mills

The Energy Star label program to promote the diffusion of energy efficient home appliances is arguably the most significant government effort to reduce U.S. residential energy consumption. Program effectiveness requires that consumers are aware of the labeling scheme and also change their purchase decisions based on label information. This paper examines the factors associated with consumer awareness of the Energy Star label of recently purchased ‘white’ major appliances and the factors associated with the choice of Energy Star labeled appliances. The paper finds that household characteristics have a much stronger association with consumer awareness of labels than with the choice of Energy Star appliances. Renting the home, Hispanic ethnicity, being poor or near poor, and living in regions with lower ACEEE scores do, however, decrease the propensity for households to purchase Energy Star appliances. Eliminating these gaps in Energy Star appliance adoption would result in house electricity cost savings of \$164million per year and associated carbon emission reductions of about 1.1million metric tons per year.

Random preferences towards bioenergy environmental externalities: A case study of woody biomass based electricity in the Southern United States

- Energy Economics---2011---Andres Susaeta,Pankaj Lal,Janaki Alavalapati,Evan Mercer

This paper contrasts alternate methodological approaches of investigating public preferences, the random parameter logit (RPL) where tastes and preferences of respondents are assumed to be heterogeneous and the conditional logit (CL) approach where tastes and preferences remain fixed for individuals. We conducted a choice experiment to assess preferences for woody biomass based electricity in Arkansas, Florida, and Virginia. Reduction of CO2 emissions and improvement of forest habitat by decreasing risk of wildfires and pest outbreaks were presented to respondents as attributes of using green electricity. The results indicate that heterogeneous preferences might be a better fit for assessing preferences for green electricity. All levels of both attributes were positive contributors to welfare but they were not statistically significant. Respondents expressed a positive mean marginal willingness to pay (WTP) for each attribute level. The total WTP for green electricity per kilowatt hour was \$0.049kWh or \$40.5 per capita year⁻¹ when converted into future total annual expenditures.

Consumers’ preference for renewable energy in the southwest USA

- Energy Economics---2011---Pallab Mozumder,William F. Vásquez,Achla Marathe

The southwestern part of the US has abundant supply of renewable energy resources but little is known about the consumers’ preferences for renewable energy in this region. This paper investigates households’ willingness to pay for a renewable energy program in a southwestern state, New Mexico (NM). Using the contingent valuation method, we provide different scenarios that include provision of 10% and 20% of renewable energy supply, to elicit households’ willingness to pay (WTP)

for the renewable energy. We estimate the WTP for specific shares of renewable energy in the total energy mix as it is a key factor in affecting the price of the energy portfolio in the market. The survey design also allows us to check the scope sensitivity of renewable energy which can help guide the future renewable energy policy. We hope results from this study will offer useful insights to energy regulators and utility companies and help them increase the share of renewable energy supply.

Coal lumps vs. electrons: How do Chinese bulk energy transport decisions affect the global steam coal market?

- Energy Economics---2011---Moritz Paulus,Johannes Trüby,Johannes Trueby

This paper demonstrates the ways in which different Chinese bulk energy transport strategies affect the future steam coal market in China and in the rest of the world. An increase in Chinese demand for steam coal will lead to a growing need for additional domestic infrastructure as production hubs and demand centers are spatially separated, and domestic transport costs could influence the future Chinese steam coal supply mix. If domestic transport capacity is available only at elevated costs, Chinese power generators could turn to the global trade markets and further increase steam coal imports. Increased Chinese imports could then yield significant changes in steam coal market economics on a global scale. This effect is analyzed in China, where coal is mainly transported by railway, and in another setting where coal energy is transported as electricity. For this purpose, a spatial equilibrium model for the global steam coal market has been developed. One major finding is that if coal is converted into electricity early in the supply chain, worldwide marginal costs of supply are lower than if coal is transported via railway. Furthermore, China's dependence on international imports is significantly reduced in this context. Allocation of welfare changes particularly in favor of Chinese consumers while rents of international producers decrease.

Economic simulation of biodiesel production: SIMB-E tool

- Energy Economics---2011---Daniela de Carvalho Lopes, Antonio José Steidle Neto, Paulo André R. Martins

Recently biodiesel has been receiving increasing attention as an alternative fuel due to its environmental benefits. It is derived from renewable sources which are considered as strategic opportunities to favor environmental sustainability, to improve the population's quality of life and to promote the development of more efficient and equitable economic systems. Besides technical aspects, economics feasibility is also of great importance to access the biodiesel production viability. This paper traces the development of a software tool capable of performing economic analysis of different biodiesel plants considering the contemporary industry practices. The economic indexes considered during the analysis are the net present value (NVP), the Benefit-Costs Ratio (BCR), the Capital Return Time (CRT) and the Internal Rate of Return (IRR). Fixed capital costs, operating costs, depreciation, and auxiliary costs are also taken into account for the economic calculations.

Ethanol demand under the flex-fuel technology regime in Brazil

- Energy Economics---2011---Luciano De Freitas, Shinji Kaneko

This paper analyzes the characteristics of ethanol demand in the context of fuel mix diversification in Brazil. Currently, ethanol is the most important gasoline additive and alternative fuel consumed in Brazil and is responsible there for profound changes in the dynamics of fuel consumption. The diffusion of flex-fuel vehicles in Brazil symbolizes a new stage of ethanol expansion and is a central component of the increasing demand for fuel. Accordingly, we evaluate ethanol demand in Brazil following the introduction of flex-fuel vehicles using a cointegration approach and autoregressive distributed lag bounds tests over the period 2003–2010. The evidences confirm that during the last decade,

ethanol has strengthened its position as both an independent fuel and a substitute for gasoline. There is also evidence that growth in the Brazilian automobile fleet based on flex-fuel technology is a major driving factor of long-run ethanol demand. Further, the dynamics of gasohol (mandatory blend of gasoline and ethanol) and ethanol prices operate in a symmetric manner over ethanol demand, thereby evidencing the increasing substitutability between these alternative fuels.

Volatility spillovers between food and energy markets: A semiparametric approach

- Energy Economics---2011---Teresa Serra

Previous literature on volatility links between food and energy prices is scarce and mainly based on parametric approaches. This article examines these links by using a semiparametric GARCH model recently proposed by Long et al. (2011), which is essentially a nonparametric correction of the parametric conditional covariance function. The analysis focuses on price links between crude oil, ethanol and sugar prices in Brazil. Results suggest strong volatility links between the prices studied. Parametric approximations of the conditional covariance matrix may lead to misleading results that can be improved upon by using nonparametric techniques.

Investments into forest biorefineries under different price and policy structures

- Energy Economics---2011---Hanna-Liisa Kangas,Jussi Lintunen,Johanna Pohjola,Lauri Hetemäki,Jussi Uusivuori

Increasing scarcity of oil reserves and the high CO₂ emissions from using oil have contributed to the development of renewable biofuels. Pulp and paper mill integrated forest biorefineries offer one important means to increase biofuel production. This study analyzes the effects of policies to support biofuel production in the pulp and paper sector. We study the relative effectiveness of three biofuel supporting policy instruments,

namely production subsidy, input subsidy and investment subsidy. We present a partial equilibrium pulp and paper market model with a biorefinery investment option. A numerical model is used to evaluate the impacts of policy instruments on wood prices, as well as input choices and investment strategies of pulp and paper industries. The data represent the Finnish pulp and paper sector. We evaluate the values and direct costs of the policy instruments in a situation of exogenous biofuel production targets. The direct costs of input and investment subsidies are higher than those of a production subsidy. With all the policy instruments, Finnish pulp and paper mills would invest in wood-gasifying technology, instead of black liquor based one. The number of biorefinery units is dependent on the subsidy type — investment and input subsidies are likely to result in more numerous but smaller biofuel production units than a production subsidy. With all the policy instruments the demand for wood increases in Finland leading to higher wood prices. This, in turn, could reflect negatively on the profitability of the pulp and paper industries. To a significant degree, the model and the results can be generalized to other countries and markets where integrated pulp and paper mills are operating.

Assessing the impact of US ethanol on fossil fuel markets: A structural VAR approach

- Energy Economics---2011---Lihong McPhail

Despite the growing importance of biofuels, the effect of biofuels on fossil fuel markets is not fully understood. We develop a joint structural Vector Auto Regression (VAR) model of the global crude oil, US gasoline, and US ethanol markets to examine whether the US ethanol market has had any impact on global oil markets. The structural VAR approach provides a unique method for decomposing price and quantity data into demand and supply shocks, allowing us to estimate the distinct dynamic effects of ethanol demand and supply shocks on the real prices of crude oil and US gasoline. Ethanol demand in the US is driven mainly by government support in the form of tax credits and blending mandates. Shocks to ethanol demand therefore reflect changes

in policy more than any other factor. In contrast, ethanol supply shocks are driven by changes in feedstock prices. A principle finding is that a policy-driven ethanol demand expansion causes a statistically significant decline in real crude oil prices, while an ethanol supply expansion does not have a statistically significant impact on real oil prices. This suggests that even though US ethanol market is small, the influence of US biofuels policy on the crude oil market is pervasive. We also show that ethanol demand shocks are more important than ethanol supply shocks in explaining the fluctuation of real prices of crude oil and US gasoline.

Investing in biogas: Timing, technological choice and the value of flexibility from input mix

- Energy Economics---2011---Luca Di Corato,Michele Moretto

In a stochastic dynamic frame, we study the technology choice problem of a continuous co-digestion biogas plant where input factors are substitutes but need to be mixed together to provide output. Given any initial rule for the composition of the feedstock, we consider the possibility of revising it if economic circumstances make it profitable. Flexibility in the mix is an advantage under randomly fluctuating input costs and comes at a higher investment cost. We show that the degree of flexibility in the productive technology installed depends on the value of the option to profitably re-arrange the input mix. Such option adds value to the project in that it provides a device for hedging against fluctuations in the input relative convenience. Accounting for such value we discuss the trade-off between investment timing and profit smoothing flexibility.

Estimating the influence of U.S. ethanol policy on plant investment decisions: A real options analysis with two stochastic variables

- Energy Economics---2011---Todd Schmit,Luo J.,J.M. Conrad

U.S. ethanol policies have contributed to changes in the levels and the volatilities of revenues and costs facing

ethanol firms. The implications of these policies for optimal investment behavior are investigated through an extension of the real options framework that allows for the consideration of volatility in both revenue and cost components, as well as the correlation between them. The effects of policy affecting plant revenues dominate the effects of those policies affecting production costs. In the absence of these policies, much of the recent expansionary periods would have not existed and market conditions in the late-1990s would have led to some plant closures. We also show that, regardless of plant size, U.S. ethanol policy has narrowed the distance between the optimal entry and exit curves, implying a more narrow range of inactivity and indicative of a more volatile evolution for the industry than would have existed otherwise.

Realized volatility and the influence of market measures on predictability: Analysis of Nord Pool forward electricity data

- Energy Economics---2011---Erik Haugom,Sjur Westgaard,Per Bjarte Solibakke,Gudbrand Lien

This is the first paper to utilize intra-daily high-frequency data and to apply known market measures for the prediction of volatility in the Nord Pool electricity forward market. The work is based on recent methods of separating realized volatility into two components: continuous and jump volatilities. In addition, the link between future price volatility and current observable economic variables is examined. The measures—trading volume, time-to-maturity, asymmetric effect from negative shocks, and intra-week seasonality—are assessed to identify improvements in day-ahead predictions. The model where the total variation is separated into its continuous and jump components is compared with the simpler heterogeneous autoregressive model of realized variation both in- and out-of-sample. The results show a strong degree of persistence in realized volatility, and significant impacts from the mentioned market measures when predicting Nord Pool forward price volatility. Hence, there is a clear preference for models accounting for the systematic impact of market measures to improve volatility assessment for tomorrow.

Moreover, separating the total variation into continuous and jump components seems potentially useful when predicting day-ahead volatility.

Distributional modeling and short-term forecasting of electricity prices by Generalized Additive Models for Location, Scale and Shape

- Energy Economics---2011---Francesco Serinaldi

In the context of the liberalized and deregulated electricity markets, price forecasting has become increasingly important for energy company's plans and market strategies. Within the class of the time series models that are used to perform price forecasting, the subclasses of methods based on stochastic time series and causal models commonly provide point forecasts, whereas the corresponding uncertainty is quantified by approximate or simulation-based confidence intervals. Aiming to improve the uncertainty assessment, this study introduces the Generalized Additive Models for Location, Scale and Shape (GAMLSS) to model the dynamically varying distribution of prices. The GAMLSS allow fitting a variety of distributions whose parameters change according to covariates via a number of linear and nonlinear relationships. In this way, price periodicities, trends and abrupt changes characterizing both the position parameter (linked to the expected value of prices), and the scale and shape parameters (related to price volatility, skewness, and kurtosis) can be explicitly incorporated in the model setup. Relying on the past behavior of the prices and exogenous variables, the GAMLSS enable the short-term (one-day ahead) forecast of the entire distribution of prices. The approach was tested on two datasets from the widely studied California Power Exchange (CalPX) market, and the less mature Italian Power Exchange (IPEX). CalPX data allow comparing the GAMLSS forecasting performance with published results obtained by different models. The study points out that the GAMLSS framework can be a flexible alternative to several linear and nonlinear stochastic models.

Forecasting electricity prices and their volatilities using Unobserved Components

- Energy Economics---2011---Carolina García-Martos, Julio Rodríguez, María Jesús Sánchez

The liberalization of electricity markets more than ten years ago in the vast majority of developed countries has introduced the need of modelling and forecasting electricity prices and volatilities, both in the short and long term.

A conditionally heteroskedastic model with time-varying coefficients for daily gas spot prices

- Energy Economics---2011---Nazim Regnard, Jean-Michel Zakoian

This paper examines the relationship between gas spot prices at the Zeebrugge market, one-month ahead Brent prices and temperatures over the period 2000–2005. A cointegration analysis is carried out and it is discovered that a cointegration relationship exists between the three series. To take into account the influence of temperature on the gas volatility, a GARCH(1,1) model with temperature-dependent coefficients is considered. Stability and estimation properties are discussed. An empirical finding is the existence of distinct volatility regimes for the volatility of gas prices, depending on the temperature level.

An hour-ahead prediction model for heavy-tailed spot prices

- Energy Economics---2011---Jae Ho Kim, Warren B. Powell

We propose an hour-ahead prediction model for electricity prices that capture the heavy tailed behavior that we observe in the hourly spot market in the Ercot (Texas) and the PJM West hub grids. We present a model according to which we separate the price process into a thin-tailed trailing median process and a heavy-tailed residual process whose probability distribution can be approximated by a Cauchy distribution. We show empirical evidence that supports our model.

Nonparametric modeling of carbon prices

- Energy Economics---2011---Julien Chevallier

This paper constitutes the first exercise of nonparametric modeling applied to carbon markets. The framework of analysis is carefully detailed, and the empirical application unfolds in the case of BlueNext spot and ECX futures prices. The data is gathered in daily frequency from April 2005 to April 2010. First, we document the presence of strong nonlinearities in the conditional mean functions. Second, the conditional volatility functions reveal an asymmetric and heteroskedastic behavior which is dramatically different between carbon spot and futures logreturns. The results for spot prices are also robust to subsamples' decomposition. Third, we show in an out-of-sample forecasting exercise that nonparametric modeling allows reducing the prediction error by almost 15% compared to linear AR models. This latter result is confirmed by the Diebold–Mariano pairwise test statistic.

Disclosed corporate responses to climate change and stock performance: An international empirical analysis

- Energy Economics---2011---Andreas Ziegler,Timo Busch,Volker H. Hoffmann

This paper examines the relationship between disclosed corporate responses to climate change and stock performance on the European and US stock markets. Methodologically, we consider investor expectations and compare risk-adjusted returns of stock portfolios comprising corporations that differ in this indicator for environmental performance. In this respect, we apply the flexible Carhart four-factor model in addition to the restricted one-factor model based on the Capital Asset Pricing Model (CAPM). The main result of our portfolio analysis is that a trading strategy which consists of buying stocks of corporations disclosing responses to climate change and selling stocks of corporations with no disclosures has become more worthwhile over time in Europe. Furthermore, it can be shown that the relationship between disclosed corporate responses to climate change and stock performance has been

positive for energy firms in the USA. One reason for these results could be the underlying stringency of institutional pressure with respect to global warming.

A model of carbon price interactions with macroeconomic and energy dynamics

- Energy Economics---2011---Julien Chevallier

This paper develops a model of carbon pricing by considering two fundamental drivers of European Union Allowances: economic activity and energy prices. On the one hand, economic activity is proxied by aggregated industrial production in the EU 27 (as it provides the best performance in a preliminary forecasting exercise vs. other indicators). On the other hand, Brent, natural gas and coal prices are selected as being the main carbon price drivers (as highlighted by previous literature). The interactions between the macroeconomic and energy spheres are captured in a Markov-switching VAR model with two states that is able to reproduce the ‘boom–bust’ business cycle (Hamilton (1989)). First, industrial production is found to impact positively (negatively) the carbon market during periods of economic expansion (recession), thereby confirming the existence of a link between the macroeconomy and the price of carbon. Second, the Brent price is confirmed to be the leader in price formation among energy markets (Bachmeier and Griffin (2006)), as it impacts other variables through the structure of the Markov-switching model. Taken together, these results uncover new interactions between the recently created EU emissions market and the pre-existing macroeconomic/energy environment.

What should we expect from innovation? A model-based assessment of the environmental and mitigation cost implications of climate-related R&D

- Energy Economics---2011---Valentina Bosetti,Carlo Carraro,Romain Duval,Massimo Tavoni

This paper addresses two basic issues related to technological innovation and climate stabilization objec-

tives: can innovation policies be effective in stabilizing climate? To what extent can innovation policies complement carbon pricing (taxes or permit trading) and improve the economic efficiency of a mitigation policy package? To answer these questions, we use an integrated assessment model with multiple externalities and an endogenous representation of the technical progress in the energy sector. We evaluate a range of innovation policies, both as stand-alone and in combination with other mitigation policies. Our analysis indicates that innovation policies alone are unlikely to stabilize global concentration and temperature. As for the benefits of combining climate and innovation policies, we find efficiency gains of 10% (6 USD Trillions in net present value terms) for a stringent climate policy, and 30% (3 USD Trillions) for a milder one. However, such gains are reduced when more plausible (sub-optimal) global innovation policy arrangements are considered.

Energy efficiency, rebound effects and the environmental Kuznets Curve

- Energy Economics---2011---Karen Turner,Nick Hanley

Technological change is one factor used to justify the existence of an Environmental Kuznets Curve, and technological improvements have been argued to be a key factor in mitigating the impacts of economic growth on environmental quality. In this paper we use a CGE model of the Scottish economy to consider the factors influencing the impacts of one form of technological change-improvements in energy efficiency-on absolute levels of CO₂ emissions, on the carbon intensity of the economy (CO₂ emissions relative to real GDP), and the per capita EKC relationship. These factors include the elasticity of substitution between energy and non-energy inputs, responses in the labour market and the structure of the economy. Our results demonstrate the key role played by the general equilibrium price elasticity of demand for energy, and the relative influence of different factors on this parameter.

Relative energy price and investment by European firms

- Energy Economics---2011---Ronald Ratti,Youn Seol,Kyung Hwan Yoon

A dynamic model of investment is estimated with data on non-financial firms in 15 European countries across 25 industries over 1991-2006. A rise in real energy price reduces the degree of persistence in the investment adjustment cost function. Panel results suggest that in manufacturing a 1% rise in real energy price reduces investment by a country's firms by 1.9% relative to that by firms in other countries with a smaller effect for non-manufacturing firms. The negative effect of a higher relative price of energy on firm-level investment is significantly less marked the larger the firm. Results imply that stabilizing the relative price of energy would steady firm investment with greater gains in stability at smaller and medium sized firms. Results are robust to consideration of country business cycle effect and firm leverage. Estimation of investment is based on the Euler equation approach with over 21,000 observations. Individual country regressions imply that a rise in the relative price of energy price has a statistically significant negative effect on firm-level investment in 14 out of 15 countries. To avoid dynamic panel bias estimation is by generalized method of moments with instrumental variables.

Modeling choice of fuelwood source among rural households in Malawi: A multinomial probit analysis

- Energy Economics---2011---Charles Jumbe,Arild Angelsen

This paper addresses two questions: what determines household's choice of fuelwood source and, what are the environmental consequences of fuelwood collection choices? We address these questions by estimating the multinomial probit model using survey data for households surrounding Chimaliro and Liwonde forest reserves in Malawi. After controlling for heterogeneity among households, we find strong substitution opportunities across fuelwood collection sources. Attributes

of the fuelwood sources (size and species composition) and distance to the sources are the most important determinants of fuelwood choice. Further results show that customary managed forests generate environmental benefits by reducing pressure on both plantation forests and forest reserves. These findings support the need to strengthen community-based institutions to manage local forest resources.

Trade and energy consumption in the Middle East

- Energy Economics---2011---Perry Sadorsky

Over the past 30 years many economies have experienced large increases in economic trade, income and energy consumption. This brings up an interesting question. How do increases in trade affect energy consumption? This study uses panel cointegration data estimation techniques to examine the impact of trade on energy consumption in a sample of 8 Middle Eastern countries covering the period 1980 to 2007. Short-run dynamics show Granger causality from exports to energy consumption, and a bi-directional feedback relationship between imports and energy consumption. Long run elasticities estimated from FMOLS show that a 1% increase in per capita exports increases per capita energy consumption by 0.11% while a one percent increase in per capita imports increases per capita energy consumption by 0.04%. These results are important in establishing that increased trade affects energy demand in the Middle East in both the short and long-run. This has implications for energy policy and environmental policy.

Testing for cross-subsidisation in the combined heat and power generation sector: A comparison of three tests

- Energy Economics---2011---Eirik S. Amundsen, Per Andersen, Frank Jensen

In this paper we examine cross-subsidisation among combined heat and power producers in Denmark. Information on stand-alone costs for heat generation allows us to empirically compare the Faulhaber

tests, tests with an upper bound on stand-alone costs (the Palmer tests) and the fully distributed cost test (FDC). All tests indicate a substantial amount of cross-subsidisation from heat generation to power generation. It is shown that the FDC test is closer to that of the Faulhaber tests in its results than the Palmer tests. Thus as the Faulhaber tests are considered in the literature to be the theoretically correct tests, the FDC test is shown to be the best approximation for tests of cross-subsidisation for this specific sector.

Anticipated and unanticipated effects of crude oil prices and gasoline inventory changes on gasoline prices

- Energy Economics---2011---Stanislav Radchenko, Dmitry Shapiro

This paper examines the effect of anticipated and unanticipated changes in oil prices and gasoline inventory on US gasoline prices. We estimate empirical responses to anticipated and unanticipated changes in oil prices and gasoline inventory and show that gasoline price adjustments are faster and stronger for anticipated changes in oil prices and inventory levels than for unanticipated changes. Furthermore, this difference is statistically significant. We use these findings to evaluate the cost of adjustment hypothesis suggested by Borenstein and Shephard (2002). We also find that there is an asymmetry in the effect of gasoline inventory on gasoline and oil prices. This finding complements a well-known result that positive and negative changes in oil prices have asymmetric effect on gasoline prices.

A dynamic panel study of economic development and the electricity consumption-growth nexus

- Energy Economics---2011---Nicholas Apergis, James Payne

This study examines the relationship between electricity consumption and economic growth for 88 countries categorized into four panels based on the World Bank income classification (high, upper middle, lower middle, and low income) within a multivariate panel framework over the period 1990-2006. The Larsson et

al. (2001) panel cointegration test indicates there is a long-run equilibrium relationship between real GDP, coal consumption, real gross fixed capital formation, and the labor force for the high, upper middle, and lower middle income country panels. The results from the panel vector error correction models reveal (1) bidirectional causality between electricity consumption and economic growth in both the short- and long-run for the high income and upper-middle income country panels; (2) unidirectional causality from electricity consumption to economic growth in the short-run, but bidirectional causality in the long-run for the lower-middle income country panel; and (3) unidirectional causality from electricity consumption to economic growth for the low income country panel.

Energy consumption and economic growth: New insights into the cointegration relationship

- Energy Economics---2011---Ansgar Belke,Frauke Dobnik,Christian Dreger

This paper examines the long-run relationship between energy consumption and real GDP, including energy prices, for 25 OECD countries from 1981 to 2007. The distinction between common factors and idiosyncratic components using principal component analysis allows to distinguish between developments on an international and a national level as drivers of the long-run relationship. Indeed, cointegration between the common components of the underlying variables indicates that international developments dominate the long-run relationship between energy consumption and real GDP. Furthermore, the results suggest that energy consumption is price-inelastic. Causality tests indicate the presence of a bi-directional causal relationship between energy consumption and economic growth.

The effect of power outages and cheap talk on willingness to pay to reduce outages

- Energy Economics---2011---Fredrik Carlsson,Peter Martinsson,Alpaslan Akay

Using an open-ended contingent valuation survey, we analyze how (i) experience of a power outage due to

one of the worst storms ever to hit Sweden and (ii) a cheap talk script affect respondents' WTP to avoid power outages. Experience significantly increases and a cheap talk script significantly decreases the proportion of respondents with zero WTP, and as a result stated WTP is lower with experience and the cheap talk script. The paper concludes with a discussion on the use of valuation studies shortly after the occurrence of an undesirable event.

Validating energy-oriented CGE models

- Energy Economics---2011---Jayson Beckman,Thomas Hertel,Wallace Tyner

Although CGE models have received heavy usage - particularly in the analysis of broad-based policies relating to energy, climate and trade, they are often criticized as being insufficiently validated. Key parameters are often not econometrically estimated, and the performance of the model as a whole is rarely checked against historical outcomes. As a consequence, questions frequently arise as to how much faith one can put in CGE results. In this paper, we employ a novel approach to the validation of a widely utilized global CGE model -- GTAP-E. By comparing the variance of model-generated petroleum price distributions - driven by historical demand and supply shocks to the model - with observed five-year moving average price distributions, we conclude that energy demand in GTAP-E is far too price-elastic over this medium run time frame. After incorporating the latest econometric estimates of energy demand and supply elasticities, we revisit the validation question and find the model to perform more satisfactorily. As a further check, we compare a deterministic global general equilibrium simulation, based on historical realizations over the five year period: 2001-2006, during which petroleum prices rose sharply, along with growing global energy demands. As anticipated by the stochastic simulations, the revised model parameters perform much better than the original GTAP-E parameters in this global, general equilibrium context.

Evaluating the regulator: Winners and losers in the regulation of Spanish electricity distribution

- Energy Economics---2011---Leticia Blázquez-Gómez, Emili Grifell-Tatjé

The principal aim of this study is to evaluate the regulation of electricity distribution in Spain. To this end, we begin by analyzing whether the changes introduced by the regulator led distribution companies to improve their efficiency; we then address whether the reimbursements paid to the distribution companies are linked to efficiency; lastly, we examine whether consumers benefited from the efficiency improvements. We focus on Spain because the electricity regulator in that country is a longstanding pioneer in the implementation of incentive-based regulatory models. Our analysis was implemented using the regulatory model proposed by Bogetoft (1997) as a benchmark. The results show that the Spanish electricity regulator did not establish a link between efficiency and the reimbursements paid to electricity companies; in addition, the electricity companies benefited to the detriment of consumers.

The political economy of energy regulation in OECD countries

- Energy Economics---2011---Chun-Ping Chang, Aziz N. Berdiev

This paper examines the effect of government ideology, political factors and globalization on energy regulation in electricity and gas industries using the bias-corrected least square dummy variable model in a panel of 23 OECD countries over the period of 1975-2007. We find that left-wing governments promote regulation in gas and electricity sectors. Also, less politically fragmented institutions contribute to deregulation of gas and electricity industries. Long tenures of incumbent government have limited impact on regulation in electricity sector, while it is associated with an increase in regulation of gas sector. Further, we find that higher political constraints and more globalized countries lead to deregulation in electricity and gas sectors. We discover that economic and social integration are

the forces that promote deregulation in the gas industry, whereas political integration advance deregulation in the electricity industry. We emphasize that political economy factors are important determinants of energy regulation.

A methodology for calculating the levelized cost of electricity in nuclear power systems with fuel recycling

- Energy Economics---2011---Guillaume De Roo, John E. Parsons

In this paper we show how the traditional definition of the levelized cost of electricity (LCOE) can be extended to alternative nuclear fuel cycles in which elements of the fuel are recycled. In particular, we define the LCOE for a cycle with full actinide recycling in fast reactors in which elements of the fuel are reused an indefinite number of times. To our knowledge, ours is the first LCOE formula for this cycle. Others have approached the task of evaluating this cycle using an 'equilibrium cost' concept that is different from a levelized cost. We also show how the LCOE implies a unique price for the recycled elements. This price reflects the ultimate cost of waste disposal postponed through the recycling, as well as other costs in the cycle. We demonstrate the methodology by estimating the LCOE for three classic nuclear fuel cycles: (i) the traditional Once-Through Cycle, (ii) a Twice-Through Cycle, and (iii) a Fast Reactor Recycle. Given our chosen input parameters, we show that the 'equilibrium cost' is typically larger than the levelized cost, and we explain why.

Effects of technological learning and uranium price on nuclear cost: Preliminary insights from a multiple factors learning curve and uranium market modeling

- Energy Economics---2011---Sondès Kahouli

This paper studies the effects of returns to scale, technological learning, i.e. learning-by-doing and learning-by-searching, and uranium price on the prospects of nuclear cost decrease. We use an extended learning curve specification, named multiple factors learning curve

(MFLC). In a first stage, we estimate a single MFLC. In a second stage, we estimate the MFLC under the framework of simultaneous system of equations which takes into account the uranium supply and demand. This permits not only to enhance the reliability of the estimation by incorporating the uranium price formation mechanisms in the MFLC via the price variable, but also to give preliminary insights about uranium supply and demand behaviors and the associated effects on the nuclear expansion. Results point out that the nuclear cost has important prospects for decrease via capacity expansion, i.e. learning-by-doing effects. In contrast, they show that the learning-by-searching as well as the scale effects have a limited effect on the cost decrease prospects. Conversely, results also show that uranium price exerts a positive and significant effect on nuclear cost, implying that when the uranium price increases, the nuclear power generation cost decreases. Since uranium is characterized by important physical availability, and since it represents only a minor part in the total nuclear cost, we consider that in a context of increasing demand for nuclear energy the latter result can be explained by the fact that the positive learning effects on the cost of nuclear act in a way to dissipate the negative ones that an increase in uranium price may exert. Further, results give evidence of important inertia in the supply and demand sides as well as evidence of slow correlation between the uranium market and oil market which may limit the inter-fuels substitutability effects, that is, nuclear capacity expansion and associated learning-by-doing benefits.

Productivity growth and biased technological change in hydroelectric dams

- Energy Economics---2011---Walter Briec,Nicolas Peypoch,Hermann Ratsimbanierana

This paper analyses productivity growth and the nature of technical change in a sample of Portuguese hydroelectric generating plants over the period 2001 to 2008. In a first step, we employ the Luenberger productivity indicator to estimate and decompose productivity change. A Malmquist productivity index

is also used for a comparative purpose. The results paint a picture of mixed productivity performance in the Portuguese energy sector. The first decomposition underlines that, in average, the productivity variation is explained by the technological change. Then, in a second step, we analyse the nature of this technical change by using the recent concept of parallel neutrality (Briec et al., 2006). We observe a global shift in the best practice frontier as well as in the evidence of input bias in technical change.

Price freezes, durables, and residential electricity demand. Evidence from Greater Buenos Aires

- Energy Economics---2011---Ariel A. Casarin,Maria Eugenia Delfino

This paper examines the determinants of residential electricity demand in Greater Buenos Aires between 1997 and 2006. During the second half of this period, residential electricity tariffs remained nominally fixed, while rising incomes increased sales of durables. Our study is one of few that use monthly data to examine the contribution of prices to residential consumption growth, and it appears to be the first time-series study to explicitly consider the impact of air conditioners on residential demand. Results indicate that durables have an impact on residential electricity demand. Simulations illustrate how prices, income, and durables impact future demand.

Residential consumption of gas and electricity in the U.S.: The role of prices and income

- Energy Economics---2011---Anna Alberini,Will Gans,Daniel Velez-Lopez

We study the residential demand for electricity and gas, working with nationwide household-level data that cover recent years, namely 1997-2007. Our dataset is a mixed panel/multi-year cross-sections of dwellings/households in the 50 largest metropolitan areas in the United States as of 2008. We estimate static and dynamic models of electricity and gas demand. We find strong household response to energy prices, both in the short and long term. From the static models, we

get estimates of the own price elasticity of electricity demand in the -0.860 to -0.667 range, while the own price elasticity of gas demand is -0.693 to -0.566 . These results are robust to a variety of checks. Contrary to earlier literature (Metcalf and Hassett, 1999; Reiss and White, 2005), we find no evidence of significantly different elasticities across households with electric and gas heat. The price elasticity of electricity demand declines with income, but the magnitude of this effect is small. These results are in sharp contrast to much of the literature on residential energy consumption in the United States, and with the figures used in current government agency practice. Our results suggest that there might be greater potential for policies which affect energy price than may have been previously appreciated.

Prediction of daily peak electricity demand in South Africa using volatility forecasting models

- Energy Economics---2011---C. Sigauke,D. Chikobvu

Daily peak electricity demand forecasting in South Africa using a seasonal autoregressive integrated moving average (SARIMA) model, a SARIMA model with generalized autoregressive conditional heteroskedastic (SARIMA-GARCH) errors and a regression-SARIMA-GARCH (Reg-SARIMA-GARCH) model is presented in this paper. The GARCH modeling methodology is introduced to accommodate the possibility of serial correlation in volatility since the daily peak demand data exhibits non-constant mean and variance, and multiple seasonality corresponding to weekly and monthly periodicity. The proposed Reg-SARIMA-GARCH model is designed in such a way that the predictor variables are initially selected using a multivariate adaptive regression splines algorithm. The developed models are used for out of sample prediction of daily peak demand. A comparative analysis is done with a piecewise linear regression model. Results from the study show that the Reg-SARIMA-GARCH model produces better forecast accuracy with a mean absolute percent error (MAPE) of 1.42%.

Response of residential electricity demand to price: The effect of measurement error

- Energy Economics---2011---Anna Alberini,Massimo Filippini

In this paper we present an empirical analysis of the residential demand for electricity using annual aggregate data at the state level for 48 US states from 1995 to 2007. Earlier literature has examined residential energy consumption at the state level using annual or monthly data, focusing on the variation in price elasticities of demand across states or regions, but has failed to recognize or address two major issues. The first is that, when fitting dynamic panel models, the lagged consumption term in the right-hand side of the demand equation is endogenous. This has resulted in potentially inconsistent estimates of the long-run price elasticity of demand. The second is that energy price is likely mismeasured. To address these issues, we estimate a dynamic partial adjustment model using the Kiviet corrected Least Square Dummy Variables (LSDV) (1995) and the Blundell-Bond (1998) estimators. We find that the long-term elasticities produced by the Blundell-Bond system GMM methods are largest, and that from the bias-corrected LSDV are greater than that from the conventional LSDV. From an energy policy point of view, the results obtained using the Blundell-Bond estimator where we instrument for price imply that a carbon tax or other price-based policy may be effective in discouraging residential electricity consumption and hence curbing greenhouse gas emissions in an electricity system mainly based on coal and gas power plants.

Electricity demand elasticities and temperature: Evidence from panel smooth transition regression with instrumental variable approach

- Energy Economics---2011---Chien-Chiang Lee,Yi-Bin Chiu

This study applies a non-linear model, i.e. the recently developed panel smooth transition regression (PSTR) model, and takes into account the potential endogeneity biases to investigate the demand function of electricity

for 24 OECD countries from the period 1978-2004. Our empirical results demonstrate that there is a strongly non-linear link among electricity consumption, real income, electricity price, and temperature, a result that is new to the literature. As real income rises, electricity consumption rapidly increases first, and after the level of real income exceeds approximately US\$2500, its increasing rate turns slow down. An increase in electricity price has a negative or no influence on electricity consumption. Evidence of a U-shaped relationship between electricity consumption and temperature is supported, and the threshold value of temperature is approximately 53°F, which is endogenously determined. Furthermore, the estimated elasticities of time dynamic indicate that electricity demand is income inelastic, price inelastic, and temperature inelastic. As time goes on, the absolute elasticities of electricity demand gradually decrease with respect to real GDP and electricity price, whereas they gradually increase with respect to temperature, suggesting that the impact of temperature on electricity demand is becoming more important in recent years.

Value-at-risk estimation of crude oil price using MCA based transient risk modeling approach

- Energy Economics---2011---Kaijian He,Kin Keung Lai,Jerome Yen

With the increasing level of volatility in the crude oil market, the transient data feature becomes more prevalent in the market and is no longer ignorable during the risk measurement process. Since there are multiple representations for these transient data features using a set of bases available, the sparsity measure based Morphological Component Analysis (MCA) model is proposed in this paper to find the optimal combinations of representations to model these transient data features. Therefore, this paper proposes a MCA based hybrid methodology for analyzing and forecasting the risk evolution in the crude oil market. The underlying transient data components with distinct behaviors are extracted and analyzed using MCA model. The proposed algorithm incorporates these transient data features to adjust for conservative risk estimates from

traditional approach based on normal market condition during its risk measurement process. The reliability and stability of Value at Risk (VaR) estimated improve as a result of finer modeling procedure in the multi frequency and time domain while maintaining competent accuracy level, as supported by empirical studies in the representative West Texas Intermediate (WTI) and Brent crude oil market.

Crude oil hedging strategies using dynamic multivariate GARCH

- Energy Economics---2011---Chia-Lin Chang,Michael McAleer,Roengchai Tansuchat

The paper examines the performance of several multivariate volatility models, namely CCC, VARMA-GARCH, DCC, BEKK and diagonal BEKK, for the crude oil spot and futures returns of two major benchmark international crude oil markets, Brent and WTI, to calculate optimal portfolio weights and optimal hedge ratios, and to suggest a crude oil hedge strategy. The empirical results show that the optimal portfolio weights of all multivariate volatility models for Brent suggest holding futures in larger proportions than spot. For WTI, however, DCC, BEKK and diagonal BEKK suggest holding crude oil futures to spot, but CCC and VARMA-GARCH suggest holding crude oil spot to futures. In addition, the calculated optimal hedge ratios (OHRs) from each multivariate conditional volatility model give the time-varying hedge ratios, and recommend to short in crude oil futures with a high proportion of one dollar long in crude oil spot. Finally, the hedging effectiveness indicates that diagonal BEKK (BEKK) is the best (worst) model for OHR calculation in terms of reducing the variance of the portfolio.

Revisiting the relationship between spot and futures oil prices: Evidence from quantile cointegrating regression

- Energy Economics---2011---Chien-Chiang Lee,Jhih-Hong Zeng

Since most real decisions depend upon current market states or whether it is advantageous to the participants

themselves, this paper revisits the relationship between spot and futures oil prices of West Texas Intermediate covering 1986 to 2009 with an innovative approach named quantile cointegration. Different to previous perspectives, we target the issues of cointegrating relationships, causalities, and market efficiency based on different market states under different maturities of oil futures. In our empirical analysis, except for market efficiency, long-run cointegrating relationships and causalities between spot and futures oil prices have significant differentials among futures maturities and the performances of spot oil markets. Furthermore, the response of spot prices to shocks in 1-month futures oil prices is much steeper in high spot prices than in low spot prices. This phenomenon is consistent with the prospect theory (Kahneman and Tversky, 1979), in that the value function is generally steeper for losses than for gains.

Multiscale entropy analysis of crude oil price dynamics

- Energy Economics---2011---Esteban Martina, Eduardo Rodriguez, Rafael Escarela-Perez, Jose Alvarez-Ramirez

Price formation in crude oil markets is the result of the action of many participants (e.g., producers, governments, speculators, etc.) whose effects are perceived at different time scales, from days to years. The diversity of participants as well as the occurrence of extreme socio-political events yields a market with complex price evolution. This paper uses entropy methods to monitor the evolution of crude oil price movements. As the complexity of the price can depend of the time horizon, entropy computations are performed for different time scales via low-pass filtering of the price difference dynamics. The results are interpreted in term of relative market efficiency concepts in the sense that high entropy values should be related to a more complex and, hence, less predictable market evolution. It is shown that the highest market efficiency is found for small time scales up to one or two weeks. The multiscale entropy pattern for high time scales, longer than one quarter, is interesting as it shows alternating

periods of high and low entropy levels. Interestingly, this alternating pattern has a dominant spectral component of about 4.3 years, which could be related to macroeconomic (Kitchin) business cycles. It is shown that U.S. recessions in the recent 25 years are coincident with periods of reduced entropy levels, meaning that during economic downturn the long-run market complexity is drastically reduced. The possible effects of extreme events (e.g., Iraq War) are analyzed in terms of the relative market efficiency, suggesting that some events have affected the short-term but not the long-term market complexity. Overall, these results show that methods based on entropy concepts can shed light on the structure of crude oil markets as well as on its link to macroeconomic conditions and socio-political extreme events.

How do crude oil prices co-move?: A copula approach

- Energy Economics---2011---Juan Reboredo

This paper examines the dependence structure between crude oil benchmark prices using copulas. By considering several copula models with different conditional dependence structures and time-varying dependence parameters, we find evidence of significant symmetric upper and lower tail dependence between crude oil prices. These findings suggest that crude oil prices are linked with the same intensity during bull and bear markets, thus supporting the hypothesis that the oil market is 'one great pool'--in contrast with the hypothesis that states that the oil market is regionalized. Our findings on crude oil price co-movements also have implications for risk management, hedging strategies and asset pricing.

Oil and stock market volatility: A multivariate stochastic volatility perspective

- Energy Economics---2011---Minh Vo

This paper models the volatility of stock and oil futures markets using the multivariate stochastic volatility structure in an attempt to extract information intertwined in both markets for risk prediction. It offers

four major findings. First, the stock and oil futures prices are inter-related. Their correlation follows a time-varying dynamic process and tends to increase when the markets are more volatile. Second, conditioned on the past information, the volatility in each market is very persistent, i.e., it varies in a predictable manner. Third, there is inter-market dependence in volatility. Innovations that hit either market can affect the volatility in the other market. In other words, conditioned on the persistence and the past volatility in their respective markets, the past volatility of the stock (oil futures) market also has predictive power over the future volatility of the oil futures (stock) market. Finally, the model produces more accurate Value-at-Risk estimates than other benchmarks commonly used in the financial industry.

Oil price shocks and industry stock returns

- Energy Economics---2011---Elyas Elyasiani,Iqbal Mansur,Babatunde Odusami

We examine the impact of changes in the oil returns and oil return volatility on excess stock returns and return volatilities of thirteen U.S. industries using the GARCH (1,1) technique. We find strong evidence in support of the view that oil price fluctuations constitute a systematic asset price risk at the industry level as nine of the thirteen sectors analyzed show statistically significant relationships between oil-futures return distribution and industry excess return. These industries are affected either by oil futures returns, oil futures return volatility or both. In general, excess returns of the oil-user industries are more likely to be affected by changes in the volatility of oil returns, than those of oil return itself. Volatilities of industry excess returns are time-varying, and return volatility for a number of sectors, appears to have long memory. Fama-French factors show universal statistical and high economic significance as risk factors influencing industry excess returns.

Oil price volatility and stock price fluctuations in an emerging market: Evidence from South Korea

- Energy Economics---2011---Rumi Masih,Sanjay Peters,Lurion De Mello

How important are oil price fluctuations and oil price volatility on equity market performance? What are the policy implications if volatility turns out to be significant? We assess this issue in an economics/finance nexus for Korea using a VEC model including interest rates, economic activity, real stock returns, real oil prices and oil price volatility. Our main aim is to capture the effects of crude oil prices on the Korean economy thoroughly covering the period of the Asian Financial Crisis of 1997, which heavily affected the country, and the oil price hikes in the early 1990s after the Gulf War. South Korea was the country most hit by the financial crisis together with Indonesia and Thailand. Results indicate the dominance of oil price volatility on real stock returns and emphasize how this has increased over time. Oil price volatility can have profound effect on the time horizon of investment and firms need adjust their risk management procedures accordingly. This increase in dependency has been found in other net oil importing emerging equity markets. We test the relationship between oil price movements and economic activity by using modern time series techniques in a cointegrating framework. We expand the standard error correction model by examining the dynamics of out of sample causality through the generalized variance decomposition and impulse response function techniques. The evidence from persistence profiles also gives important guidelines based on how fast the entire system adjusts back to equilibrium. In addition, we find the cointegrating relationship to be stable and find that the linear error correction model to be more favorable than an asymmetric 2 period Markov switching model.

Crude oil shocks and stock markets: A panel threshold cointegration approach

- Energy Economics---2011---Hui-Ming Zhu,Su-Fang Li,Keming Yu

This paper proposes a panel threshold cointegration approach to investigate the relationship between crude oil shocks and stock markets for the OECD and non-OECD panel from January 1995 to December 2009. Nonlinear cointegration is confirmed for the oil-stock nexus in the panel. Because threshold cointegration is found, the threshold vector error correction models can be run to investigate the presence of asymmetric dynamic adjustment. The Granger causality tests demonstrate the existence of bidirectional long-run Granger causality between crude oil shocks and stock markets for these OECD and non-OECD countries. However, the short-run Granger causality between them is bidirectional under positive changes in the deviation and unidirectional under negative ones. Moreover, the speed of adjustment toward equilibrium is faster under negative changes in the deviation than that under positive ones in these OECD and non-OECD countries.

The impact of the European Union emission trading scheme on the electricity-generation sector

- Energy Economics---2011---Djamel Kirat,Ibrahim Ahamada

In order to comply with their commitments under the Kyoto Protocol, France and Germany participate in the European Union Emission Trading Scheme (EU ETS) which predominantly concerns the electricity-generation sectors. In this paper we ask whether the EU ETS provides the appropriate economic incentives to produce an efficient system in line with the Kyoto commitments. If so, electricity producers in the countries concerned should include the price of carbon in their cost functions. After identifying different sub-periods of the EU ETS during its pilot phase (2005-2007), we model the prices of various electricity contracts in France and Germany and look at the volatility of electricity prices around their fundamentals while evaluating the correlation between electricity prices in the two countries. We find that electricity producers in both countries were constrained to include the carbon price in their cost functions during the first two years of the EU ETS. Over this period, German

electricity producers were more constrained than their French counterparts, and the inclusion of the carbon price in the electricity-generation cost function was much more stable in Germany than in France. We also find evidence of fuel switching in electricity generation in Germany after the collapse of the carbon market. Furthermore, the European market for emission allowances has greatly contributed to the partial alignment of the wholesale price of electricity in France to that in Germany.

Decarbonization of the U.S. electricity sector: Are state energy policy portfolios the solution?

- Energy Economics---2011---Sanya Carley

State governments have taken the lead on U.S. energy and climate policy. It is not yet clear, however, whether state energy policy portfolios can generate results in a similar magnitude or manner to their presumed carbon mitigation potential. This article seeks to address this lack of policy evidence and contribute empirical insights on the carbon mitigation effects of state energy portfolios within the U.S. electricity sector. Using a dynamic, long-term electricity dispatch model with U.S. power plant, utility, and transmission and distribution data between 2010 and 2030, this analysis builds a series of state-level policy portfolio scenarios and performs a comparative scenario analysis. Results reveal that state policy portfolios have modest to minimal carbon mitigation effects in the long run if surrounding states do not adopt similar portfolios as well. The difference in decarbonization potential between isolated state policies and larger, more coordinated policy efforts is due in large part to carbon leakage, which is the export of carbon intensive fossil fuel-based electricity across state lines. Results also confirm that a carbon price of \$50/metric ton CO₂e can generate substantial carbon savings. Although both policy options - an energy policy portfolio or a carbon price - are effective at reducing carbon emissions in the present analysis, neither is as effective alone as when the two strategies are combined.

Supply of renewable energy sources and the cost of EU climate policy

- Energy Economics---2011---Stefan Boeters,Joris Koornneef

What are the excess costs of a separate 20% target for renewable energy as a part of the EU climate policy for 2020? We answer this question using a computable general equilibrium model, WorldScan, which has been extended with a bottom-up module of the electricity sector. The model set-up makes it possible to base the calibration directly on available estimates of costs and capacity potentials for renewable energy sources. In our base case simulation, the costs of EU climate policy with the renewables target are 6% higher than those of a policy without this target. The uncertainty in this estimate is considerable, however, and depends on our assumptions about the availability of low-cost renewable energy: the initial cost level, the steepness of the supply curves and share of renewable energy in the baseline. Within the range we explore, the excess costs vary from zero (when the target is not a binding constraint) to 32% (when the cost progression and the initial cost disadvantage for renewable energy are high and its initial share is low).

General equilibrium, electricity generation technologies and the cost of carbon abatement: A structural sensitivity analysis

- Energy Economics---2011---Bruno Lanz,Sebastian Rausch

Electricity generation is a major contributor to carbon dioxide emissions, and abatement in this sector is a key determinant of economy-wide regulation costs. The complexity of an integrated representation of economic and electricity systems makes simplifying assumptions appealing, but there is no evidence in the literature on how important the pitfalls may be. The aim of this paper is to provide such evidence, drawing on numerical simulations from a suite of partial and general equilibrium models that share common technological features and are calibrated to the same benchmark data. We report two basic findings. First, general

equilibrium inter-sectoral effects of an economy-wide carbon policy are large. It follows that assessing abatement potentials and price changes in the electricity sector with a partial equilibrium Marshallian demand can only provide a crude approximation of the complex demand-side interactions. Second, we provide evidence that widely used top-down representations of electricity technologies produce fuel substitution patterns that are inconsistent with bottom-up cost data. This supports the view that the parametrization of substitution possibilities with highly aggregated production functions is difficult to validate empirically. The overall picture that emerges is one of large quantitative and even qualitative differences, highlighting the role of key structural assumptions in the interpretation of climate policy projections.

Editors' introduction: The economics of technologies to combat global warming

- Energy Economics---2011---Nebojsa Nakicenovic,William Nordhaus

2011

Prospects for nuclear energy

- Energy Economics---2011---John F. Ahearne

Support for a growth in nuclear power has been seen in China and the United States. Obstacles to further growth include cost, concerns about links to proliferation of nuclear weapons, public attitudes, how to handle nuclear waste, and workforce shortages. More than 20 countries are considering building nuclear power plants. Among new designs being considered are pebble-bed reactors and small reactors. Continued growth will require addressing the obstacles and continued safe operation of plants worldwide.

Comment

- Energy Economics---2011---John Steinbruner

The Ahearne paper demonstrates that the current nuclear industry is unlikely to expand to the extent required to stabilize GHG concentrations by 2050. It is

conceivable, however, that adequate expansion could occur on the basis of advanced reactor designs, internationalized control of fuel cycle services and fundamentally altered security relationships among the nuclear weapon states. Those enabling developments can only occur if the underlying problem of global warming acquires greater priority than it currently enjoys, but there are imaginable developments that could produce such an outcome.

The status and prospects of renewable energy for combating global warming

- Energy Economics---2011---Douglas J. Arent, Alison Wise, Rachel Gelman

Reducing anthropogenic greenhouse gas (GHG) emissions in material quantities, globally, is a critical element in limiting the impacts of global warming. GHG emissions associated with energy extraction and use are a major component of any strategy addressing climate change mitigation. Non-emitting options for electrical power and liquid transportation fuels are increasingly considered key components of an energy system with lower overall environmental impacts. Renewable energy technologies (RETs) as well as biofuels technologies have been accelerating rapidly during the past decades, both in technology performance and cost-competitiveness -- and they are increasingly gaining market share. These technology options offer many positive attributes, but also have unique cost/benefit trade-offs, such as land-use competition for bioresources and variability for wind and solar electric generation technologies. This paper presents a brief summary of status, recent progress, some technological highlights for RETs and biofuels, and an analysis of critical issues that must be addressed for RETs to meet a greater share of the global energy requirements and lower GHG emissions.

Comment

- Energy Economics---2011---Elmar Kriegler

The article by Douglas Arent, Alison Wise, and Rachel Gelman provides an excellent overview on the rapid

development of the renewable energy sector. The article focuses on trends in renewable energy markets, the status and prospects of renewable energy technology (RET), and policy frameworks for RETs. It is more reticent on the role of renewable energy for combating global warming. This acknowledges the fact that a full assessment of the potential contribution of RETs requires an integrated systems perspective, including consideration of the climate change mitigation requirement and the status and prospects of alternative mitigation options ([Edenhofer et al., 2009], [Edenhofer et al., 2010] and [Clarke et al., 2009]). This comment will briefly review the article's perspective on the trends and prospects of renewable energy, and then move on to a short discussion of some system-level considerations for assessing the role of renewable energy for combating global warming.

Scaling up carbon dioxide capture and storage: From megatons to gigatons

- Energy Economics---2011---Howard J. Herzog

Carbon dioxide (CO₂) capture and storage (CCS) is the only technology that can reduce CO₂ emissions substantially while allowing fossil fuels to meet the world's pressing energy needs. Even though the technological components of CCS--separation of CO₂ from emissions, transport, and secure storage--are all in use somewhere in the economy, they do not currently function together in the manner required for large-scale CO₂ reduction. The challenge for CCS to be considered commercial is to integrate and scale up these components. Significant challenges remain in growing CCS from the megaton level where it is today to the gigaton level where it needs to be to help mitigate global climate change. These challenges, none of which are showstoppers, include lowering costs, developing needed infrastructure, reducing subsurface uncertainty, and addressing legal and regulatory issues. Progress will require a series of demonstration projects worldwide, an economically viable policy framework, and the evolution of a business model.

Comment

- Energy Economics---2011---Brian P. Flannery

This comment will address CCS from the perspective of potential suppliers, operators, and clients in large-scale systems. CCS today lacks both an economically viable policy framework and a business model. Although little has changed regarding the available technology, and the potential for CCS to mitigate emissions since publication of the comprehensive IPCC (2005) review, much has changed concerning estimates of costs, institutional barriers, and enablers. As well, the major expansion in proven reserves of natural gas gives increased impetus to understand the implications of CCS applied to power from natural gas as a significant option to mitigate emissions.

Uncertainty, loss aversion, and markets for energy efficiency

- Energy Economics---2011---David L. Greene

Increasing energy efficiency is critical to mitigating greenhouse gas emissions from fossil-fuel combustion, reducing oil dependence, and achieving a sustainable global energy system. The tendency of markets to neglect apparently cost-effective energy efficiency options has been called the "efficiency gap" or "energy paradox." The market for energy efficiency in new, energy-using durable goods, however, appears to have a bias that leads to undervaluation of future energy savings relative to their expected value. This paper argues that the bias is chiefly produced by the combination of substantial uncertainty about the net value of future fuel savings and the loss aversion of typical consumers. This framework relies on the theory of context-dependent preferences. The uncertainty-loss aversion bias against energy efficiency is quantifiable, making it potentially correctible by policy measures. The welfare economics of such policies remains unresolved. Data on the costs of increased fuel economy of new passenger cars, taken from a National Research Council study, illustrate how an apparently cost-effective increase in energy efficiency would be uninteresting to loss-averse consumers.

Comment

- Energy Economics---2011---Lawrence Goulder

2011

Technology interactions among low-carbon energy technologies: What can we learn from a large number of scenarios?

- Energy Economics---2011---Haewon C. McJeon, Leon Clarke, Page Kyle, Marshall Wise, Andrew Hackbarth, Benjamin P. Bryant, Robert J. Lempert

Advanced low-carbon energy technologies can substantially reduce the cost of stabilizing atmospheric carbon dioxide concentrations. Understanding the interactions between these technologies and their impact on the costs of stabilization can help inform energy policy decisions. Many previous studies have addressed this challenge by exploring a small number of representative scenarios that represent particular combinations of future technology developments. This paper uses a combinatorial approach in which scenarios are created for all combinations of the technology development assumptions that underlie a smaller, representative set of scenarios. We estimate stabilization costs for 768 runs of the Global Change Assessment Model (GCAM), based on 384 different combinations of assumptions about the future performance of technologies and two stabilization goals. Graphical depiction of the distribution of stabilization costs provides first-order insights about the full data set and individual technologies. We apply a formal scenario discovery method to obtain more nuanced insights about the combinations of technology assumptions most strongly associated with high-cost outcomes. Many of the fundamental insights from traditional representative scenario analysis still hold under this comprehensive combinatorial analysis. For example, the importance of carbon capture and storage (CCS) and the substitution effect among supply technologies are consistently demonstrated. The results also provide more clarity regarding insights not easily demonstrated through representative scenario analysis. For example, they show more clearly how

certain supply technologies can provide a hedge against high stabilization costs, and that aggregate end-use efficiency improvements deliver relatively consistent stabilization cost reductions. Furthermore, the results indicate that a lack of CCS options combined with lower technological advances in the buildings sector or the transportation sector is the most powerful predictor of high-cost scenarios.

Comment

- Energy Economics---2011---Valentina Bosetti

The paper by Haewon McJeon and coauthors seeks to estimate the benefits (measured as avoided climate policy costs) of different carbon-free and low-carbon technologies in the context of climate stabilization. The paper does not include a full cost-benefit analysis of these technologies nor does it evaluate what would be needed to bring these technologies about (e.g., in an optimal R&D investment portfolio). Nonetheless, in its main conclusions, the paper provides a sensible analysis and adds to the expanding literature on this extremely relevant topic by exploring a new dimension, that of the interactions among technologies and their combined impact.

Energy R&D portfolio analysis based on climate change mitigation

- Energy Economics---2011---Graham Pugh,Leon Clarke,Robert Marlay,Page Kyle,Marshall Wise,Haewon McJeon,Gabriel Chan

Abstract The diverse nature and uncertain potential of the energy technologies that are or may be available to mitigate greenhouse gas emissions pose a challenge to policymakers trying to invest public funds in an optimal R&D portfolio. This paper discusses two analytical approaches to this challenge used to inform funding decisions related to the U.S. Department of Energy (DOE) applied energy R&D portfolio. The two approaches are distinguished by the constraints under which they were conducted: the need to provide an end-to-end portfolio analysis as input to internal DOE budgeting processes, but with limited time and subject

to institutional constraints regarding important issues such as expert judgment. Because of these constraints, neither approach should be viewed as an attempt to push forward the state of the art in portfolio analysis in the abstract. Instead, they are an attempt to use more stylized, heuristic methods that can provide first-order insights in the DOE institutional context. Both approaches make use of advanced technology scenarios implemented in an integrated assessment modeling framework and then apply expert judgment regarding the likelihood of achieving associated R&D and commercialization goals. The approaches differ in the granularity of the scenarios used and in the definition of the benefits of technological advance: in one approach the benefits are defined as the cumulative emission reduction attributable to a particular technology; in the other approach benefits are defined as the cumulative cost reduction. In both approaches a return on investment (ROI) criterion is established based on benefits divided by federal R&D investment. The ROI is then used to build a first-order approximation of an optimal applied energy R&D investment portfolio. Although these methodologies have been used to inform an actual budget request, the results reflect only one input among many used in budget formulation. The results are therefore not representative of an official U.S. government or DOE funding recommendation but should instead be considered illustrative of the way in which methodologies such as these could be applied.

Comment

- Energy Economics---2011---Detlef P. van Vuuren,Tom Kram

Integrated assessment models are being used to support R&D portfolio decisions, in order to provide a more systems view on the impact of progress for individual technologies. While the model-supported assessment provides a more structured framework for analysis, it should not hide that there are large uncertainties. This paper shows that results are dependent on the model, the ambition of climate policy and other technology assumptions. It is important in R&D investment advice to realize these uncertainties, and assess the robustness

of results against results of other models and studies.

Technology and the diffusion of renewable energy

- Energy Economics---2011---David Popp,Ivan Haščič,Neelakshi Medhi

We consider investment in wind, solar photovoltaic, geothermal, and electricity from biomass and waste across 26 OECD countries from 1991 to 2004. Using the PATSTAT database, we obtain a comprehensive list of patents for each of these technologies throughout the world, which we use to assess the impact of technological change on investment in renewable energy capacity. We consider four alternative methods for counting patents, using two possible filters: weighting patents by patent family size and including only patent applications filed in multiple countries. For each patent count, we create knowledge stocks representing the global technological frontier. We find that technological advances do lead to greater investment, but the effect is small. Investments in other carbon-free energy sources, such as hydropower and nuclear power, serve as substitutes for renewable energy. Comparing the effectiveness of our four patent counts, we find that both using only patents filed in multiple countries and weighting by family size improve the fit of the model.

Comment

- Energy Economics---2011---Adam Jaffe

2011

Designing a friendly space for technological change to slow global warming

- Energy Economics---2011---William Nordhaus

What is the best strategy to encourage research and development on new energy technologies in a market economy? What steps can ensure a rapid and efficient transition to an economy that has much lower net carbon emissions? This paper shows that, under limited conditions, a necessary and sufficient condition for an appropriate innovational environment is a universal,

credible, and durable price on carbon emissions. Such a price would balance the marginal damages from carbon emissions against the marginal costs of abating emissions; it should not contain a correction factor for inducing technological change. This result, which the paper calls "price fundamentalism," applies principally to the market-oriented part of research and innovation. It is subject to qualifications regarding the efficacy of intellectual property protection and the proper level of carbon prices, and it applies primarily to market sectors. The role of appropriate prices on emissions is a central part of public policies to encourage technologies to combat global warming.

Accelerating the development and diffusion of new energy technologies: Beyond the "valley of death"

- Energy Economics---2011---John P. Weyant

There are at least three motivations for government intervention in GHG mitigation: (1) inducing the private sector to reduce GHG emissions directly by setting a price on emissions, (2) increasing the amount of innovative activity in GHG mitigation technology development, and (3) educating the public regarding GHG-reducing investment opportunities, allowing consumers to make better private decisions. This paper discusses the pros and cons of policy instruments that might be used to respond to these motivations and makes recommendations for an appropriate mix of policy instruments over time given both economic and political/institutional considerations.

Comment

- Energy Economics---2011---Roger Noll

2011

The future of the European Emission Trading System and the Clean Development Mechanism in a post-Kyoto world

- Energy Economics---2011---Gernot Klepper

This paper discusses developments in the markets for CO₂ emissions rights since the Kyoto Protocol was signed. The different emissions trading schemes, dominated by the Emission Trading System of the European Union and the Clean Development Mechanism, are surveyed. These schemes will need to be incorporated into any post-Kyoto multilateral agreement. Drawing on a simple model, the paper analyzes the incentives that developing and developed countries face for continuing or transforming the Clean Development Mechanism in the light of future agreements for a worldwide emissions control program.

Inducing transformational energy technological change

- Energy Economics---2011---Thomas J. Wilbanks

Reducing risks of severe climate change in the latter part of the 20th Century is likely to require not only incremental improvements in known energy technologies, but the discovery of transformational new energy technologies. This paper reviews current knowledge about both demand and supply aspects of the challenge of accelerating transformational change, considering both economic and policy incentives, including targeted government funding of research and development, and several other schools of thought about drivers of scientific discovery and innovation.

Investment in electricity markets with asymmetric technologies

- Energy Economics---2011---Talat Genc, Henry Thille

Capacity investments in electricity markets is one of the main issues in the restructuring process to ensure competition and enhance system security of networks. We study competition between hydro and thermal electricity generators under demand uncertainty. Producers compete in quantities and each is constrained: the thermal generator by capacity and the hydro generator by water availability. We analyze a two-period game emphasizing the incentives for capacity investments by the thermal generator. We characterize both Markov

perfect and open-loop equilibria. In the Markov perfect equilibrium, investment is discontinuous in initial capacity and higher than it is in the open-loop equilibrium. However, since there are two distortions in the model, equilibrium investment can be either higher or lower than the efficient investment.

Taxing incumbent monopoly to foster entry

- Energy Economics---2011---Franz Wirl

This paper investigates whether it is welfare enhancing to tax the output of a monopoly in order to foster cost-inefficient entry. This question is of particular concern in the energy markets dominated by cartel-like affiliations (OPEC and oil, Russia's gas exports to Europe) and the interest and practice to stimulate the development of alternative fuels. Making the realistic assumption that none of the players can commit to future policies, subsidies are not a viable strategy for the government. A tax cannot be first best but can be second best if the government cannot force the incumbent monopoly to sell its output at no profit and if the incumbent's profit is discounted. However, stimulating supply by improving the conditions for entry is not the prime concern of taxation (after all it lowers aggregate supplies and may even lower the entrant's supply) but to accrue parts of the monopoly rent.

Optimal taxation of a monopolistic extractor: Are subsidies necessary?

- Energy Economics---2011---Julien Daubanes

This note reconsiders the optimal taxation problem when extraction of an exhaustible resource is monopolistic. In a standard model, I explicitly characterize and examine all the efficiency-inducing paths of taxes/subsidies on the resource. Consistently with the literature, there is a family of such optimal paths. In contrast with Im (2002), it may not be necessary to subsidize the monopoly at any date: within the family of optimal paths of taxes/subsidies, there may exist some paths along which the regulator raises positive revenues at all dates. This illustrates how the static

trade-off between inducing efficiency and raising tax revenues in the presence of market power is relaxed under exhaustibility.

Causal modeling and inference for electricity markets

- Energy Economics---2011---Egil Ferk-
ingstad, Anders Løland, Mathilde Wilhelmsen

How does dynamic price information flow among Northern European electricity spot prices and prices of major electricity generation fuel sources? We use time series models combined with new advances in causal inference to answer these questions. Applying our methods to weekly Nordic and German electricity prices, and oil, gas and coal prices, with German wind power and Nordic water reservoir levels as exogenous variables, we estimate a causal model for the price dynamics, both for contemporaneous and lagged relationships. In contemporaneous time, Nordic and German electricity prices are interlinked through gas prices. In the long run, electricity prices and British gas prices adjust themselves to establish the equilibrium price level, since oil, coal, continental gas and EUR/USD are found to be weakly exogenous.

Implicit auctioning on the Kontek Cable: Third time lucky?

- Energy Economics---2011---Leonardo Meeus

Implicit auctioning in Europe is about eliminating cross-border trade inefficiencies by internalizing cross-border trade into the day-ahead auction procedures of the Power Exchanges that are already organizing trade nationally. On the Kontek Cable, implicit auctioning has first been implemented with "no coupling" between the relevant Power Exchanges, followed by a "volume coupling" implementation, and finally a "one way price coupling" implementation that is still operational today. The main contribution of this paper is to compare the theoretical properties of these three implementations and to analyze their performance empirically. We find that the third implementation is significantly outperforming the previous two implementations, but in this

third implementation stakeholders partly abandoned the "volume coupling" approach they initially believed to be a viable alternative and institutionally easier to implement.

R&D and abatement under environmental liability law: Comparing incentives under strict liability and negligence if compensation differs from harm

- Energy Economics---2011---Alfred Endres, Tim Friehe

This paper analyzes equilibrium R&D in pollution control and equilibrium pollution abatement by polluters who are subject to environmental liability law when the level of compensation differs from the level of environmental harm. We contrast the performance of strict liability with that of the negligence rule. Privately optimal levels necessarily deviate from socially optimal ones under strict liability, whereas private decisions are first-best under negligence unless compensation is much smaller than harm. It is established that the way in which privately optimal R&D deviates from the first-best level depends on the kind of technical change in pollution abatement. Counterintuitively polluters might overinvest into R&D in pollution control if compensation falls short of harm, and may underinvest if compensation exceeds harm.

Industrial electricity demand for Turkey: A structural time series analysis

- Energy Economics---2011---Zafer Dilaver, Lester Hunt

This research investigates the relationship between Turkish industrial electricity consumption, industrial value added and electricity prices in order to forecast future Turkish industrial electricity demand. To achieve this, an industrial electricity demand function for Turkey is estimated by applying the structural time series technique to annual data over the period 1960 to 2008. In addition to identifying the size and significance of the price and industrial value added (output) elasticities, this technique also uncovers the electricity

Underlying Energy Demand Trend (UEDT) for the Turkish industrial sector and is, as far as is known, the first attempt to do this. The results suggest that output and real electricity prices and a UEDT all have an important role to play in driving Turkish industrial electricity demand. Consequently, they should all be incorporated when modelling Turkish industrial electricity demand and the estimated UEDT should arguably be considered in future energy policy decisions concerning the Turkish electricity industry. The output and price elasticities are estimated to be 0.15 and - 0.16 respectively, with an increasing (but at a decreasing rate) UEDT and based on the estimated equation, and different forecast assumptions, it is predicted that Turkish industrial electricity demand will be somewhere between 97 and 148 TWh by 2020.

Estimation of tourism-induced electricity consumption: The case study of Balearics Islands, Spain

- Energy Economics---2011---Mohcine Bakhat,Jaume Rossello

Tourism has started to be acknowledged as a significant contributor to the increase in environmental externalities, especially to climate change. Various studies have started to estimate and compute the role of the different tourism sectors' contributions to greenhouse gas (GHG) emissions. These estimations have been made from a sectoral perspective, assessing the contribution of air transport, the accommodation sector, or other tourism-related economic sectors. However, in order to evaluate the impact of this sector on energy use the approaches used in the literature consider tourism in its disaggregated way. This paper assesses the electricity demand pattern and investigates the aggregated contribution of tourism to electricity consumption using the case study of the Balearic Islands (Spain). Using a conventional daily electricity demand model, including data for daily stocks of tourists the impact of the different population growth rate scenarios on electricity loads is also investigated. The results show that, in terms of electricity consumption, tourism cannot be considered a very energy-intensive sector.

The effect of population density, road network density, and congestion on household gasoline consumption in U.S. urban areas

- Energy Economics---2011---Qing Su

This paper applies both semiparametric and parametric approaches to explore the effect of population density, freeway road density, and congestion on household gasoline consumption in U.S. urban areas while controlling for household demographic and economic characteristics. Regression results indicate that households living in those urban areas with higher freeway densities, higher levels of congestion, or lower population densities consume more gasoline.

Analyzing energy consumption and GDP nexus using maximum entropy bootstrap: The case of Turkey

- Energy Economics---2011---A. Talha Yalta

We employ a maximum entropy bootstrap based framework to analyze the energy consumption and real GDP nexus between 1950 and 2006 in Turkey. Our approach provides more accurate inference in comparison to conventional hypothesis tests based on asymptotic theory. It also avoids preliminary testing and shape-destroying transformations such as differencing and detrending. The bivariate analysis as well as a multivariate framework controlling for exchange rate and oil prices shows no evidence of a causal relation. Our results are robust to both the number of lags and the time period chosen. We also perform a cointegration analysis of the data and point out a common misunderstanding in the literature regarding the concept of causation.

Development of method for estimation of world industrial energy consumption and its application

- Energy Economics---2011---Shinichiro Fujimori,Yuzuru Matsuoka

The energy balances published by the International Energy Agency (IEA) are one of the most valuable sources of energy statistics covering world energy supply and

demand. However, some issues arise when these data are analyzed or used directly. Even when industrial energy consumption alone is examined, at least three types of issues are encountered: missing data, large amounts of misallocated data in some countries, and numerous unrealistic outliers in the time-series variations. When we deal with only a few regions, we can look at data one by one and modify them. In this case, we are going to overcome these issues with a systematic method because the data covers world including more than a hundred regions. This paper proposes a data reconciliation method to treat these issues, and describes its application to world industrial energy consumption. As a result of its application, we found that the three issues mentioned above seemed to be overcome. The degree of the reconciliation by region showed that OECD countries' degree tends to be smaller than those of non-OECD countries. However, not all of the OECD countries have low values and some countries, such as the United States, have high values.

Inequality across countries in energy intensities: An analysis of the role of energy transformation and final energy consumption

- Energy Economics---2011---Juan Duro, Emilio Padilla

This paper analyzes the role of the energy transformation index and of final energy consumption per GDP unit in the disparities in energy intensity across countries. In that vein, we use a Theil decomposition approach to analyze global primary energy intensity inequality as well as inequality across different regions of the world and inequality within these regions. The paper first demonstrates the pre-eminence of divergence in final energy consumption per GDP unit in explaining global primary energy intensity inequality and its evolution during the 1971-2006 period. Secondly, it shows the lower (albeit non negligible) impact of the transformation index in global primary energy inequality. Thirdly, the relevance of regions as unit of analysis in studying cross-country energy intensity inequality and their explanatory factors is highlighted.

And finally, how regions around the world differ as to the relevance of the energy transformation index in explaining primary energy intensity inequality.

Energy and output dynamics in Bangladesh

- Energy Economics---2011---Biru Paksha Paul, Gazi Uddin

The relationship between energy consumption and output is still ambiguous in the existing literature. The economy of Bangladesh, having spectacular output growth and rising energy demand as well as energy efficiency in recent decades, can be an ideal case for examining energy-output dynamics. We find that while fluctuations in energy consumption do not affect output fluctuations, movements in output inversely affect movements in energy use. The results of Granger causality tests in this respect are consistent with those of innovative accounting that includes variance decompositions and impulse responses. Autoregressive distributed lag models also suggest a role of output in Bangladesh's energy use. Hence, the findings of this study have policy implications for other developing nations where measures for energy conservation and efficiency can be relevant in policymaking.

World oil prices and agricultural commodity prices: Evidence from an emerging market

- Energy Economics---2011---Saban Nazlioglu, Ugur Soytas

Oil prices are thought to have direct effect on agricultural prices followed by an indirect effect through the exchange rate. This paper examines the short- and long-run interdependence between world oil prices, lira-dollar exchange rate, and individual agricultural commodity prices (wheat, maize, cotton, soybeans, and sunflower) in Turkey. To this end, the Toda-Yamamoto causality approach and generalized impulse-response analysis for identification of the long- and short-run interrelationships are applied to the monthly data spanning from January 1994 to March 2010. The impulse-response analysis suggests the Turkish agricultural

prices do not significantly react to oil price and exchange rate shocks in the short-run. The long-run causality analysis reveals that the changes in oil prices and appreciation/depreciation of the Turkish lira are not transmitted to agricultural commodity prices in Turkey. Hence, our results support neutrality of agricultural commodity markets in Turkey to both direct and indirect effects of oil price changes.

Speculation and volatility spillover in the crude oil and agricultural commodity markets: A Bayesian analysis

- Energy Economics---2011---Xiaodong Du,Cindy L. Yu,Dermot Hayes

This paper assesses factors that potentially influence the volatility of crude oil prices and the possible linkage between this volatility and agricultural commodity markets. Stochastic volatility models are applied to weekly crude oil, corn, and wheat futures prices from November 1998 to January 2009. Model parameters are estimated using Bayesian Markov Chain Monte Carlo methods. Speculation, scalping, and petroleum inventories are found to be important in explaining the volatility of crude oil prices. Several properties of crude oil price dynamics are established, including mean-reversion, an asymmetry between returns and volatility, volatility clustering, and infrequent compound jumps. We find evidence of volatility spillover among crude oil, corn, and wheat markets after the fall of 2006. This can be largely explained by tightened interdependence between crude oil and these commodity markets induced by ethanol production.

Jumps and stochastic volatility in oil prices: Time series evidence

- Energy Economics---2011---Karl Larsson,Marcus Nossman

In this paper we examine the empirical performance of affine jump diffusion models with stochastic volatility in a time series study of crude oil prices. We compare four different models and estimate them using the Markov Chain Monte Carlo method. The support for

a stochastic volatility model including jumps in both prices and volatility is strong and the model clearly outperforms the others in terms of a superior fit to data. Our estimation method allows us to obtain a detailed study of oil prices during two periods of extreme market stress included in our sample; the Gulf war and the recent financial crisis. We also address the economic significance of model choice in two option pricing applications. The implied volatilities generated by the different estimated models are compared and we price a real option to develop an oil field. Our findings indicate that model choice can have a material effect on the option values.

Do global risk perceptions influence world oil prices?

- Energy Economics---2011---Ramazan Sarı,Ugur Soytaş,Erk Hacıhasanoglu

This paper investigates the information transmission mechanism between world oil, gold, silver, dollar/euro exchange rate markets, and volatility index (VIX) accommodating for global risk perceptions. We find that there is a unique long run equilibrium relationship, where gold, silver, exchange rate, and risk perceptions appear as long run forcing variables of world oil prices. We uncover that global risk perceptions have a significantly suppressing effect on oil prices in the long run. We also discover that global risk perceptions play a less important role in explaining the forecast error variance of oil prices in the short run, than prices in the alternative investment markets. Our results also suggest that a shock in risk perceptions of global investors have a negative but short lived initial impact on oil prices.

Risk factors in oil and gas industry returns: International evidence

- Energy Economics---2011---Sofia Ramos,Helena Veiga

The recent boom in oil prices has attracted many investors to oil companies in search of both returns and diversification benefits. This analysis of the risk factors of investing in the oil and gas industry in 34 countries

finds evidence that oil price is a globally priced factor for the oil industry. The oil and gas sector in developed countries responds more strongly to oil price changes than in emerging markets. Oil and gas industry returns also respond asymmetrically to changes in oil prices; oil price rises have a greater impact than oil price drops. There is no parallel to the asymmetry of oil price changes in other industries related to commodities. If there is any asymmetry, it is in the opposite direction from oil. Negative commodity price changes have a greater impact than positive ones. The results seem to indicate that the oil and gas industry is distinguished by a pass-through effect.

Restricted carbon emissions and directed R&D support; an applied general equilibrium analysis

- Energy Economics---2011---Brita Bye, Karl Jacobsen

We analyse welfare effects of supporting general versus emission-saving technological development when carbon emissions are regulated by a carbon tax. We use a computable general equilibrium model with induced technological change (ITC). ITC is driven by two separate, economically motivated research and development (R&D) activities, one general and one emission-saving specified as carbon capture and storage (CCS). We study public revenue neutral policy alternatives targeted towards general R&D and CCS R&D. Support to general R&D is the welfare superior. However, the welfare gap between the two R&D policy alternatives is reduced with higher carbon tax levels. For sufficiently high levels of the carbon tax equal subsidy rates are preferred.

Carbon control policies, competitiveness, and border tax adjustments

- Energy Economics---2011---Yazid Dissou, Terry Eyland

Several propositions have recently been made to use border tax adjustments (BTAs) to address the loss of competitiveness induced by unilateral stringent domestic pollution control policies. This paper explores in a

general equilibrium framework the sectoral and welfare implications of a unilateral domestic GHG control policy combined with a BTA scheme. Using the Canadian economy as an illustration, we assess the extent to which BTAs achieve their objectives and analyze the impacts of different methods of recycling the BTA proceeds to support domestic industries. Our simulation results suggest that imposing BTAs on the imports of non-fossil and energy-intensive products reduces or removes completely the negative competitiveness impacts that domestic industries suffer from. The use of the proceeds of the BTAs to support domestic energy-intensive industries improves their competitiveness and, more importantly, in some cases, overprotects them, as it allows them to even increase their output in comparison to the benchmark without emissions control. Our results also shed light on the existence of heterogeneity in the composition of energy-intensive industries as far as the recycling method of the BTA proceeds is concerned. Energy-intensive industries that are more oriented toward the domestic market are better off with the recycling of the BTA proceeds towards gross output than towards exports alone. Finally, abstracting from the environmental benefits of reduced emissions, we find that a BTA entails a higher welfare cost to households.

Using modeling to generate alternatives (MGA) to expand our thinking on energy futures

- Energy Economics---2011---Joseph F. DeCarolis

Energy-economy optimization models - encoded with a set of structured, self-consistent assumptions and decision rules - have emerged as a key tool for the analysis of energy and climate policy at the national and international scale. Given the expansive system boundaries and multi-decadal timescales involved, addressing future uncertainty in these models is a critical challenge. The approach taken by many modelers is to build larger models with greater complexity to deal with structural uncertainty, and run a few highly detailed scenarios under different input assumptions to address parametric uncertainty. The result is often large and inflexible models used to conduct analysis

that offers little insight. This paper introduces a technique borrowed from the operations research literature called modeling to generate alternatives (MGA) as a way to flex energy models and systematically explore the feasible, near-optimal solution space in order to develop alternatives that are maximally different in decision space but perform well with regard to the modeled objectives. The resultant MGA alternatives serve a useful role by challenging preconceptions and highlighting plausible alternative futures. A simple, conceptual model of the U.S. electric sector is presented to demonstrate the utility of MGA as an energy modeling technique.

Business-as-Unusual: Existing policies in energy model baselines

- Energy Economics---2011---Neil Strachan

Baselines are generally accepted as a key input assumption in long-term energy modelling, but energy models have traditionally been poor on identifying baseline assumptions. Notably, transparency on the current policy content of model baselines is now especially critical as long-term climate mitigation policies have been underway for a number of years. This paper argues that the range of existing energy and emissions policies are an integral part of any long-term baseline, and hence already represent a "with-policy" baseline, termed here a Business-as-Unusual (BAuU). Crucially, existing energy policies are not a sunk effort; as impacts of existing policy initiatives are targeted at future years, they may be revised through iterative policy making, and their quantitative effectiveness requires ex-post verification. To assess the long-term role of existing policies in energy modelling, currently identified UK policies are explicitly stripped out of the UK MARKAL Elastic Demand (MED) optimisation energy system model, to generate a BAuU (with-policy) and a REF (without policy) baseline. In terms of long-term mitigation costs, policy-baseline assumptions are comparable to another key exogenous modelling assumption -- that of global fossil fuel prices. Therefore, best practice in energy modelling would be to have both a no-policy reference baseline, and a current policy reference base-

line (BAuU). At a minimum, energy modelling studies should have a transparent assessment of the current policy contained within the baseline. Clearly identifying and comparing policy-baseline assumptions are required for cost effective and objective policy making, otherwise energy models will underestimate the true cost of long-term emissions reductions.

Energy consumption at business cycle horizons: The case of the United States

- Energy Economics---2011---Paresh Narayan, Seema Narayan, Russell Smyth

In this paper, we propose a simple extension to a Keynesian type macro model by augmenting it with energy consumption. We show the relationship between energy consumption and output in a macroeconomic setting and ask the question: Do permanent shocks dominate changes in energy consumption and output at business cycle horizons for the United States? To achieve the goal of this paper, we undertake a variance decomposition analysis of shocks based on a common trend and common cycle framework within a vector error correction model. Our main finding is that permanent shocks explain the bulk of the variations in energy consumption and output at business cycle horizons for the United States.

Capacity choice and water management in hydroelectricity systems

- Energy Economics---2011---Mohamed S. Haddad

This paper proposes a simple two-period model that captures the seasonal pattern of water inflows and electricity demand observed in many countries where hydropower is a major source of electricity supply. The model characterizes the effects of different inflows pattern on the optimal water management, capacity, and the associated electricity production and price. The first best capacity is a non-monotonic function of water inflows, which provides a rationale for the observed differences in reservoirs sizes across hydropower systems around the world. The monopoly solution is qualitatively similar to the first best outcome, and the

privatization of hydroelectric power generation systems does not always imply a social welfare loss.

«Would you say that the price you pay for electricity is fair?» Consumers' satisfaction and utility reforms in the EU15

- Energy Economics---2011---Carlo Fiorio,Massimo Florio

The research question addressed by this paper is a simple one: are European consumers happy with the price they pay for electricity supply services after two decades of reforms? We focus on self-assessed consumers' satisfaction as reported in three waves of the Eurobarometer surveys, 2000-2002-2004, conditioning on a set of indicators of public ownership and liberalisation across the EU-15. After controlling for individual and country characteristics, we find that consumers are happier with the prices they pay when in their country there are both public ownership and liberalisation. We discuss this finding.

Do household energy expenditures affect mortgage delinquency rates?

- Energy Economics---2011---Robert Kaufmann,Nancy Gonzalez,Thomas A. Nickerson,Tyler S. Nesbit

We postulate a direct role for energy prices in the 2008 financial crisis. Rising energy prices constrain consumer budgets and thereby raise mortgage delinquency rates. This hypothesis is tested by estimating a quarterly cointegrating vector autoregressive (CVAR) model that seeks to quantify the factors that influence the percentage of US mortgages that are 30 to 89 days past due and those that enter foreclosure. Results identify a long-run relationship for the percentage of US mortgages that are 30 to 89 days past due that includes the interest rate on one-year adjustable mortgages, household expenditures on energy, nominal home prices, rates of home ownership, and the fraction of mortgages 90 days or more past due that enter foreclosure--unemployment rates have a short-run effect. Together, these variables account for much of the

historical variation in the percentage of US mortgages that are 30 to 89 days past due and indicate that the post 2006 rise in this measure of mortgage delinquency is associated with falling home prices, an increase in household expenditures on energy, and rising unemployment.

Consumer choice on ecologically efficient water heaters: Marketing strategy and policy implications in Japan

- Energy Economics---2011---Hisanori Goto,Mika Goto,Toshiyuki Sueyoshi

This study examines how consumers select ecologically efficient water heaters in Japan. Energy conservation in household water heating is increasingly important for reducing an amount of CO2 emission, because the share of water heating in household energy consumption is approximately 30%. Recently, Japanese households have widely used ecologically efficient electric heat pump water heaters (Eco Cute) or gas-fired water heaters (Eco Jozu). The total number of such efficient water heaters sold in Japan was more than 2.5 million at the end of 2008. This study investigates various factors and impacts of marketing strategy for promoting the appliances in Japan. We apply mixed and nested logit models to a disaggregated choice data on water heaters from 2004 to 2008. This study considers retail energy prices, a government financial support and marketing activities as important factors for appliance selection. In addition, we consider consumers' housing attributes such as floor space and age of building. This empirical study finds two business implications. One of the two implications is that an increase in an energy price may enhance a choice probability of Eco Cute and Eco Jozu because a price increase invites consumer's consciousness on energy conservation so that a cost reduction on energy consumption becomes essential in a use of the efficient appliances. The other implication is that marketing activities, especially by recommendations from sales representatives and/or housing suppliers, are important for consumer behaviors. The other important findings are discussed in this study. This business experience in Japan is useful to the other countries where

ecologically efficient water heaters are not popular at the current moment.

International evidence on aggregate short-run and long-run interfuel substitution

- Energy Economics---2011---Apostolos Serletis, Govinda Timilsina, Olexandr Vasetsky

In this paper, we build on recent work by Serletis et al. (2010, in press) and report short- and long-run estimates of aggregate interfuel substitution for a number of OECD and non-OECD countries. In doing so, we use recent pooled intercountry data (since 1980), and state-of-the-art advances in microeconometrics, including duality theory and flexible functional forms. Also, motivated by the widespread practice in the empirical energy demand literature of ignoring theoretical regularity, we estimate our model subject to global curvature (but not monotonicity), using methods developed by Diewert and Wales (1987). We provide inference, and also a policy perspective, using parameter estimates that are consistent with the theoretical regularity conditions of neoclassical microeconomic theory.

Natural gas prices, LNG transport costs, and the dynamics of LNG imports

- Energy Economics---2011---Don Maxwell, Zhen Zhu

According to the U.S. Energy Information Administration, LNG is projected to become a much larger share of U.S. natural gas consumption, rising from current levels of around 2.5% of total natural gas consumption to 12.4% by 2030. Because natural gas and LNG are substitutes, natural gas prices are expected to be an important determinant of LNG imports. Furthermore, an increasing share of LNG is traded under short-term contracts with spot shipments being diverted to markets offering the highest returns (netbacks). Relative natural gas prices as well as LNG transportation costs are important determinants of LNG netbacks. This paper examines the empirical relationship between U.S.

LNG imports, the Henry Hub price of natural gas relative to U.K. and Asia gas prices, and a proxy for LNG transportation costs using monthly data from 1997 to 2007. Granger causality tests, error variance decomposition, and impulse response analyses using a VAR model are employed to establish Granger-causality as well as the dynamics of natural gas prices and LNG transportation innovations on LNG imports.

Market integration and price transmission in the U.S. natural gas market: From the wellhead to end use markets

- Energy Economics---2011---Hassan Mohammadi

Examination of the upstream-downstream pricing behavior in U.S. natural gas industry reveals that: (a) natural gas markets are integrated but subject to regime shifts and asymmetric adjustments, suggesting market imperfections. (b) Demand- and supply-side shocks play important roles in determining short-run price movements as evidenced by tests of causality and impulse response functions. (c) The response of end use prices to deviations from equilibrium with wellhead prices vary. Electrical, industrial and city gate prices adjust fast while commercial and residential prices adjust slowly, consistent with the role of administered pricing in later markets. (d) Long-run variations in end use prices are primarily due to their own shocks, while long-run variations in wellhead prices are due to innovations in residential and electrical prices. These findings point to the importance of demand shocks as the primary determinant of natural gas prices in the long-run.

Nuclear energy consumption, oil prices, and economic growth: Evidence from highly industrialized countries

- Energy Economics---2011---Chien-Chiang Lee, Yi-Bin Chiu

This study utilizes the Johansen cointegration technique, the Granger non-causality test of Toda and Yamamoto (1995), the generalized impulse response

function, and the generalized forecast error variance decomposition to examine the dynamic interrelationship among nuclear energy consumption, real oil price, oil consumption, and real income in six highly industrialized countries for the period 1965-2008. Our empirical results indicate that the relationships between nuclear energy consumption and oil are as substitutes in the U.S. and Canada, while they are complementary in France, Japan, and the U.K. Second, the long-run income elasticity of nuclear energy is larger than one, indicating that nuclear energy is a luxury good. Third, the results of the Granger causality test find evidence of unidirectional causality running from real income to nuclear energy consumption in Japan. A bidirectional relationship appears in Canada, Germany and the U.K., while no causality exists in France and the U.S. We also find evidence of causality running from real oil price to nuclear energy consumption, except for the U.S., and causality running from oil consumption to nuclear energy consumption in Canada, Japan, and the U.K., suggesting that changes in price and consumption of oil influence nuclear energy consumption. Finally, the results observe transitory initial impacts of innovations in real income and oil consumption on nuclear energy consumption. In the long run the impact of real oil price is relatively larger compared with that of real income on nuclear energy consumption in Canada, Germany, Japan, and the U.S.

Gone with the wind? -- Electricity market prices and incentives to invest in thermal power plants under increasing wind energy supply

- Energy Economics---2011---Thure Traber, Claudia Kemfert

The increased wind energy supplied to many electricity markets around the world has to be balanced by reliably ramping units or other complementary measures when wind conditions are low. At the same time wind energy impacts both, the utilization of thermal power plants and the market prices. While the market prices tend to decrease, the impact on the utilization of different plant types is at the outset unclear. To analyze the incentives to invest in thermal power plants

under increased wind energy supply, we develop a computational model which includes ramping restrictions and costs and apply it to the German case. We find that due to current wind supply the market prices are reduced by more than five percent, and the incentives to invest in natural gas fired units are largely reduced. An increased wind supply erodes their attractiveness further. Consequently, a gap between the need for and the incentive to provide flexibility can be expected.

Growth and renewable energy in Europe: A random effect model with evidence for neutrality hypothesis

- Energy Economics---2011---Angeliki N. Menegaki

This is an empirical study on the causal relationship between economic growth and renewable energy for 27 European countries in a multivariate panel framework over the period 1997-2007 using a random effect model and including final energy consumption, greenhouse gas emissions and employment as additional independent variables in the model. Empirical results do not confirm causality between renewable energy consumption and GDP, although panel causality tests unfold short-run relationships between renewable energy and greenhouse gas emissions and employment. The estimated cointegration factor refrains from unity, indicating only a weak, if any, relationship between economic growth and renewable energy consumption in Europe, suggesting evidence of the neutrality hypothesis, which can partly be explained by the uneven and insufficient exploitation of renewable energy sources across Europe.

Value-at-risk estimation with the optimal dynamic biofuel portfolio

- Energy Economics---2011---Ting-Huan Chang, Hsin-Mei Su, Chien-Liang Chiu

In the past, petroleum companies only paid attention to hedging the variation in the crude oil price and volatility. However, they have now expanded their analysis to encompass renewable sources, such as corn and

soybeans, under the current low-carbon biofuel obligations. This paper employs GARCH(1,1) and ARJI models to estimate the one-day-ahead Value-at-Risk (VaR) of the optimal dynamic biofuel portfolio, which consists of crude oil, corn and soybeans. The optimal blended standard is subject to the dual limitations of minimum production costs and the lowest biofuel using requirements. Our empirical findings confirm that the ARJI model is more suitable than the GARCH (1,1) model and further captures the discontinuous jump behavior from the in-the-sample data. The results of out-of-sample forecasts also are represented that our models play important roles in VaR estimation and risk management for biofuel portfolio. We therefore suggest that the petroleum companies should simultaneously pay attention to jump risk in hedging material costs in the prices of energy-related crops.

Estimates of energy subsidies in China and impact of energy subsidy reform

- Energy Economics---2011---Boqiang Lin,Zhujun Jiang

For a transitional economy such as China, some energy subsidies are reasonable, and sometimes even necessary for achieving social goals. However, with rising energy prices and environmental concerns, we see conflicts emerging between energy subsidies, energy demand/supply fundamentals and climate change considerations. Energy subsidies have important implications for sustainable development through their effects on energy use, efficiency and the choice of fuel source. This paper applies the price-gap approach to estimate China's energy subsidies. Results indicate that China's energy subsidies amounted to CNY 356.73 billion in 2007, equivalent to 1.43% of GDP. Subsidies for oil products consumption are the largest, followed by subsidies for the electricity and coal sectors. Furthermore, a CGE model is used to analyze the economic impacts of energy subsidy reforms. Our findings show that removing energy subsidies will result in a significant fall in energy demand and emissions, but will have negative impacts on macroeconomic variables. We conclude that offsetting policies could be

adopted such that certain shares of these subsidies are reallocated to support other sustainable development measures, which could lead to reducing energy intensity and favoring the environment.

The impact of growth, energy and financial development on the environment in China: A cointegration analysis

- Energy Economics---2011---Abdul Jalil,Mete Feridun

This article aims to investigate the impact of financial development, economic growth and energy consumption on environmental pollution in China from 1953 to 2006 using the Autoregressive Distributed Lag (ARDL) bounds testing procedure. The main objective is to examine the long run equilibrium relationship between financial development and environmental pollution. The results of the analysis reveal a negative sign for the coefficient of financial development, suggesting that financial development in China has not taken place at the expense of environmental pollution. On the contrary, it is found that financial development has led to a decrease in environmental pollution. It is concluded that carbon emissions are mainly determined by income, energy consumption and trade openness in the long run. Moreover, the findings confirm the existence of an Environmental Kuznets Curve in the case of China.

DEA approach for unified efficiency measurement: Assessment of Japanese fossil fuel power generation

- Energy Economics---2011---Toshiyuki Sueyoshi,Mika Goto

This study discusses a new DEA (Data Envelopment Analysis) approach to measure the unified (operational and environmental) efficiency of energy firms. It is widely known that they produce not only desirable (good) outputs (e.g., electricity) but also undesirable (bad) outputs (e.g., CO₂) as a result of their plant operations. The proposed approach incorporates an output separation (desirable and undesirable outputs) for the

performance evaluation of energy firms. In addition to the output separation, this study separates inputs into energy and non-energy inputs. Consequently, the proposed approach incorporates not only the output separation but also the input separation within a computational framework of DEA non-radial measurement. This study compares the proposed approach with other previous DEA approaches used for the performance evaluation of energy firms. After the methodological comparison, this study applies the proposed approach for measuring the unified efficiency of Japanese fossil fuel power generation. This empirical study confirms that the implementation of Kyoto Protocol (2005) has not been effective on the unified efficiency of Japanese fossil fuel power generation during the observed period (2004-2008). Although the empirical result is inconsistent with the current Japanese environmental policy under Kyoto Protocol, it contains policy implications for guiding the future direction of Japanese environmental policy on the electric power industry.

Observed and unobserved heterogeneity in stochastic frontier models: An application to the electricity distribution industry

- Energy Economics---2011---Maria Kopsakangas-Savolainen,Rauli Svento

In this study we combine different possibilities to model firm level heterogeneity in stochastic frontier analysis. We show that both observed and unobserved heterogeneities cause serious biases in inefficiency results. Modelling observed and unobserved heterogeneities treat individual firms in different ways and even though the expected mean inefficiency scores in both cases diminish the firm level efficiency rank orders turn out to be very different. The best fit with the data is obtained by modelling unobserved heterogeneity through randomizing frontier parameters and at the same time explicitly modelling the observed heterogeneity into the inefficiency distribution. These results are obtained by using data from Finnish electricity distribution utilities and the results are relevant in relation to electricity distribution pricing and regulation.

Co-integration of ICE Gas oil and Crude oil futures

- Energy Economics---2011---Sjur Westgaard,Maria Estenstad,Maria Seim,Stein Frydenberg

In this paper, the relationship between Gas oil and Brent Crude oil futures prices is investigated. The analysis is based on daily price series for five different contract lengths traded on ICE Futures Europe. The price series and their first differences are tested for stationarity. Linear relationships between the pair-wise Gas oil and Crude oil contracts are then tested for co-integration. A co-integrated relationship is found for the 1 and 2 month contracts covering data from 1994 to 2009, and Error Correction Models are established to estimate the relationships. No co-integrated relationships are found for the 3, 6 and 12 month contracts covering the period 2002-2009, nor for the 1 and 2 month contracts for this period. The futures prices for this period are collected from a volatile market, including hurricane Katrina, the economic boom and the following financial crises which might explain these results. Thus, in such volatile periods the spread between Gas oil and Crude oil is likely to deviate, and it might take several years until it reverts to its equilibrium value. For energy traders and hedgers, this will imply that exposures to the crack spread should be treated with great care in such market environments.

Forecasting petroleum futures markets volatility: The role of regimes and market conditions

- Energy Economics---2011---Nikos K. Nomikos,Panos K. Pouliasis

In this paper we employ regime volatility models to describe time dependency in petroleum markets. Using a sample of NYMEX and ICE futures contracts, we establish the existence of a regime process and link this process to market fundamentals. This formulation results in two distinct states: a highly persistent conditional volatility process, characterised by long memory and low sensitivity to market shocks, and a relatively short-lived nonstationary process with less memory but higher sensitivity to shocks. Moreover, to

investigate the relationship between disequilibrium and volatility of oil futures across high and low volatility regimes we use augmented regime GARCH models to address in a realistic way the potential diverse response of volatility to forward curve shocks. The performance of these models is compared to benchmarks, using both statistical tests and risk management loss functions. To test the robustness of the forecasting strategies, we also perform a reality check employing the stationary bootstrap approach. The findings of this paper have important implications for decision making concerning trading and risk management, as well as energy market operations, such as refining and budget planning, by providing valuable information on the oil price volatility dynamics and the ability to predict risk.

Oil price cycles and wavelets

- Energy Economics---2011---Théo Naccache

The present paper addresses the question of the oil price-macroeconomy relationship using world data and a time scale decomposition based on the theory of wavelets. Our approach is based on a global indicator, the Morgan Stanley Capital International (MSCI) Index for the World, and on the new framework offered by wavelets to analyse the oil price cycles and to investigate the oil price-MSCI relationship. This original approach enables us to identify that the cycles which contribute the most to oil price variations are 20 to 40 years cycles, which correspond to the size of Kuznets infrastructure cycles and probably represent energy investment cycles. This wavelet decomposition also provides additional evidence to the "reverse causality" theory.

An emerging equilibrium in the EU emissions trading scheme

- Energy Economics---2011---Don Bredin, Cal Muckley

The European Union's Emissions Trading Scheme (ETS) is the key policy instrument of the European Commission's Climate Change Program aimed at reducing greenhouse gas emissions to eight percent below

1990 levels by 2012. A critically important element of the EU ETS is the establishment of a market determined price for EU allowances. This article examines the extent to which several theoretically founded factors including, economic growth, energy prices and weather conditions determine the expected prices of the European Union CO₂ allowances during the 2005 through to the 2009 period. The novel aspect of our study is that we examine heavily traded futures instruments that have an expiry date in Phase 2 of the EU ETS. Our study adopts both static and recursive versions of the Johansen multivariate cointegration likelihood ratio test as well as a variation on this test with a view to controlling for time varying volatility effects. Our results are indicative of a new pricing regime emerging in Phase 2 and point to a maturing market driven by the fundamentals. These results are valuable both for traders of EU allowances and for those policy makers seeking to improve the design of the European Union ETS.

Eliciting public support for greening the electricity mix using random parameter techniques

- Energy Economics---2011---Peter Grösche, Carsten Schröder

With its commitment to double the share of renewable fuels in electricity generation to at least 30% by 2020, the German government has embarked on a potentially costly policy course whose public support remains an open empirical question. Building on household survey data, in this paper we assess people's willingness-to-pay (WTP) for various fuel mixes in electricity generation, and capture preference heterogeneity among respondents using random parameter techniques. Based on our estimates, we trace out the locus that links the premia charged for specific electricity mixes with the fraction of people supporting the policy. Albeit people's WTP for a certain fuel mix in electricity generation is positively correlated to the renewable fuel share, our results imply that the current surcharge effectively exhausts the financial scope for subsidizing renewable fuels.

Carbon offsets with endogenous environmental policy

- Energy Economics---2011---Jon Strand

Interests in obtaining carbon offsets in host countries for CDM projects may serve as an obstacle to implementing more stringent general environmental policies in the same countries. A relatively lax environmental policy, whereby carbon emissions remain high, can be advantageous for such countries as it leaves them with a higher than otherwise scope for future emissions reductions through CDM and other offset projects. In this paper, the potential to affect the availability of future CDM projects is shown to distort environmental and energy policies of CDM host countries, in two ways. First, policies to reduce the use of fossil energy are weakened. This in turn weakens private sector incentives to switch to lower-carbon technology through CDM projects. CDM host governments then also find it attractive to subsidize this switch, in order to maximize the country's advantage from the CDM.

Editorial

- Energy Economics---2011---Beng Wah Ang, Richard Tol, John P. Weyant

2011

Balancing energy strategies in electricity portfolio management

- Energy Economics---2011---Christoph Möller, Svetlozar T. Rachev, Frank Fabozzi

Traditional management of electricity portfolios is focused on the day-ahead market and futures of longer maturity. Within limits, market participants can however also resort to the balancing energy market to close their positions. In this paper, we determine strategic positions in the balancing energy market and identify corresponding economic incentives in an analysis of the German balancing energy demand. We find that those strategies allow an economically optimal starting point for real-time balancing and create a marketplace for flexible capacity that is more open than alternative

marketplaces. The strategies we proffer in this paper we believe will contribute to an effective functioning of the electricity market.

Applying portfolio theory to the electricity sector: Energy versus power

- Energy Economics---2011---Erik Delarue, Cedric De Jonghe, Ronnie Belmans, D'haeseleer, William

Portfolio theory has found its way in numerous applications for optimizing the electricity generation mix of a particular region. Existing models, however, consider typically a single time period and correspondingly do not properly account for actual dispatch constraints and energy sources with a non-dispatchable, variable output. This paper presents a portfolio theory model that explicitly distinguishes between installed capacity (power), electricity generation (energy) and actual instantaneous power delivery. This way, the variability of wind power and ramp limits of conventional power plants are correctly included in the investment optimization. The model is written as a quadratically constrained programming problem and illustrated in a case study. The results show that the introduction of wind power can be motivated to lower the risk on generation cost, albeit to smaller levels than typically reported in the literature. This wind power deployment further requires the need for sufficiently rampable technologies, to deal with its fluctuating output.

Portfolio optimization using Mixture Design of Experiments: Scheduling trades within electricity markets

- Energy Economics---2011---Francisco Alexandre de Oliveira, Anderson Paulo de Paiva, José Wanderley Marangon Lima, Pedro Paulo Balestrassi, Ronã Rinston Amaury Mendes

Deregulation of the electricity sector has given rise to several approaches to defining optimal portfolios of energy contracts. Financial tools - requiring substantial adjustments - are usually used to determine risk and return. This article presents a novel approach to adjusting the conditional value at risk (CVaR) metric

to the mix of contracts on the energy markets; the approach uses Mixture Design of Experiments (MDE). In this kind of experimental strategy, the design factors are treated as proportions in a mixture system considered quite adequate for treating portfolios in general. Instead of using traditional linear programming, the concept of desirability function is here used to combine the multi-response, nonlinear objective functions for mean with the variance of a specific portfolio obtained through MDE. The maximization of the desirability function is implied in the portfolio optimization, generating an efficient recruitment frontier. This approach offers three main contributions: it includes risk aversion in the optimization routine, it assesses interaction between contracts, and it lessens the computational effort required to solve the constrained nonlinear optimization problem. A case study based on the Brazilian energy market is used to illustrate the proposal. The numerical results verify the proposal's adequacy.

Electricity tariff design for transition economies: Application to the Libyan power system

- Energy Economics---2011---Javier Reneses,Tomás Gómez,Juan Rivier,Jorge L. Angarita

This paper presents a general electricity tariff design methodology, especially applicable for transition economies. These countries are trying to modernize their power systems from a centralized environment (with normally, a public vertically integrated electric company) to a liberalized framework (unbundling electricity companies and, eventually, starting a privatization process). Two issues arise as crucial to achieving a successful transition: i) ensuring cost recovery for all future unbundled activities (generation, transmission, distribution and retailing), and ii) sending the right price signals to electricity customers, avoiding cross-subsidies between customer categories. The design of electricity tariffs plays a pivotal role in achieving both objectives. This paper proposes a new tariff design methodology that, complying with these two aforementioned criteria, requires a low amount of information regarding system data and customer load profiles. This is important since, typically, volume and quality of data

are poor in those countries. The presented methodology is applied to computing tariffs for the Libyan power system in 2006, using real data.

Evaluating the economic cost of natural gas strategic storage restrictions

- Energy Economics---2011---João Miguel Ejarque

The European Commission wants to implement a single market for gas. One of the components of this market is a regulated provision for "security of supply" which consists of rules for the implementation and use of a given reserve stock of gas. We investigate the impact of this policy on the profitability of a storage operator, using data from Denmark and Italy. Keeping storage capacity constant, the costs of the strategic stock are around 20% of the value of the storage market for Denmark, and 16% for Italy. This cost is due to the inability to extract arbitrage profits from the captive stock. Furthermore, the strategic storage restriction induces behavior that would virtually never be replicated by a private storage operator in an unconstrained market, in particular in the first 6 months of the year when unconstrained firms empty their reservoirs much faster, suggesting the strategic restriction is unnecessarily distorting the market.

A comparative analysis of the value of pure and hybrid electricity storage

- Energy Economics---2011---Ramteen Sioshansi,Paul Denholm,Thomas Jenkin

Significant natural gas and electricity price variation and volatility, especially during the past few years, raise questions about understanding the value drivers behind electricity storage. The impact of these drivers for pure storage (such as pumped hydroelectric storage) and compressed air energy storage (CAES) are different and in this paper we explore these differences in operation and net revenue over a variety of timescales. We also consider the arbitrage value that is attainable in practice and explain why simple forecasting techniques based on historical data will generally be less successful for CAES. The breakeven cost of storage

and how this can depend on regulatory treatment of storage and market structure is also considered.

Energy price uncertainty, energy intensity and firm investment

- Energy Economics---2011---Kyung Hwan Yoon, Ronald Ratti

This paper examines the effect of energy price uncertainty on firm-level investment. An error correction model of capital stock adjustment is estimated with data on U.S. manufacturing firms. Higher energy price uncertainty is found to make firms more cautious by reducing the responsiveness of investment to sales growth. The result is robust to consideration of energy intensity by industry. The effect is greater for high growth firms. It must be emphasized that the direct effect of uncertainty is not estimated. Conditional variance of energy price is obtained from a GARCH model. Findings suggest that stability in energy prices would be conducive to greater stability in firm-level investment.

The effect of oil price volatility on strategic investment

- Energy Economics---2011---Irene Henriques, Perry Sadorsky

In this paper, we investigate how oil price volatility affects the strategic investment decisions of a large panel of US firms. This paper uses key insights from the real options literature to develop a model of a company's strategic investment and shows how changes in oil price volatility can impact strategic investment decisions. The model is estimated using recently developed generalized method of moment estimation techniques for panel data sets. Empirical results are presented to show that there is a U shaped relationship between oil price volatility and firm investment. This is consistent with the predictions from the strategic growth options literature. The results should be useful to decision makers, investors, managers, policy makers and others who need to make strategic investment decisions in an uncertain world.

Multifractal features of spot rates in the Liquid Petroleum Gas shipping market

- Energy Economics---2011---Steve Engelen, Payam Norouzzadeh, Wout Dullaert, Bahareh Rahmani

We investigate for the first time the spot rate dynamics of Very Large Gas Carriers (VLGCs) by means of multifractal detrended fluctuation analysis (MF-DFA) and rescaled range (R/S) analysis. Both non-parametric methods allow for a rigorous statistical analysis of the freight process by detecting correlation, scaling and fluctuation behavior regardless of nonlinearity issues. By applying different data-frequencies and a temporal framework, the Hurst exponents indicate that freight rates exhibit trend-reinforcement and persistence subject to limited time-dependency and controlled volatility. The found long-range dependence corroborates that a predictive freight model can be built undermining the efficient market hypothesis. Memory effects seem to each time build up until they are interrupted by seasonal transitions, stochastic events or cycles which all spark a sudden loss in correlations or increase in nonlinearities. The surrogate and shuffling data procedures demonstrate that, dependent on the data-frequency used, memory effects and fat-tail distributions should be contained differently in freight rate models.

Detecting instability in the volatility of carbon prices

- Energy Economics---2011---Julien Chevallier

This article investigates the presence of outliers in the volatility of carbon prices. We compute three different measures of volatility for European Union Allowances, based on daily data (EGARCH model), option prices (implied volatility), and intraday data (realized volatility). Based on the methodology developed by Zeileis et al. (2003) and Zeileis (2006), we detect instability in the volatility of carbon prices based on two kinds of tests: retrospective tests (OLS/Recursive-based CUSUM processes, F-statistics, and residual sum of squares), and forward-looking tests (by monitoring structural changes recursively or with moving estimates). We show evidence of strong shifts

mainly for the EGARCH and IV models during the time period. Overall, we suggest that yearly compliance events, and growing uncertainties in post-Kyoto international agreements, may explain the instability in the volatility of carbon prices.

A simple state-contingent pricing rule for complex intertemporal externalities

- Energy Economics---2011---Ross McKittrick

Some externalities, such as global warming, involve complex relationships between emissions and an environmental state variable, with effects over lags of uncertain length. Coming up with theoretically-motivated and practical policy options in such cases has proven difficult. Deterministic intertemporal general equilibrium models yield what appear to be feasible optimal price paths, but only by assuming away many key uncertainties, nor do they specify how the possibility of new information should affect the policy path. Bayesian models allow limited uncertainty and optimal learning based on observed effects of policy changes, but suggest a discouraging delay before optimal policy can be identified. A full insurance model suggests that risk aversion and 'fat-tailed' probabilities of catastrophe imply an implausibly (or at least impractically) large risk premium, implying that practical policy decisions depend so critically on uncertain parameters as to be unavoidably arbitrary. This paper proposes an entirely new approach based on the observation that the situation giving rise to a complex intertemporal externality also yields an observable state variable that contains information relevant to the identification of the optimal policy path. I derive a simple transformation by which the state variable can yield a good approximation to the optimal externality price. I outline assumptions sufficient to yield the transformation, and present numerical examples that illustrate its ability to follow linear and nonlinear first-best price paths. A specific application to greenhouse gases is proposed.

Distributional effects of a carbon tax on car fuels in France

- Energy Economics---2011---Benjamin Bureau

This paper analyses the distributional effects of alternative scenarios of carbon taxes on car fuels using disaggregated French panel data from 2003 to 2006. It incorporates household price responsiveness that differs across income groups into a consumer surplus measure of tax burden. Carbon taxation is regressive before revenue recycling. However, taking into account the benefits from congestion reduction induced by the tax mitigates regressivity. We show also that recycling additional revenues from the carbon tax either in equal amounts to each household or according to household size makes poorest households better off.

Technology diffusion under contraction and convergence: A CGE analysis of China

- Energy Economics---2011---Michael Hübler

This paper introduces a mechanism of international technology diffusion via FDI and imports into recursive-dynamic CGE modeling for climate policy analysis. As a novel feature, the mechanism distinguishes spillovers from foreign to domestic capital within sectors and across sectors within the production chain. The paper applies the mechanism to the analysis of a contraction and convergence type climate policy focusing on China. The mechanism of international technology diffusion leads to an increase in China's energy productivity and a decline in China's economic growth rates in a convergence process. In this case, inter-regional emissions trading could (more than) compensate China's welfare losses due to climate policy. Otherwise, China's welfare losses due to climate policy could be significant.

Corrigendum to: "Solving discretely-constrained MPEC problems with applications in electric power markets"[Energy Economics 32 (2010) 3-14]

- Energy Economics---2011---Steven A. Gabriel, Florian Leuthold

2011

Asian energy in the context of growing security and environmental concerns

- Energy Economics---2010---Yunchang Bor,ZhongXiang Zhang

2010

Oil price shocks and their short- and long-term effects on the Chinese economy

- Energy Economics---2010---Weiqi Tang,Libo Wu,ZhongXiang Zhang

A considerable body of economic literature shows the adverse economic impacts of oil-price shocks for the developed economies. However, there has been a lack of similar empirical study on China and other developing countries. This paper attempts to fill this gap by answering how and to what extent oil-price shocks impact China's economy, emphasizing on the price transmission mechanisms. To that end, we develop a structural vector auto-regressive model. Our results show that an oil-price increase negatively affects output and investment, but positively affects inflation rate and interest rate. However, with price control policies in China, the impact on real economy, represented by real output and real investment, lasts much longer than that to price/monetary variables. Our decomposition results also show that the short-term impact, namely output decrease induced by the cut in capacity-utilization rate, is greater in the first 6 periods (namely half a year), but the portion of the long-term impact, defined as the impact realized through an investment change, increases steadily and exceeds that of short-term impact in the 7th period. Afterwards, the long-term impact dominates, and maintains for quite some time.

Sectoral demand for petroleum in Thailand

- Energy Economics---2010---Poonpat Leesombatpi-boon,Fred Joutz

This paper examines the short-run and long-run determinants of final oil consumption in seven major economic sectors in Thailand. Two different approaches are compared. The first approach uses dynamic panel

data estimation techniques taking into account oil consumption of the whole economy in an aggregate manner. The second approach employs the ADL equilibrium correction framework to model oil demand in each economic sector separately. The dynamic panel data approach estimates appear consistent with economic theory. The coefficients have the correct signs and the magnitudes of long-run responses are larger than the short-run responses. The single sector model approach yields similar but richer results. Relaxing the identical slope assumption reveals interesting sector specific characteristics.

The incidence of fuel taxation in India

- Energy Economics---2010---Ashokankur Datta

Fuel taxes have returned to centre stage as a potential policy instrument for greenhouse gas abatement. On the basis of some studies in developed countries, critics have complained that a fuel tax would be regressive. This paper uses data from a representative household survey covering more than 124 thousand Indian households to examine this claim. It finds that a fuel tax would be progressive as would a carbon tax. Using an input-output approach, it is found that the progressivity results holds good even when one considers indirect consumption of fuel through its use as an intermediate input. Sensitivity checks allowing for differing price elasticities of demand between rich and poor confirm this result for most of fuels. A tax on kerosene is the only fuel tax that is regressive in all situations.

Estimating short and long-term residential demand for electricity: New evidence from Sri Lanka

- Energy Economics---2010---P.P.A Wasantha Athukorala,Clevo Wilson

This study investigates the short-run dynamics and long-run equilibrium relationship between residential electricity demand and factors influencing demand - per capita income, price of electricity, price of kerosene oil and price of liquefied petroleum gas - using annual data for Sri Lanka for the period, 1960-2007. The study uses

unit root, cointegration and error-correction models. The long-run demand elasticities of income, own price and price of kerosene oil (substitute) were estimated to be 0.78, - 0.62, and 0.14 respectively. The short-run elasticities for the same variables were estimated to be 0.32, - 0.16 and 0.10 respectively. Liquefied petroleum (LP) gas is a substitute for electricity only in the short-run with an elasticity of 0.09. The main findings of the paper support the following (1) increasing the price of electricity is not the most effective tool to reduce electricity consumption (2) existing subsidies on electricity consumption can be removed without reducing government revenue (3) the long-run income elasticity of demand shows that any future increase in household incomes is likely to significantly increase the demand for electricity and (4) any power generation plans which consider only current per capita consumption and population growth should be revised taking into account the potential future income increases in order to avoid power shortages in the country.

What causes the change in energy demand in the economy?: The role of technological change

- Energy Economics---2010---Shinichiro Okushima,Makoto Tamura

This paper proposes a simple and theoretically clear approach to the estimation of technological change in a multisector general equilibrium framework. This study employs the Multiple Calibration Decomposition Analysis (MCDA) to evaluate technological change that is responsible for changes in energy use and carbon dioxide emissions in the Japanese economy in the oil crises period from 1970 to 1985. The MCDA serves as an elementary way of separating structural change due to technological change from that due to price substitution effects, capturing the interdependence among economic sectors. The empirical result provides a better understanding of the effects on the economy of technological change in that significant period.

Is it fair to treat China as a Christmas tree to hang everybody's complaints? Putting its own energy saving into perspective

- Energy Economics---2010---ZhongXiang Zhang

China had been the world's second largest carbon emitter for years. However, recent studies show that China had overtaken the U.S. as the world's largest emitter in 2007. This has put China in the spotlight, just at a time when the world community starts negotiating a post-Kyoto climate regime under the Bali roadmap. China seems to have become such a Christmas tree on which everybody could hang his/her complaints. This paper first discusses whether such criticism is fair by examining China's own efforts towards energy saving, the widespread use of renewable energy and participation in a clean development mechanism. Next, the paper puts carbon reductions of China's unilateral actions into perspective by examining whether the estimated greenhouse gas emission reduction from meeting the country's national energy saving goal is achieved from China's unilateral actions or mainly with support from the clean development mechanism projects. Then the paper discusses how far developing country commitments can go in an immediate post-2012 climate regime, thus pointing out the direction and focus of future international climate negotiations. Finally, emphasizing that China needs to act as a large and responsible developing country, take due responsibilities and set a good example for the majority of developing countries, the paper articulates what can be expected from China to illustrate that China can be a good partner in combating global climate change.

A dynamic general equilibrium analysis on fostering a hydrogen economy in Korea

- Energy Economics---2010---Jeong Hwan Bae,Gyeong-Lyeob Cho

Hydrogen is anticipated to become one of the major alternative energy technologies for a sustainable energy system. This study analyzes the dynamic economic impacts of building a hydrogen economy in Korea employing a dynamic Computable General Equilibrium

(CGE) model. As a frontier technology, hydrogen is featured as having a slow diffusion rate due to option value, positive externality, resistance of old technology, and complementary vintages. Without government intervention, hydrogen-derived energy will supply up to 6.5% of final energy demand by 2040. Simulation outcomes show that as price subsidy rates increase by 10%, 20%, and 30%, hydrogen demand will increase by 9.2%, 15.2%, and 37.7%, respectively, of final energy demand by 2040. The output of the transportation sector will increase significantly, while demands for oil and electricity will decline. Demands for coal and LNG will experience little change. Household consumption will decline because of the increase of income taxes. Overall GDP will increase because of the increase in exports and investments. CO₂ emission will decline for medium and high subsidy rate cases, but increase for low subsidy cases. Ultimately, subsidy policy on hydrogen will not be an effective measure for mitigating CO₂ emission in Korea when considering dynamic general equilibrium effects.

Renewable energy policy evaluation using real option model -- The case of Taiwan

- Energy Economics---2010---Shun-Chung Lee, Li-Hsing Shih

This study presents a policy benefit evaluation model that integrates cost efficiency curve information on renewable power generation technologies into real options analysis (ROA) methods. The proposed model evaluates quantitatively the policy value provided by developing renewable energy (RE) in the face of uncertain fossil fuel prices and RE policy-related factors. The economic intuition underlying the policy-making process is elucidated, while empirical analysis illustrates the option value embedded in the current development policy in Taiwan for wind power. In addition to revealing the benefits that RE development provides when considering real options, analytical results indicate that ROA is a highly effective means of quantifying how policy planning uncertainty including managerial flexibility influences RE development. In addition to assessing the policy value of current RE development

policy, this study also compares policy values in terms of internalized external costs and varying feed-in tariff (FIT). Simulation results demonstrate that the RE development policy with internalized CO₂ emission costs is appropriate policy planning from sustainability point of view. Furthermore, relationship between varying FIT and policy values can be shown quantitatively and appropriate FIT level could be determined accordingly.

Using a spark-spread valuation to investigate the impact of corn-gasoline correlation on ethanol plant valuation

- Energy Economics---2010---Natasha Kirby, Matt Davison

Corn ethanol plants have been criticized for a number of reasons in recent years. This paper provides another ground for criticizing these plants. Historical corn and gasoline prices are uncorrelated, but widespread adoption of corn ethanol production might reasonably lead to future correlation between these prices. We present a real options -- like valuation of an ethanol plant as a spark spread between the corn price and the gasoline price. This analysis shows that the value of an ethanol plant monotonically decreases with increasing correlation and the optimal production schedule greatly depends on the correlation. Even relatively small new correlations can result in a significant proportional value decrease; a 50% correlation between corn and gasoline causes ethanol plants to lose 10% of their value. The limiting case of full correlation would lead to a 30% value loss.

Powering America: The impact of ethanol production in the Corn Belt states

- Energy Economics---2010---Luisa Blanco, Michelle Isenhouer

This paper investigates the impact of ethanol production in the Corn Belt states (Iowa, Indiana, Illinois, Kansas, Kentucky, Michigan, Minnesota, Missouri, Nebraska, Ohio, South Dakota, and Wisconsin). Employing data at the county level, from 2005 to 2006,

we investigate the effect of ethanol production on employment and wages. Our empirical results show that ethanol production has a positive significant effect on employment and wages, but this effect is of insignificant magnitude. We also find that counties with high and medium levels of ethanol production capacity show higher levels of employment and wages than those counties that do not produce ethanol. Counties with low levels of ethanol production do not show any significant difference in employment and wages than non-producing ethanol counties.

Do green tech policies need to pass the consumer test?: The case of ethanol fuel

- Energy Economics---2010---Gustavo Collantes

This paper investigates a question sometimes overlooked by policymakers and regulators, namely the need of a robust value proposition for green technologies to successfully enter the market. In particular, results from consumer choice models are used to develop measures of consumer acceptance of ethanol blends and flex-fuel vehicles is studied, a fuel-vehicle system that has received attention in a variety of federal and state policies. The analysis suggests that, under projected fuel prices and given the characteristics of the competing vehicle-fuel systems, consumers are unlikely to substitute ethanol blends for gasoline. The analysis also highlights the need for further research in this area.

Exploratory analysis of prospects for renewable energy private investment in the U.S

- Energy Economics---2010---Francisco X. Aguilar,Zhen Cai

Opportunities for private investments in renewable energies were explored using a stated-preference investment allocation instrument. Allocation alternatives included conventional and renewable energy investments. Among renewable energy investments, solar and wind energy were ranked the highest while grass and wood-based technologies were at the bottom of the renewable energy list. This ranking mirrors the

allocation of investments in sustainable energy technologies in global markets. Results were analyzed using a two-limit tobit model which suggests that certainty of investments, a diversified portfolio and expectation on financial returns were the primary drivers behind funds allocated to renewable energy investments. Using cluster analysis, twenty-three percent of our sample of current and future investors was identified as individuals most willing to invest in renewable energies.

Willingness to pay for E85 from corn, switchgrass, and wood residues

- Energy Economics---2010---Kimberly L. Jensen,Christopher Clark,Burton English,R. Jamey Menard,Denise K. Skahan,Adrienne C. Marra

Willingness to pay (WTP) for E85 (automotive fuel blend of 85% ethanol and 15% gasoline) was estimated from a contingent choice exercise contained in a national survey of consumers. The choice exercise included E85 blends from three different feedstock sources (corn grain, switchgrass, and wood wastes) and an E10 blend (10% ethanol and 90% gasoline) with corn grain as the ethanol feedstock. Results from the study indicate willingness to pay a premium for E85 from switchgrass compared with E10 from corn. Concerns about land use for "food versus fuel" had a negative impact on WTP for E85 from corn grain, while greater concerns about fuel security relative to the environment had a positive impact.

On the economic sustainability of ethanol E85

- Energy Economics---2010---Shaun W. Tatum,Sarah J. Skinner,John Jackson

Several studies have considered the sustainability of corn-based ethanol as produced in the US as a major fuel source from a technical perspective. However, not much attention has been paid to the market-based aspects of corn-based ethanol as a sustainable fuel. We address this question by offering an econometric analysis of the E85 (apparently the most viable of the potential substitutes for gasoline) market using demand

and supply analysis. Reduced form price equation estimates indicate that the cross elasticity of E85's price with respect to the price of gasoline does not differ significantly from unity, so that any rise in gasoline prices will be matched (in percentage terms) by a corresponding rise in the price of E85. Thus, given the current market, which includes significant government subsidy, the prospect that E85 will ever be price competitive with gasoline is indeed dim.

Insuring unit failures in electricity markets

- Energy Economics---2010---S. Pineda,A.J. Conejo,M. Carrión

An electric energy producer participates in futures markets in the hope of hedging the risk of trading in the pool. However, this producer is required to supply the energy associated with all its signed forward contracts even if some of its units are forced out due to unexpected failures. In this case, the producer must purchase some of the energy needed to meet its futures market commitments in the pool, which may result in high losses if the pool prices happen to be higher than the forward contract prices. To mitigate these losses, the producer can take out insurance against the forced outages of its units. Using a stochastic programming model, this paper analyzes the convenience of signing an insurance against unit failure by an electric energy producer and its impact on forward contracting decisions. Results from a realistic case study are provided and analyzed.

Development and application of a cost-benefit framework for energy reliability: Using probabilistic methods in network planning and regulation to enhance social welfare: The N-1 rule

- Energy Economics---2010---Michiel De Nooij,Barbara Baarsma,Gabriël Bloemhof,Han Slootweg,Harold Dijk

Although electricity is crucial to many activities in developed societies, guaranteeing a maximum reliability of supply to end-users is extremely costly. This

situation gives rise to a trade-off between the costs and benefits of reliability. The Dutch government has responded to this trade-off by changing the rule stipulating that electricity networks must be able to maintain supply even if one component fails (known as the N-1 rule), even in maintenance situations. This rule was changed by adding the phrase "unless the costs exceed the benefits." We have developed a cost-benefit framework for the implementation and application of this new rule. The framework requires input on failure probability, the cost of supply interruptions to end-users and the cost of investments. A case study of the Dutch grid shows that the method is indeed practicable and that it is highly unlikely that N-1 during maintenance will enhance welfare in the Netherlands. Therefore, including the limitation "unless the costs exceed the benefits" in the rule has been a sensible policy for the Netherlands, and would also be a sensible policy for other countries.

When and how do tropical storms affect markets? The case of refined petroleum

- Energy Economics---2010---Jason Fink,Kristin E. Fink,Allison Russell

Little is known about the magnitude of the effect of powerful tropical storms on asset prices, or when markets revise price expectations in response to such storms. Refinery clustering in the coastal northwest Gulf of Mexico provides an opportunity to examine such effects directly. We examine the effect of tropical storm forecasts on the crack spread -- the difference between refined petroleum and crude oil prices. Prices appear to reflect storm effects at the 24-h forecast horizon. Further, the magnitude is significant -- category 4 hurricanes in this region increase refined petroleum prices relative to crude oil by about 13.5%.

Estimating the impact of refinery outages on petroleum product prices

- Energy Economics---2010---Michael Kendix,W. Walls

We quantify the impact of refinery outages on

petroleum product prices. The empirical analysis focuses on wholesale gasoline prices in the US using weekly data collected from January 2002 through September 2008, a period including many refinery outages. We match refinery unit output to specific wholesale gasoline markets, and then estimate panel data regressions to quantify the impact of refinery unit outages on wholesale gasoline prices while controlling for time-specific effects, city-specific effects, fuel-specific effects, refinery concentration, and other factors that could impact the price of refined petroleum products. The estimation results show that refinery outages have a statistically significant positive impact on refined product prices, and that the magnitude of this effect is larger for certain special fuel blends. Policy implications are discussed.

Determinants of the number of bidders in the competitive procurement of electricity supply contracts in the Japanese public sector

- Energy Economics---2010---Toru Hattori

Since the electricity retail market in Japan was partially opened to competition in 2000, many government entities have sought to solicit competing bids for the electricity supply to their office buildings or facilities, encouraging competition between the incumbents and new entrants. However, in many cases, only the incumbent utility bids for the contract and the competitive effects are limited. This paper presents a statistical analysis of bidders' participation in competitive procurement. We employ several count data regression models to explain the number of bidders other than the local electric utility. Our results suggest that the number of bidders would decrease in response to an increase in the load factor, perhaps because the new entrants are less competitive in serving customers with high load factors as they do not operate low-cost base-load power plants such as nuclear power plants; It would increase along with the voltage level and contract demand. The results also indicate that new entrants are more likely to participate in the bidding process in large city areas.

Capacity choice, technology mix and market power

- Energy Economics---2010---Guy Meunier

This paper investigates strategic capacity choices in electricity markets comprised of heterogeneous firms. Long term strategic investments are analyzed assuming that the wholesale market is competitive. There are two technologies available to produce electricity; both are efficient and used at a first best optimum. When not all firms can invest in both technologies, there can be over investment in either of these technologies. It is shown that if the number of firms that can invest in a particular technology is limited, the development of competition solely using the other technology can decrease welfare.

Bundling and Mergers in Energy Markets

- Energy Economics---2010---Laurent Granier, Marion Podesta

Does bundling trigger mergers in energy industries? We observe mergers between firms belonging to various energy markets, for instance between gas and electricity providers. These mergers enable firms to bundle. We consider two horizontally differentiated markets. In this framework, we show that bundling strategies in energy markets create incentives to form multi-market firms in order to supply bi-energy packages. Moreover, we find that this type of merger is detrimental to social welfare.

Economies of vertical integration in the Swiss electricity sector

- Energy Economics---2010---Aurelio Fetz, Massimo Filippini

Over the last two decades, several European nations have introduced reforms to their electricity sector. Generally, these reforms require a legal and functional unbundling of vertically integrated companies. These unbundling processes may reduce the possibilities that exist to fruitfully exploit the advantages of vertical integration. The goal of this paper is to empirically

analyze the presence of economies of scale and vertical integration in the Swiss electricity sector. Economies of vertical integration between electricity production and distribution result from reduced transaction costs, better coordination of highly specific and interdependent investments and less financial risk. Different econometric specifications for panel data, including a random effects and a random-coefficients model, have been used to estimate a quadratic multi-stage cost function for a sample of electricity companies. The empirical results reflect the presence of considerable economies of vertical integration and economies of scale for most of the companies considered in the analysis. Moreover, the results suggest a variation in economies of vertical integration across companies due to unobserved heterogeneity.

Carbon trading thickness and market efficiency

- Energy Economics---2010---Alberto Montagnoli, Frans de Vries

This note tests for the efficient market hypothesis (EMH) in the market for CO₂ emission allowances in Phase I and Phase II of the European Union Emissions Trading Scheme (EU ETS). As usually is the case in emerging and non-competitive markets such as the EU ETS, trading often not occurs on a frequent basis. This has adverse implications for both the gains from permit trade as well as biases the EMH tests. Variance ratio tests are employed to adjust for the thin trading effect. The results indicate that Phase I--the trial and learning period--was inefficient, whereas the first period under Phase II shows signs of restoring market efficiency.

Using logarithmic mean Divisia index to analyze changes in energy use and carbon dioxide emissions in Mexico's iron and steel industry

- Energy Economics---2010---Claudia Sheinbaum, Leticia Ozawa, Daniel Castillo

Using international comparisons and Log mean Divisia index, this paper analyzes energy and CO₂ emission trends of Mexico's iron and steel industry during the

period 1970-2006, examining CO₂ emissions related to energy use and production process. The decomposition analysis is based on the structure/efficiency analysis for international comparisons, considering industrial structure and the best available technology. Results show that for the period 1970-2006, activity drove up primary energy use by 227% instead of the actual 133%, while structure and efficiency effects drove it down by 5% and by 90% respectively. The important improvement in Mexican iron and steel primary energy efficiency reduced the gap between best international practice and actual primary energy consumption from 103% in 1970 to only 15% in 2006. CO₂ emissions from fuel consumption and production process increased by 134%, and in addition to structure and efficiency, fuel share effect also drove down emissions by 4.2% in the entire period.

A sequential Malmquist-Luenberger productivity index: Environmentally sensitive productivity growth considering the progressive nature of technology

- Energy Economics---2010---Dong-hyun Oh, Almas Heshmati

This study proposes an index for measuring environmentally sensitive productivity growth which appropriately considers the nature of technical change. The rationale of this methodology is to exclude a spurious technical regress from the macroeconomic perspective. In order to incorporate this in developing the index, a directional distance function and the concept of the successive sequential production possibility set are combined. With this combination, the conventional Malmquist-Luenberger productivity index is modified to give the sequential Malmquist-Luenberger productivity index. This index is employed in measuring environmentally sensitive productivity growth and its decomposed components of 26 OECD countries for the period 1970-2003. We distinguish two main empirical findings. First, even though the components of the conventional Malmquist-Luenberger productivity index and the proposed index are different, the trends of rates of average productivity growth are similar. Second,

unlike in previous studies, the efficiency change is the main contributor to the earlier study period, whereas the effect of technical change has prevailed over time.

Greenhouse gases emissions, growth and the energy mix in Europe

- Energy Economics---2010---Gustavo Marrero

The importance of energy on greenhouse gases (GHG) emissions is reflected by the fact that 65% of said emissions in the World are currently due to the use and production of energy. However, most empirical emission models are found within the Environmental Kuznetz Curve (EKC) framework, which focuses on the relationship between emissions and economic development. Ang's (2007, 2008) papers are some of the exceptions that simultaneously study the relationship between emissions, growth and energy. With respect to Ang's research, we contribute on two important aspects. First, while Ang uses a particular country as the study and use time series techniques, we take advantage of a panel data set of 24 European countries between 1990 and 2006 and use a Dynamic Panel Data (DPD) framework. Second, the impact of energy consumption on emissions would depend on the primary energy mix and on the final use of this energy, and we consider both factors in the model.

Convergence of per capita carbon dioxide emissions in the EU: Legend or reality?

- Energy Economics---2010---Thomas Jobert,Fatih Karanfil,Anna Tykhonenko

Designing appropriate environmental and energy policies, in order to meet the Kyoto protocol's carbon dioxide (CO₂) reduction targets in the European Union (EU), requires a detailed examination and thorough understanding of CO₂ emission trends across the EU member states. This paper investigates whether CO₂ emissions have converged across 22 European countries over the 1971 to 2006 period. The Bayesian shrinkage estimation method is employed to do this work and the results reveal the following: first, the hypothesis of absolute convergence in per capita CO₂ emissions is

supported and a slight upward convergence is observed; second, the fact that countries differ considerably in both their speed of convergence and volatility in emissions makes it possible to identify different groups of countries; third, the results with respect to convergence do not vary much once the share of industry in GDP is accounted for in a conditional convergence analysis. However, a decreasing share of industry in GDP seems to contribute to a decline in per capita emissions. These findings may carry important implications for both national and EU environmental policies.

Energy consumption, pollutant emissions and economic growth in South Africa

- Energy Economics---2010---Kojo Menyah,Yemane Wolde-Rufael

This paper examines the long-run and the causal relationship between economic growth, pollutant emissions and energy consumption for South Africa for the period 1965-2006 in a multivariate framework which includes labour and capital as additional variables. Using the bound test approach to cointegration, we found a short-run as well as a long-run relationship among the variables with a positive and a statistically significant relationship between pollutant emissions and economic growth. Further, applying a modified version of the Granger causality test we also found a unidirectional causality running from pollutant emissions to economic growth; from energy consumption to economic growth and from energy consumption to CO₂ emissions all without a feedback. The econometric evidence suggests that South Africa has to sacrifice economic growth or reduce its energy consumption per unit of output or both in order to reduce pollutant emissions. In the long-run however, it is possible to meet the energy needs of the country and at the same time reduce CO₂ emissions by developing energy alternatives to coal, the main source of CO₂ emissions. However, the econometric results upon which the policy suggestions are made should be interpreted with care, as they may not be sufficiently robust enough to categorically warrant the choice of an unpalatable policy option by South Africa.

Threshold cointegration and causality relationship between energy use and growth in seven African countries

- Energy Economics---2010---Jacques Esso

The paper investigates the long-run and the causality relationship between energy consumption and economic growth for seven Sub-Saharan African countries during the period 1970-2007. Using the Gregory and Hansen (1996a, 1996b) testing approach to threshold cointegration, we find that energy consumption is cointegrated with economic growth in Cameroon, Cote d'Ivoire, Ghana, Nigeria and South Africa. Moreover, this test suggests that economic growth has a significant positive long-run impact on energy consumption in these countries before 1988 and this effect becomes negative after 1988 in Ghana and South Africa. Furthermore, causality tests suggest bidirectional causality between energy consumption and real GDP in Cote d'Ivoire and unidirectional causality running from real GDP to energy usage in the case of Congo and Ghana.

Renewable energy consumption and growth in Eurasia

- Energy Economics---2010---Nicholas Apergis,James Payne

This study examines the causal relationship between renewable energy consumption and economic growth for 13 countries within Eurasia over the period 1992-2007 within a multivariate panel data framework. The heterogeneous panel cointegration test reveals a long-run equilibrium relationship exists between real GDP, renewable energy consumption, real gross fixed capital formation, and labor force. The results from the error correction models indicate bidirectional causality between renewable energy consumption and economic growth in both the short-run and long-run. Thus, the empirical findings lend support for the feedback hypothesis of the interdependent relationship between renewable energy consumption and economic growth.

Economic growth and energy consumption causal nexus viewed through a bootstrap rolling window

- Energy Economics---2010---Mehmet Balciar,Zeynel Ozdemir,Yalcin Arslanturk

One puzzling results in the literature on energy consumption-economic growth causality is the variability of results particularly across sample periods, sample sizes, and model specification. In order overcome these issues this paper analyzes the causal links between energy consumption and economic growth for G-7 countries using bootstrap Granger non-causality tests with fixed size rolling subsamples. The data used includes annual total energy consumption and real Gross Domestic Product (GDP) series from 1960 to 2006 for G-7 countries, excluding Germany, for which the sample period starts from 1971. Using the full sample bootstrap Granger causality test, we find that there is predictive power from energy consumption to economic growth only for Canada. However, parameter instability tests show that none of the estimated models have constant parameters and hence the full sample results are not reliable. Analogous to the full sample results, the results obtained from the bootstrap rolling window estimation indicate no consistent causal links between energy consumption and economic growth. We, however, find that causal links are present between the series in various subsamples. Furthermore, these subsample periods correspond to significant economic events, indicating that the findings are not statistical artefacts, but correspond to real economic changes. Our results encompass previous findings and offer an explanation to varying findings.

The importance of electrical energy for economic growth in Barbados

- Energy Economics---2010---Troy Lorde,Kimberly Waithe,Brian Francis

Using a neo-classical aggregate production model where capital, labour, technology, and energy are treated as separate inputs, this paper tests for the existence and

direction of causality between output growth and electrical energy use in Barbados, analysed as a whole and in sectors respectively. Results indicate the presence of a long-run relationship between growth and electricity consumption; specifically we find that the non-residential sector is a key driver of growth. In addition, the evidence reveals a bidirectional causal relationship between electrical energy consumption and real GDP in the long run, but only a unidirectional causal relationship from energy to output in the short run. Forecasts indicate increasing consumption of electrical energy, particularly by the residential sector. We suggest that plans by the Government to liberalise the sector should encourage efficiency and innovation in production and distribution which should result in lower prices, as independent suppliers compete to maintain their market shares. Changes in the regulatory environment will also be necessary if such plans materialise. Policymakers will need to pay greater attention to the expected increase in the rate of consumption by the residential sector, as this will help to reduce the imports of oil and depletion of scarce foreign exchange resources by a sector that does not spur economic growth. An increase in energy capacity should be encouraged as contingency planning in the event of a technical or political disruption to fuel imports will be critical, notwithstanding the drive to use more renewable sources of energy.

Energy consumption and growth in South America: Evidence from a panel error correction model

- Energy Economics---2010---Nicholas Apergis,James Payne

This study examines the relationship between energy consumption and economic growth for a panel of nine South American countries over the period 1980-2005 within a multivariate framework. Given the relatively short span of the time series data, a panel cointegration and error correction model is employed to infer the causal relationship. Pedroni's heterogeneous panel cointegration test reveals a long-run equilibrium relationship between real GDP, energy consumption, the

labor force, and real gross fixed capital formation with the respective coefficients positive and statistically significant. The Granger-causality results indicate both short-run and long-run causality from energy consumption to economic growth which supports the growth hypothesis.

Oil price dynamics: A behavioral finance approach with heterogeneous agents

- Energy Economics---2010---Saskia ter Ellen,Remco Zwinkels

In this paper, we develop and test a heterogeneous agent model for the oil market. The demand for oil is divided in a speculative component and a real component. Speculators are boundedly rational in forming price expectations. Expectations are formed by one of two boundedly rational rules of thumb: fundamentalist and chartist. While fundamentalists trade on mean-reversion, chartists follow the trend in prices. Speculators then choose between these rules based on past profitability. Estimation results on Brent and WTI oil reveal that both groups are active in the oil market, and that speculators often switch between the groups. The model outperforms both the random walk and VAR models in out-of-sample forecasting.

Price dynamics of crude oil and the regional ethylene markets

- Energy Economics---2010---Abul Masih,Ibrahim Algahtani,Lurion De Mello

This paper is the first attempt to investigate: (i) is the crude oil (WTI) price significantly related to the regional ethylene prices in the Naphtha intensive ethylene markets of the Far East, North West Europe, and the Mediterranean? (ii) What drives the regional ethylene prices? The paper is motivated by the recent and growing debate on the lead-lag relationship between crude oil and ethylene prices. Our findings, based on the long-run structural modelling approach of Pesaran and Shin, and subject to the limitations of the study, tend to suggest: (i) crude oil (WTI) price is cointegrated with the

regional ethylene prices (ii) our within-sample error-correction model results tend to indicate that although the ethylene prices in North West Europe and the Mediterranean were weakly endogenous, the Far East ethylene price was weakly exogenous both in the short and long term. These results are consistent, during most of the period under review (2000.1-2006.4) with the surge in demand for ethylene throughout the Far East, particularly in China and South Korea. However, during the post-sample forecast period as evidenced in our variance decompositions analysis, the emergence of WTI as a leading player as well, is consistent with the recent surge in WTI price (fuelled mainly, among others, by the strong hedging activities in the WTI futures/options and refining tightness) reflecting the growing importance of input cost in determining the dynamic interactions of input and product prices.

Analyzing and forecasting volatility spillovers, asymmetries and hedging in major oil markets

- Energy Economics---2010---Chia-Lin Chang, Michael McAleer, Roengchai Tansuchat

Crude oil price volatility has been analyzed extensively for organized spot, forward and futures markets for well over a decade, and is crucial for forecasting volatility and Value-at-Risk (VaR). There are four major benchmarks in the international oil market, namely West Texas Intermediate (USA), Brent (North Sea), Dubai/Oman (Middle East), and Tapis (Asia-Pacific), which are likely to be highly correlated. This paper analyses the volatility spillover and asymmetric effects across and within the four markets, using three multivariate GARCH models, namely the constant conditional correlation (CCC), vector ARMA-GARCH (VARMA-GARCH) and vector ARMA-asymmetric GARCH (VARMA-AGARCH) models. A rolling window approach is used to forecast the 1-day ahead conditional correlations. The paper presents evidence of volatility spillovers and asymmetric effects on the conditional variances for most pairs of series. In addition, the forecast conditional correlations between pairs of crude oil returns have both positive and negative trends. Moreover, the optimal hedge ratios and optimal port-

folio weights of crude oil across different assets and market portfolios are evaluated in order to provide important policy implications for risk management in crude oil markets.

New evidence of anti-herding of oil-price forecasters

- Energy Economics---2010---Christian Pierdzioch, Jan Christoph Rülke, Georg Stadtmann

We used the oil-price forecasts of the Survey of Professional Forecasters published by the European Central Bank to analyze whether oil-price forecasters herd or anti-herd. Oil-price forecasts are consistent with herding (anti-herding) of forecasters if forecasts are biased towards (away from) the consensus forecast. Based on a new empirical test developed by Bernhardt et al. (J. Financ. Econ. 80: 657-675, 2006), we found strong evidence of anti-herding among oil-price forecasters.

The asymmetric effects of oil price and monetary policy shocks: A nonlinear VAR approach

- Energy Economics---2010---Sajjadur Rahman, Apostolos Serletis

In this paper we investigate the asymmetric effects of oil price shocks and monetary policy on macroeconomic activity, using monthly data for the United States, over the period from 1983:1 to 2008:12. In doing so, we use a logistic smooth transition vector autoregression (VAR), as detailed in Terasvirta and Anderson (1992) and Weise (1999), and make a distinction between two oil price volatility regimes (high and low), using the realized oil price volatility as a switching variable. We isolate the effects of oil price and monetary policy shocks and their asymmetry on output growth and, following Koop et al. (1996) and Weise (1999), we employ simulation methods to calculate Generalized Impulse Response Functions (GIRFs) to trace the effects of independent shocks on the conditional means of the variables. Our results suggest that in addition to the price of oil, oil price volatility has an impact on macroeconomic activity and that monetary policy is not only reinforcing the effects of oil price shocks

on output, it is also contributing to the asymmetric response of output to oil price shocks.

The behavior of crude oil spot and futures prices around OPEC and SPR announcements: An event study perspective

- Energy Economics---2010---Riza Demirer, Ali Kutan

This paper examines the informational efficiency of crude oil spot and futures markets with respect to OPEC conference and U.S. Strategic Petroleum Reserve (SPR) announcements. We employ the event study methodology to examine the abnormal returns in crude oil spot and futures markets around OPEC conference and SPR announcement dates between 1983 and 2008. Our findings regarding OPEC announcements indicate an asymmetry in that only OPEC production cut announcements yield a statistically significant impact with the impact diminishing for longer maturities. We also find that the persistence of returns following OPEC production cut announcements creates substantial excess returns to investors who take long positions on the day following the end of OPEC conferences. In the case of SPR announcements, we find that the government's use of this program initiates a short-run market reaction following the announcement date. Furthermore, our tests of cumulative abnormal returns suggest that the market reacts efficiently to SPR announcements providing support for the use of the strategic reserves as a tool to stabilize the oil market. Our findings have significant policy implications for investors and are useful in designing effective energy policy strategies.

Forecasting crude oil market volatility: Further evidence using GARCH-class models

- Energy Economics---2010---Yu Wei, Yudong Wang, Dengshi Huang

This paper extends the work of Kang et al. (2009). We use a greater number of linear and nonlinear generalized autoregressive conditional heteroskedasticity

(GARCH) class models to capture the volatility features of two crude oil markets -- Brent and West Texas Intermediate (WTI). The one-, five- and twenty-day out-of-sample volatility forecasts of the GARCH-class models are evaluated using the superior predictive ability test and with more loss functions. Unlike Kang et al. (2009), we find that no model can outperform all of the other models for either the Brent or the WTI market across different loss functions. However, in general, the nonlinear GARCH-class models, which are capable of capturing long-memory and/or asymmetric volatility, exhibit greater forecasting accuracy than the linear ones, especially in volatility forecasting over longer time horizons, such as five or twenty days.

Oil prices -- Brownian motion or mean reversion? A study using a one year ahead density forecast criterion

- Energy Economics---2010---Nigel Meade

For oil related investment appraisal, an accurate description of the evolving uncertainty in the oil price is essential. For example, when using real option theory to value an investment, a density function for the future price of oil is central to the option valuation. The literature on oil pricing offers two views. The arbitrage pricing theory literature for oil suggests geometric Brownian motion and mean reversion models. Empirically driven literature suggests ARMA-GARCH models. In addition to reflecting the volatility of the market, the density function of future prices should also incorporate the uncertainty due to price jumps, a common occurrence in the oil market. In this study, the accuracy of density forecasts for up to a year ahead is the major criterion for a comparison of a range of models of oil price behaviour, both those proposed in the literature and following from data analysis. The Kullback Leibler information criterion is used to measure the accuracy of density forecasts. Using two crude oil price series, Brent and West Texas Intermediate (WTI) representing the US market, we demonstrate that accurate density forecasts are achievable for up to nearly two years ahead using a mixture of two Gaussians innovation processes with GARCH and no mean

reversion.

An empirical model of daily highs and lows of West Texas Intermediate crude oil prices

- Energy Economics---2010---Angela W.W. He, Jerry T.K. Kwok, Alan Wan

There is a large collection of literature on energy price forecasting, but most studies typically use monthly average or close-to-close daily price data. In practice, the daily price range constructed from the daily high and low also contains useful information on price volatility and is used frequently in technical analysis. The interaction between the daily high and low and the associated daily range has been examined in several recent studies on stock price and exchange rate forecasts. The present paper adopts a similar approach to analyze the behaviour of the West Texas Intermediate (WTI) crude oil price over a ten-year period. We find that daily highs and lows of the WTI oil price are integrated, with the error correction term being closely approximated by the daily price range. Two forecasting models, one based on a vector error correction mechanism and the other based on a transfer function framework with the range taken as a driver variable, are presented for forecasting the daily highs and lows. The results show that both of these models offer significant advantages over the naïve random walk and univariate ARIMA models in terms of out-of-sample forecast accuracy. A trading strategy that makes use of the daily high and low forecasts is further developed. It is found that this strategy generally yields very reasonable trading returns over an evaluation period of about two years.

Forecasting oil price trends using wavelets and hidden Markov models

- Energy Economics---2010---Edmundo G. de Souza e Silva, Luiz F.L. Legey, Edmundo A. de Souza e Silva

The crude oil price is influenced by a great number of factors, most of which interact in very complex ways.

For this reason, forecasting it through a fundamentalist approach is a difficult task. An alternative is to use time series methodologies, with which the price's past behavior is conveniently analyzed, and used to predict future movements. In this paper, we investigate the usefulness of a nonlinear time series model, known as hidden Markov model (HMM), to predict future crude oil price movements. Using an HMM, we develop a forecasting methodology that consists of, basically, three steps. First, we employ wavelet analysis to remove high frequency price movements, which can be assumed as noise. Then, the HMM is used to forecast the probability distribution of the price return accumulated over the next F days. Finally, from this distribution, we infer future price trends. Our results indicate that the proposed methodology might be a useful decision support tool for agents participating in the crude oil market.

The interaction between food prices and oil prices

- Energy Economics---2010---Moawia Alghalith

This paper provides a statistical methodology to estimate the impact of oil price uncertainty on food prices. In doing so, it examines the joint impact of oil price and food price uncertainties and their correlation on the food price. Also, the theoretical model was applied to the oil-based Trinidad and Tobago and the empirical results confirm the theoretical predictions. The empirical results indicate that a higher oil price increases food price. Also, a higher oil price volatility yields a higher food price. Moreover, an increase in the oil supply reduces the food price.

Relationship between oil prices, interest rate, and unemployment: Evidence from an emerging market

- Energy Economics---2010---H. Günsel Doğrul, Ugur Soytas

While the interrelation between oil price changes, economic activity and employment is an important issue that has been studied mainly for developed countries,

little attention has been devoted to inquiries on fluctuations in the price of crude oil and its impact on employment for small open economies. Adopting an efficiency wage model for equilibrium employment that does not require any assumptions regarding labor supply, this paper contributes to the literature by investigating the causality between unemployment and two input prices, namely energy (crude oil) and capital (real interest rate) in an emerging market, Turkey for the period 2005:01-2009:08. Applying a relatively new technique, the Toda-Yamamoto procedure, we find that the real price of oil and interest rate improve the forecasts of unemployment in the long run. This finding supports the hypothesis that labor is a substitute factor of production for capital and energy.

Determinants of residential space heating expenditures in Great Britain

- Energy Economics---2010---Helena Meier,Katrin Rehdanz

In Great Britain, several policy measures have been implemented in order to increase energy efficiency and reduce carbon emissions. In the domestic sector, this could, for example, be achieved by improving space heating efficiency and thus decreasing heating expenditure. However, in order to efficiently design and implement such policy measures, a better understanding of the determinants affecting heating expenditure is needed. In this paper we examine the following determinants: socio-economic factors, building characteristics, heating technologies and weather conditions. In contrast to most other studies we use panel data to investigate household demand for heating in Great Britain. Our data sample is the result of an annual set of interviews with more than 5000 households, starting in 1991 and ending in 2005. The sample represents a total of 64,000 observations over the fifteen-year period. Our aim is to derive price and income elasticities both for Britain as a whole and for different types of household. Our results suggest that differences exist between owner-occupied and renter households. These households react differently to changes in income and prices. Our results also imply that a number of socio-

economic criteria have a significant influence on heating expenditure, independently of the fuel used for heating. Understanding the impacts of different factors on heating expenditure and impact differences between types of household is helpful in designing target-oriented policy measures.

Inequality in the distribution of expense allocated to the main energy fuels for Mexican households: 1968-2006

- Energy Economics---2010---Jorge Alberto Rosas-Flores,David Morillón Gálvez,José Luís Fernández Zayas

Energy is a decisive and essential factor to provide quality of life, technological development related to its use, and an economic development overview of a given country. This essay presents the expense distribution allocated to the main fuel sources used at Mexican households. The essay herein was carried out for the 1968-2006 period. The main purpose of this essay is to determine the expense allocation of the main energy fuels (electricity, gas, firewood, kerosene, gasoline).The methodology used in this essay is based on the Lorenz curves and Gini coefficient.

The relationship between spot and futures prices in the Nord Pool electricity market

- Energy Economics---2010---Audun Botterud,Tarjei Kristiansen,Marija D. Ilic

We analyze 11 years of historical spot- and futures prices from the hydro-dominated Nord Pool electricity market. We find that futures prices tend to be higher than spot prices. The average convenience yield is therefore negative, but varies by season and depends on the storage levels in hydro reservoirs. The average realized return on holding a long position in the futures market is also negative. The negative convenience yield and risk premium contrast empirical findings in most other commodity markets. We argue that differences between the supply and demand sides in terms of risk preferences and the ability to take advantage of short-term price variations can contribute to explain the

observed relationship between spot- and futures prices. In addition, our analysis shows that the relationship between spot and futures prices is clearly linked to the physical state of the system, such as hydro inflow, reservoir levels, and demand.

Market efficiency of oil spot and futures: A mean-variance and stochastic dominance approach

- Energy Economics---2010---Hooi Hooi Lean, Michael McAleer, Wing-Keung Wong

This paper examines the market efficiency of oil spot and futures prices by using both mean-variance (MV) and stochastic dominance (SD) approaches. Based on the West Texas Intermediate crude oil data for the sample period 1989-2008, we find no evidence of any MV and SD relationships between oil spot and futures indices. This infers that there is no arbitrage opportunity between these two markets, spot and futures do not dominate one another, investors are indifferent to investing spot or futures, and the spot and futures oil markets are efficient and rational. The empirical findings are robust to each sub-period before and after the crises for different crises, and also to portfolio diversification.

Is WTI crude oil market becoming weakly efficient over time?: New evidence from multiscale analysis based on detrended fluctuation analysis

- Energy Economics---2010---Yudong Wang, Li Liu

This paper extends the work in Tabak and Cajueiro [Are the crude oil markets becoming weakly efficient over time, *Energy Economics* 29 (2007) 28-36] and Alvarez-Ramirez et al. [Short-term predictability of crude oil markets: a detrended fluctuation analysis approach, *Energy Economics* 30 (2008) 2645-2656]. In this paper, we test for the efficiency of WTI crude oil market through observing the dynamic of local Hurst exponents employing the method of rolling window based on multiscale detrended fluctuation analysis. Empirical results show that short-term, medium-term

and long-term behaviors were generally turning into efficient behavior over time. However, in this way, the results also show that the market did not evolve along stable conditions for long times. Multiscale analysis is also implemented based on multifractal detrended fluctuation analysis. We found that the small fluctuations of WTI crude oil market were persistent; however, the large fluctuations had high instability, both in the short- and long-terms. Our discussion is also extended by incorporating arguments from the crude oil market structure for explaining the different correlation dynamics.

Crude oil market efficiency and modeling: Insights from the multiscaling autocorrelation pattern

- Energy Economics---2010---Jose Alvarez-Ramirez, Jesus Alvarez, Ricardo Solis

Empirical research on market inefficiencies focuses on the detection of autocorrelations in price time series. In the case of crude oil markets, statistical support is claimed for weak efficiency over a wide range of time-scales. However, the results are still controversial since theoretical arguments point to deviations from efficiency as prices tend to revert towards an equilibrium path. This paper studies the efficiency of crude oil markets by using lagged detrended fluctuation analysis (DFA) to detect delay effects in price autocorrelations quantified in terms of a multiscaling Hurst exponent (i.e., autocorrelations are dependent of the time scale). Results based on spot price data for the period 1986-2009 indicate important deviations from efficiency associated to lagged autocorrelations, so imposing the random walk for crude oil prices has pronounced costs for forecasting. Evidences in favor of price reversion to a continuously evolving mean underscores the importance of adequately incorporating delay effects and multiscaling behavior in the modeling of crude oil price dynamics.

International evidence on crude oil price dynamics: Applications of ARIMA-GARCH models

- Energy Economics---2010---Hassan Moham-madi,Lixian Su

We examine the usefulness of several ARIMA-GARCH models for modeling and forecasting the conditional mean and volatility of weekly crude oil spot prices in eleven international markets over the 1/2/1997-10/3/2009 period. In particular, we investigate the out-of-sample forecasting performance of four volatility models -- GARCH, EGARCH and APARCH and FIGARCH over January 2009 to October 2009. Forecasting results are somewhat mixed, but in most cases, the APARCH model outperforms the others. Also, conditional standard deviation captures the volatility in oil returns better than the traditional conditional variance. Finally, shocks to conditional volatility dissipate at an exponential rate, which is consistent with the covariance-stationary GARCH models than the slow hyperbolic rate implied by the FIGARCH alternative.

An agent-based approach equipped with game theory: Strategic collaboration among learning agents during a dynamic market change in the California electricity crisis

- Energy Economics---2010---Toshiyuki Sueyoshi

An agent-based approach is a numerical (computer-intensive) method to explore the complex characteristics and dynamics of microeconomics. Using the agent-based approach, this study investigates the learning speed of traders and their strategic collaboration in a dynamic market change of electricity. An example of such a market change can be found in the California electricity crisis (2000-2001). This study incorporates the concept of partial reinforcement learning into trading agents and finds that they have two learning components: learning from a dynamic market change and learning from collaboration with other traders. The learning speed of traders becomes slow when a large fluctuation occurs in the power exchange market. The learning speed depends upon the type of traders,

their learning capabilities and the fluctuation of market fundamentals. The degree of collaboration among traders gradually reduces during the electricity crisis. The strategic collaboration among traders is examined by a large simulator equipped with multiple learning capabilities.

An agent-based approach with collaboration among agents: Estimation of wholesale electricity price on PJM and artificial data generated by a mean reverting model

- Energy Economics---2010---Toshiyuki Sueyoshi

This study examines the performance of MAIS (Multi-Agent Intelligent Simulator) equipped with various learning capabilities. In addition to the learning capabilities, the proposed MAIS incorporates collaboration among agents. The proposed MAIS is applied to estimate a dynamic change of wholesale electricity price in PJM (Pennsylvania-New Jersey-Mainland) and an artificial data set generated by a mean reverting model. Using such different types of data sets, the methodological validity of MAIS is confirmed by comparing it with other well-known alternatives in computer science. This study finds that the MAIS needs to incorporate both the mean reverting model and the collaboration behavior among agents in order to enhance its estimation capability. The MAIS discussed in this study will provide research on energy economics with a new numerical capability that can investigate a dynamic change of not only wholesale electricity price but also speculation and learning process of traders.

HMM filtering and parameter estimation of an electricity spot price model

- Energy Economics---2010---Christina Erlwein,Fred Espen Benth,Rogemar Mamon

In this paper we develop a model for electricity spot price dynamics. The spot price is assumed to follow an exponential Ornstein-Uhlenbeck (OU) process with an added compound Poisson process. In this way, the model allows for mean-reversion and possible jumps. All parameters are modulated by a hidden

Markov chain in discrete time. They are able to switch between different economic regimes representing the interaction of various factors. Through the application of reference probability technique, adaptive filters are derived, which in turn, provide optimal estimates for the state of the Markov chain and related quantities of the observation process. The EM algorithm is applied to find optimal estimates of the model parameters in terms of the recursive filters. We implement this self-calibrating model on a deseasonalised series of daily spot electricity prices from the Nordic exchange Nord Pool. On the basis of one-step ahead forecasts, we found that the model is able to capture the empirical characteristics of Nord Pool spot prices.

A vector autoregressive model for electricity prices subject to long memory and regime switching

- Energy Economics---2010---Niels Haldrup, Frank S. Nielsen, Morten Nielsen

A regime dependent VAR model is suggested that allows long memory (fractional integration) in each of the observed regime states as well as the possibility of fractional cointegration. The model is motivated by the dynamics of electricity prices where the transmission of power is subject to occasional congestion periods. For a system of bilateral prices non-congestion means that electricity prices are identical whereas congestion makes prices depart. Hence, the joint price dynamics implies switching between a univariate price process under non-congestion and a bivariate price process under congestion. At the same time, it is an empirical regularity that electricity prices tend to show a high degree of long memory, and thus that prices may be fractionally cointegrated. Analysis of Nord Pool data shows that even though the prices are identical under non-congestion, the prices are not, in general, fractionally cointegrated in the congestion state. Hence, in most cases price convergence is a property following from regime switching rather than a conventional error correction mechanism. Finally, the suggested model is shown to deliver forecasts that are more precise compared to competing models.

An empirical comparison of alternate regime-switching models for electricity spot prices

- Energy Economics---2010---Joanna Janczura, Rafał Weron

One of the most profound features of electricity spot prices are the price spikes. Markov regime-switching (MRS) models seem to be a natural candidate for modeling this spiky behavior. However, in the studies published so far, the goodness-of-fit of the proposed models has not been a major focus. While most of the models were elegant, their fit to empirical data has either been not examined thoroughly or the signs of a bad fit ignored. With this paper we want to fill the gap. We calibrate and test a range of MRS models in an attempt to find parsimonious specifications that not only address the main characteristics of electricity prices but are statistically sound as well. We find that the best structure is that of an independent spike 3-regime model with time-varying transition probabilities, heteroscedastic diffusion-type base regime dynamics and shifted spike regime distributions. Not only does it allow for a seasonal spike intensity throughout the year and consecutive spikes or price drops, which is consistent with market observations, but also exhibits the 'inverse leverage effect' reported in the literature for spot electricity prices.

A long-term/short-term model for daily electricity prices with dynamic volatility

- Energy Economics---2010---Stephan Schlueter

In this paper we introduce a new stochastic long-term/short-term model for short-term electricity prices, and apply it to four major European indices, namely to the German, Dutch, UK and Nordic one. We give evidence that all time series contain certain periodic (mostly annual) patterns, and show how to use the wavelet transform, a tool of multiresolution analysis, for filtering purpose. The wavelet transform is also applied to separate the long-term trend from the short-term oscillation in the seasonal-adjusted log-prices. In all time series we find evidence for dynamic volatility,

which we incorporate by using a bivariate GARCH model with constant correlation. Eventually we fit various models from the existing literature to the data, and come to the conclusion that our approach performs best. For the error distribution, the Normal Inverse Gaussian distribution shows the best fit.

Are daily and weekly load and spot price dynamics in Australia's National Electricity Market governed by episodic nonlinearity?

- Energy Economics---2010---Phillip Wild,Melvin Hinich,John Foster

In this article, we use half hourly spot electricity prices and load data for the National Electricity Market (NEM) of Australia for the period from December 1998 to June 2009 to test for episodic nonlinearity in the dynamics governing daily and weekly cycles in load and spot price time series data. We apply the portman-teau correlation, bicorrelation and tricorrelation tests introduced in Hinich (1996) to the time series of half hourly spot prices and load demand from 7/12/1998 to 30/06/2009 using a FORTRAN 95 program. We find the presence of significant third and fourth-order (non-linear) serial dependence in the weekly load and spot price data in particular, but to a much more marginal extent, in the daily data.

Impacts of climate policy on the competitiveness of Canadian industry: How big and how to mitigate?

- Energy Economics---2010---Nicholas Rivers

Competitiveness concerns have been at the forefront of climate policy debates in Canada particularly as a result of its high energy intensity and significant exposure to international markets. This paper uses a dynamic computable general equilibrium model to assess the likely impacts on sectoral competitiveness that would accompany efforts to meet greenhouse gas mitigation targets that have been set by the Canadian government. Additionally, it evaluates several design mechanisms that could be used to reduce the negative competitiveness impacts associated with adoption

of domestic climate policies. The analysis suggests that several sectors would likely face significant competitiveness challenges under a reference scenario in which permits are given to emitters in lump sum. However, it finds that competitiveness impacts can be minimized by using output-based recycling of permits, or by using border tax adjustments.

Exploring IMAGE model scenarios that keep greenhouse gas radiative forcing below 3 W/m² in 2100

- Energy Economics---2010---Detlef P. van Vuuren,Elke Stehfest,Michel G.J. den Elzen,Jasper van Vliet,Morna Isaac

A high probability of limiting temperature increase to 2 °C requires a radiative forcing below 3 W/m², around the end of this century, according to current knowledge. This paper identifies conditions under which achieving such low radiative forcing levels is feasible. Calculations here show that such targets could be achieved, based on technical and physical considerations, provided some key conditions are met. These key conditions include early participation by major sectors and regions in sufficiently stringent policy regimes, and a wide portfolio of mitigation options. Bio-energy and carbon capture and storage (CCS) play an important role in achieving low stabilisation targets. This would require optimistic assumptions with respect to the expansion of the area needed for food production, to allow space for bio-energy crops, and a significant increase in the efficiency of second-generation biofuels. The sensitivity analysis shows that if certain technologies are removed from the available portfolio, low targets -- especially the 2.6 W/m² target -- are no longer within reach.

Balancing contemporary fairness and historical justice: A 'quasi-equitable' proposal for GHG mitigations

- Energy Economics---2010---Zili Yang,Philip Sirianni

In this paper, we analyze the impasse, caused by polarizing positions of the United States and China - in

international negotiations on carbon mitigation. By incorporating the Bern carbon cycle module into the RICE model developed by Nordhaus and Yang (1996), we set up a framework for tracking regional contributions to carbon concentration and to global climate change. Our proposal, labeled the "color preservation" principle, uses regional contribution share to global carbon concentration as the criterion for international cooperation. Through simulations in RICE model with Bern module (RICE-B), we examine the rationales of the arguments made by the United States and China. We conclude that both countries' standpoints are severely flawed. To facilitate the global cooperation on carbon mitigations, major concessions are needed from the two top carbon emitters.

Can environmental sustainability be used to manage energy price risk?

- Energy Economics---2010---Irene Henriques,Perry Sadorsky

Energy security issues and climate change are two of the most pressing problems facing society and both of these problems are likely to increase energy price variability in the coming years. This paper develops and estimates a model of a company's energy price exposure and presents evidence showing that increases in a company's environmental sustainability lowers its energy price exposure. This result is robust across two different measures of energy prices. These results should be useful to companies seeking new ways of addressing energy price risk as well as governments concerned about the impact that energy price risk can have on economic growth and prosperity.

The integration of major fuel source markets in China: Evidence from panel cointegration tests

- Energy Economics---2010---Hengyun Ma,Les Oxley

The paper tests for energy price co-movement in China over the 'new regime' as part of a strategy to test for the existence of a national energy market. Panel cointegration test statistics suggest that not all energy

commodities are spatially homogenous in prices and the processes of energy price cointegration are different over time and over groups of fuels. The statistics demonstrate China's gradual, spatially partial and idiosyncratic energy reform process. Coal and electricity price series have co-moved since 2003, while the national panel cointegration test statistics suggest that gasoline and diesel price series have co-moved since 1997. Regional panel tests also show that there are apparently differences in the emergence of energy price co-movement. This suggests that regional energy markets have emerged in China. One of the important lessons of the research is that an energy market has, to some extent, already emerged in China and, as a consequence, energy prices are much less distorted than previously. If correct, this fact is of major global significance both in terms of future environmental effects and future trade and investment negotiations as China is seen internationally as a 'market driven economy'.

Trends in world energy prices

- Energy Economics---2010---Atanu Ghoshray,Ben Johnson

The correct identification of the time series path of non-renewable energy resources has far reaching consequences for economists and policymakers alike. This study builds on the existing literature by employing a data series that includes a sample period of institutional change and recently developed unit root testing procedures. Besides crude oil, natural gas and coal prices are also examined, aiming to further the knowledge of non-renewable energy resource time paths in order to inform future research and update the conclusions of past studies. The unit root tests allow for structural breaks and are based on the procedures developed by Zivot and Andrews (1992), Lumsdaine and Papell (1997) and Lee and Strazicich (2003). Finally, we investigate whether the trend changes signs in the regimes which are bounded by the structural breaks and quantify the prevalence of the trends over the sample period considered. The results show that the trend is not well represented by a single positive or negative trend. The variability of the trend suggests that fore-

casting energy prices should not typically occur about a single trend.

Asymmetric price responses and the underlying energy demand trend: Are they substitutes or complements? Evidence from modelling OECD aggregate energy demand

- Energy Economics---2010---Olutomi Adeyemi,David Broadstock,Mona Chitnis,Lester Hunt,Guy Judge

A number of energy demand studies have considered the importance of modelling Asymmetric Price Responses (APR), for example, the often-cited work of Gately and Huntington (2002). Griffin and Schulman (2005) questioned the asymmetric approach arguing that this is only capturing energy saving technical progress. Huntington (2006), however, showed that for whole economy aggregate energy and oil demand there is a role statistically for both APR and exogenous energy saving technical change. In a separate strand of the literature the idea of the Underlying Energy Demand Trend (UEDT) has been developed, see for example Hunt et al. (2003a and 2003b) and Dimitropoulos et al. (2005). They argue that it is important, in time series energy demand models, to allow for stochastic trends (or UEDTs) based upon the structural time series/dynamic regression methodology recommended by Harvey (1989, 1997). This paper attempts to bring these strands of the literature together by proposing a testing procedure for the UEDT and APR in energy demand models within both a panel context (consistent with the Huntington, 2006 approach) and the structural time series modelling framework. A set of tests across a range of specifications using time-series and panel data are therefore suggested in order to try and ascertain whether energy saving technical change (or the more general UEDT) and APR are substitutes for each other when modelling energy demand or whether they are actually picking up different influences and are therefore complements. Using annual whole economy data for 17 OECD countries over the period 1960-2006 the results suggest that for most of the countries the UEDT is preferred to APR, whereas for another group

the UEDT and APR are complements, and for another group they are substitutes. It is argued therefore that energy demand modellers should not assume at the outset that one method is superior to the other. Moreover, wherever possible, a general model (be it in a time series or panel context) that includes a 'non linear UEDT' and APR should be initially estimated, and only if accepted by the data should symmetry and/or a more restrictive UEDT be imposed.

Price transmission in the UK electricity market: Was NETA beneficial?

- Energy Economics---2010---Monica Giulietti,Luigi Grossi,Michael Waterson

This paper explores the relationship between domestic retail electricity prices in Great Britain and their determinants in the context of the New Electricity Trading Arrangements (NETA) introduced in 2001. We employ a consistent comparison of wholesale power price series before and after NETA, alongside a difference-in-differences analysis based on using Scotland as a control. Despite NETA's stated intention of reducing wholesale and thereby retail prices, we conclude that its net effect, alongside other developments, instead merely rearranged where money was made in the system.

Explaining the inefficiency of electrical distribution companies: Peruvian firms

- Energy Economics---2010---Raúl Pérez-Reyes,Beatriz Tovar

This paper investigates the extent to which the structural reform of the Peruvian electricity market, implemented in the 1990s, has improved the efficiency of the distribution companies; and it evaluates the influence on efficiency of firm specific explanatory variables. To do this, we rely on data from 14 distribution companies between 1996 and 2006. The results indicate that the incentives generated by the reform process led to the firms becoming more efficient. Moreover, the time trend and private management of the distribution companies are variables that positively affect the levels of

efficiency, whereas the lower network densities are then the greater the inefficiency.

Technical and allocative inefficiencies and factor elasticities of substitution: An analysis of energy waste in Iran's manufacturing

- Energy Economics---2010---Nasser Khia-bani,Karim Hasani

Ignoring technical and allocative inefficiencies or embedding one of them alone in a system of input demands may result in biased elasticities. We consider a comprehensive model including technical inefficiency (in input and output forms) and allocative inefficiency and apply it to panel data from Iran's manufacturing sector. The results show that the presence of both inefficiencies affects the computed elasticities of demand and substitution. Moreover, in spite of current waste of energy in Iran's manufacturing, the elimination of environmental constraints will prompt the manufacturing firms to increase the utilization of energy relative to both capital and labor.

The deregulation effects of Finnish electricity markets on district heating prices

- Energy Economics---2010---Mikael Linden,Päivi Peltola-Ojala

This paper investigates an empirical econometric panel data model in order to test deregulation and regional market structure effects on district heating prices in Finland for period 1996-2002. The data was collected from 76 district heating firms throughout Finland. Special emphasis is placed on the modeling of policy-induced competition, which began in year 1999, regional based fuel selection, local market structures, and distribution network sharing effects. The results imply that the local structures of energy production and sales have an important role to play in the formation of market prices and that the price lowering effects of energy market deregulation are permanent.

Measurement of productive efficiency with frontier methods: A case study for wind farms

- Energy Economics---2010---Guillermo Iglesias,Pablo Castellanos,Amparo Seijas

In this paper, we measure the productive efficiency of a group of wind farms during the period 2001-2004 using the frontier methods Data Envelopment Analysis (DEA) and Stochastic Frontier Analysis (SFA). Taking an extensive definition of the productive process of wind electricity as our starting point, we obtain results which allow us to identify, on the one hand, an essentially ex ante efficiency measure and, on the other hand, aspects of relevance for wind farm development companies (developers), technology suppliers and operators in terms of their economic impact. These results may also be of interest for regulators and other stakeholders in the sector. Furthermore, we discuss the implications of the simultaneous use of DEA and SFA methodologies.

Accounting frameworks for tracking energy efficiency trends

- Energy Economics---2010---B.W. Ang,A.R. Mu,Peng Zhou

Many differences can be found among the existing accounting systems for tracking economy-wide energy efficiency trends. There is a need for greater uniformity in the design and application of such systems but a formal study does not exist. This paper seeks to fill some of the gaps. It begins by introducing the basic concepts, indicators and terminology in this study area. This is followed by a review of the existing economy-wide energy efficiency accounting systems with a focus on the analytical framework. The merit of having a precise and meaningful relationship between two basic energy indicators, the energy efficiency index and the energy savings due to efficiency improvement, is elaborated. An accounting framework based on the LMDI decomposition technique which possesses a number of desirable properties is proposed. Numerical examples are presented to highlight these properties and show the differences among the various accounting frameworks. Several methodological and application

issues are discussed, and the study concludes with key findings and recommendations.

Policymaking benefits and limitations from using financial methods and modelling in electricity markets

- Energy Economics---2010---Richard Green,Benjamin Hobbs,Shmuel Oren,Afzal Siddiqui

2010

Restructuring electricity policy and financial models

- Energy Economics---2010---Leonard S. Hyman

The old, regulated electric industry provided reliable service, not necessarily in the most economic manner, at a declining real price. The semi-competitive electric industry model now operating in the United States and the UK has shown that electric companies can operate more efficiently than before, but it has not delivered significantly greater benefits to consumers than the old model. Financial modelers and policy makers should address those issues whose solution will provide the most bang for the buck, in order to bring about greater benefits to consumers.

Volatility transmission and volatility impulse response functions in European electricity forward markets

- Energy Economics---2010---Yannick Le Pen,Benoît Sévi

Using daily data from March 2001 to June 2005, we estimate a VAR-BEKK model and find evidence of return and volatility spillovers between the German, the Dutch and the British forward electricity markets. We apply Hafner and Herwartz [2006, Journal of International Money and Finance 25, 719-740] Volatility Impulse Response Function (VIRF) to quantify the impact of shock on expected conditional volatility. We observe that a shock has a high positive impact only if

its size is large compared to the current level of volatility. The impact of shocks are usually not persistent, which may be a consequence of the non-storability of power. Finally, we estimate the density of the VIRF at different forecast horizons. These fitted distributions are asymmetric and show that large increases in expected conditional volatilities are possible even if their probability is low. These results have interesting implications for market participants whose risk management policy depends on option prices which themselves depend on the characteristics of volatility.

Efficiency of financial transmission rights markets in centrally coordinated periodic auctions

- Energy Economics---2010---Seabron Adamson,Thomas Noe,Geoffrey Parker

Electricity market design in the United States is increasingly dominated by locational marginal pricing (LMP) of energy and transmission. LMP markets are typically coupled with periodic auctions of financial transmission rights (FTRs) to hedge transmission price risks. While LMP designs offer considerable advantages, forward price discovery in these markets requires participants to form efficient expectations on spot congestion price differences. In this paper, we examine trends in the efficiency of one of the early LMP markets, the New York Independent System Operator (NYISO), analyzing a panel data set of over 9000 contracts over a six-year period beginning September 2000. We show that NYISO FTR markets were inefficient in their early years, but that market participants learned to predict forward prices and thus efficiency improved for FTRs not solely within the New York City/Long Island sub-region. FTRs within this sub-region, which has a number of special characteristics, remain relatively inefficient.

The inherent inefficiency of simultaneously feasible financial transmission rights auctions

- Energy Economics---2010---Shi-Jie Deng,Shmuel Oren,A.P. Meliopoulos

Empirical evidence from the New York ISO shows that the clearing prices for point-to-point congestion revenue rights, also known as financial transmission rights (FTRs), resulting from centralized auctions conducted by Independent System Operators differ significantly and systematically from the realized congestion revenues that determine the accrued payoffs of these rights. The question addressed by this paper is whether such deviations are due to price discovery errors which will eventually vanish or due to inherent inefficiencies in the auction structure. We show that even with perfect foresight of average congestion rents the clearing prices for the FTRs depend on the bid quantity and therefore may not be priced correctly in the financial transmission right (FTR) auction. In particular, we prove that quantity limits on the FTR bids may cause the auction clearing prices to differ from the bid prices. This phenomenon which is inherent in the theoretical properties of the optimization algorithm used to clear the auction, is further illustrated through numerical simulations with test systems. We conclude that price discovery alone would not remedy the discrepancy between the auction prices and the realized values of the FTRs. Secondary markets or frequent reconfiguration auctions are necessary in order to achieve such convergence.

Market completeness: How options affect hedging and investments in the electricity sector

- Energy Economics---2010---Bert Willems,Joris Morbee

The high volatility of electricity markets gives producers and retailers an incentive to hedge their exposure to electricity prices by buying and selling derivatives. This paper studies how welfare and investment incentives are affected when an increasing number of derivatives are introduced. It develops an equilibrium model of the electricity market with risk averse firms and a set of traded financial products, more specifically: a forward contract and an increasing number of options. We first show that aggregate welfare (the sum of individual firms' utility) increases with the number of derivatives offered, although most of the benefits are

captured with one to three options. Secondly, power plant investments typically increase because additional derivatives enable better hedging of investments. However, the availability of derivatives sometimes leads to 'crowding-out' of physical investments because firms' limited risk-taking capabilities are being used to speculate on financial markets. Finally, we illustrate that players basing their investment decisions on risk-free probabilities inferred from market prices, may significantly overinvest when markets are not sufficiently complete.

Risks, revenues and investment in electricity generation: Why policy needs to look beyond costs

- Energy Economics---2010---Robert Gross,William Blyth,Philip Heptonstall

Energy policy goals frequently depend upon investment in particular technologies, or categories of technology. Whilst the British government has often espoused the virtues of technological neutrality, UK policies now seek to promote nuclear power, coal with CO₂ capture and storage, and renewable energy. Policy decisions are often informed by estimates of cost per unit of output (for example, £/MWh), also known as levelised costs. Estimates of these costs for different technologies are often used to provide a 'ballpark' guide to the levels of financial support needed (if any) to encourage uptake, or direct investment away from the technologies the market might otherwise have chosen. Levelised cost estimates can also help to indicate the cost of meeting public policy objectives, and whether there is a rationale for intervention (for example, based on net welfare gains). In the UK electricity sector, investment is undertaken by private companies, not governments. Investment is driven by expected returns, in the light of a range of risks related to both costs and revenues. Revenue risks are not captured in estimates of cost or cost-related risks. An important category of revenue risk is associated with electricity price fluctuations. Exposure to price risks differs by technology. Low electricity prices represent a revenue risk to technologies that cannot influence electricity

prices. By contrast, 'price makers' that set marginal prices are, to an extent, able to pass fuel price increases through to consumers. They have an inherent 'hedge' against fuel and electricity price fluctuations. Based on recent research by the UK Energy Research Centre, this paper considers the implications of such price risks for policy design. The authors contrast the range of levelised costs estimated for different generating options with the spread of returns each is exposed to when electricity price fluctuations are factored in. Drawing on recent policy experiences in the renewable energy arena, in the UK and elsewhere, the authors provide an assessment of investment risk in policy effectiveness and consider how policy design can increase or ameliorate price risk. They discuss the circumstances under which policy goals might be best served by 'socialising' price risk, through fixed price policies. The importance of increased and explicit attention to revenue risk in policymaking is discussed, along with the means by which this might be achieved.

Gas-fired power plants: Investment timing, operating flexibility and CO2 capture

- Energy Economics---2010---Stein-Erik Fleten,Erkka Näsäkkälä

We analyze investments in gas-fired power plants based on stochastic electricity and natural gas prices. A simple but realistic two-factor model is used for price processes, enabling analysis of the value of operating flexibility, the opportunity to abandon the capital equipment, as well as finding thresholds for energy prices for which it is optimal to enter into the investment. We develop a method to compute upper and lower bounds on plant values and investment threshold levels. Our case study uses representative power plant investment and operations data, and historical forward prices from well-functioning energy markets. We find that when the decision to build is considered, the abandonment option does not have significant value, whereas the operating flexibility and time-to-build option have significant effect on the building threshold. Furthermore, the joint value of the operating flexibility and the abandonment option is much smaller than the

sum of their separate values, because both are options to shut down. The effects of emission costs on the value of installing CO2 capture technology are also analyzed.

How to proceed with competing alternative energy technologies: A real options analysis

- Energy Economics---2010---Afzal Siddiqui,Stein-Erik Fleten

Concerns about CO2 emissions create incentives for the development and deployment of energy technologies that do not use fossil fuels. Indeed, such technologies would provide tangible benefits in terms of avoided fossil-fuel costs, which are likely to increase as restrictions on CO2 emissions are imposed. However, a number of challenges need to be overcome prior to market deployment, and the commercialisation of alternative energy technologies may require a staged approach given price and technical risk. We analyse how a firm may proceed with staged commercialisation and deployment of competing alternative energy technologies. An unconventional new alternative technology is one possibility, where one could undertake cost-reducing production enhancement measures as an intermediate step prior to deployment. By contrast, the firm could choose to deploy a smaller-scale existing renewable energy technology, and, using the real options framework, we compare the two projects to provide managerial implications on how one might proceed.

Measuring energy linkages with the hypothetical extraction method: An application to Spain

- Energy Economics---2010---Ana-Isabel Guerra,Ferran Sancho

Efficiency improvements in energy use are nowadays one of the main concerns of policy makers and plans of action have been designed to achieve targets such as those of the Kyoto protocol. The measure of their success will depend on the degree that these plans spread through the system. In this light the inter-industry linkages turn out to be quite significant for the effectiveness of policies. We propose in this paper an adaptation of the hypothetical extraction method to measure the

role of energy and non-energy efficiency gains in an interconnected, multisectorial economy while relating the results to the Rebound effects literature.

A model for energy pricing with stochastic emission costs

- Energy Economics---2010---Robert J. Elliott, Matthew R. Lyle, Hong Miao

We use a supply-demand approach to value energy products exposed to emission cost uncertainty. We find closed form solutions for a number of popularly traded energy derivatives such as: forwards, European call options written on spot prices and European Call options written on forward contracts. Our modeling approach is to first construct noisy supply and demand processes and then equate them to find an equilibrium price. This approach is very general while still allowing for sensitivity analysis within a valuation setting. Our assumption is that, in the presence of emission costs, traditional supply growth will slow down causing output prices of energy products to become more costly over time. However, emission costs do not immediately cause output price appreciation, but instead expose individual projects, particularly those with high emission outputs, to much more extreme risks through the cost side of their profit stream. Our results have implications for hedging and pricing for producers operating in areas facing a stochastic emission cost environment.

Trade linkages and macroeconomic effects of the price of oil

- Energy Economics---2010---Iikka Korhonen, Svetlana Ledyeva

In this paper we assess the impact of oil price shocks on oil-producer and oil-consuming economies. VAR models for different countries are linked together via a trade matrix, as in Abeysinghe (2001). As expected, we find that oil producers (here, Russia and Canada) benefit from oil price shocks. For example, a large oil shock leading to a price increase of 50% boosts Russian GDP by about 6%. However, oil producers are hurt by indirect effects of positive oil price shocks,

as economic activity in their exporter countries suffers. For oil consumers, the effects are more diverse. In some countries, output falls in response to an oil price shock, while other countries seem to be relatively immune to oil price changes. Finally, indirect effects are also detected for oil-consumer countries. Those countries, which trade more with oil producers, gain indirect benefits via higher demand from oil-producing countries. In general, the largest negative total effects from positive oil price shocks are found for Japan, China, the USA, Finland and Switzerland, while other countries in our sample seem to have fared quite well during recent positive oil price shocks. The indirect effects are negative for Russia, Finland, Germany and Netherlands.

To consume or not: How oil prices affect the comovement of consumption and aggregate wealth

- Energy Economics---2010---Babatunde Olatunji Odusami

This paper provides insight into how oil price movements affect the consumption choices of U.S. households through the wealth channel. Lettau and Ludvigson (2001) show that while consumption, asset wealth, and labor income share a common long-term trend; they substantially deviate from one another in the short run. In this paper, I show that these transitory deviations can be explained by fluctuations in the price of crude oil. Linear and threshold multivariate autoregressive models are used to measure the oil price effect. Oil price effect on the consumption to aggregate wealth ratio is robust to monetary policy effect, sub-period effect, and econometric specifications of oil price effect. Generally speaking, higher (lower) oil price will lead to a decrease (increase) in the proportion of aggregate wealth consumed. In addition, the magnitude of the oil price effect is asymmetric and sub-period dependent. Oil price effect was higher before the 1980's than in succeeding periods.

Global economic activity and crude oil prices: A cointegration analysis

- Energy Economics---2010---Yanan He, Shouyang Wang, Kin Keung Lai

This paper empirically investigates the cointegrating relationship between crude oil prices and global economic activity. The Kilian economic index is used as an indicator of global economic activity. Based on a supply-demand framework and the cointegration theory, we find that real futures prices of crude oil are cointegrated with the Kilian economic index and a trade weighted US dollar index, and crude oil prices are influenced significantly by fluctuations in the Kilian economic index through both long-run equilibrium conditions and short-run impacts. We also develop an empirically stable, data-coherent and single-equation error-correction model (ECM) which has sensible economic properties. Empirical results based on the ECM show that the adjustment implied by a permanent change in the Kilian economic index is a relatively drawn-out process.

Macro economy, stock market and oil prices: Do meaningful relationships exist among their cyclical fluctuations?

- Energy Economics---2010---George Filis

This paper examines the relationship among consumer price index, industrial production, stock market and oil prices in Greece. Initially we use a unified statistical framework (cointegration and VECM) to study the data in levels. We then employ a multivariate VAR model to examine the relationship among the cyclical components of our series. The period of the study is from 1996:1 to 2008:6. Findings suggest that oil prices and the stock market exercise a positive effect on the Greek CPI, in the long run. Cyclical components analysis suggests that oil prices exercise significant negative influence to the stock market. In addition, oil prices are negatively influencing CPI, at a significant level. However, we find no effect of oil prices on industrial production and CPI. Finally, no relationship can be documented between the industrial production and

stock market for the Greek market. The findings of this study are of particular interest and importance to policy makers, financial managers, financial analysts and investors dealing with the Greek economy and the Greek stock market.

Time series analysis applied to construct US natural gas price functions for groups of states

- Energy Economics---2010---V.V. Kalashnikov, T.I. Matis, G.A. Pérez-Valdés

The study of natural gas markets took a considerably new direction after the liberalization of the natural gas markets during the early 1990s. As a result, several problems and research opportunities arose for those studying the natural gas supply chain, particularly the marketing operations. Consequently, various studies have been undertaken about the econometrics of natural gas. Several models have been developed and used for different purposes, from descriptive analysis to practical applications such as price and consumption forecasting. In this work, we address the problem of finding a pooled regression formula relating the monthly figures of price and consumption volumes for each state of the United States during the last twenty years. The model thus obtained is used as the basis for the development of two methods aimed at classifying the states into groups sharing a similar price/consumption relationship: a dendrogram application, and an heuristic algorithm. The details and further applications of these grouping techniques are discussed, along with the ultimate purpose of using this pooled regression model to validate data employed in the stochastic optimization problem studied by the authors.

Estimating the long-run equilibrium relationship: The case of city-gate and residential natural gas prices

- Energy Economics---2010---Kathleen Arano, Marieta Velikova

This paper examines market cointegration of city-gate and residential natural gas prices. Cointegration of gas

prices across different segments of the industry provides evidence that deregulation has resulted into a more integrated, competitive natural gas industry where gas prices converge into a long-run equilibrium. Our results indicate prices further down the distribution line, the final two points of consumption, are cointegrated for a majority of the US states post open access and retail unbundling, although we find little evidence of perfect market integration. The two price series likewise converge to the long-run equilibrium faster post open access and retail unbundling. Results relative to state level unbundling (choice programs) reveal mixed outcomes with a few states without retail unbundling exhibiting market integration while some states with full unbundling exhibiting non-cointegration.

When is a break-up of Gazprom good for Russia?

- Energy Economics---2010---Marina Tsygankova

In the late 1990s, several proposals for a structural reform that would bring competition and market prices to the Russian gas industry were intensely debated. Splitting up Russian gas monopolist Gazprom into several producing companies was a considered option. In this paper, I examine theoretically and numerically how a split-up of Gazprom would affect Russian national welfare. Results show that under the current gas market structures in Europe and Russia, the split-up of Gazprom's monopoly might not be beneficial for Russia. However, analysis in the paper indicates that the market shares that Gazprom has in both Russian domestic and European gas markets are important in determining whether Gazprom's dominance is supported under the national welfare criteria. When Gazprom has small market share in Europe and large market share in Russia, a break-up of Gazprom might plausibly result in increase of Russian national welfare.

Do gasoline prices exhibit asymmetry? Not usually!

- Energy Economics---2010---Christopher C. Douglas

Previous studies have found evidence of asymmetric

price adjustment in U.S. retail gasoline prices in that gasoline prices rise more rapidly in response to a cost increase than fall in response to a cost decrease. By estimating a threshold cointegration model that allows for multiple regimes, I am able to test how sensitive this result is to outlying observations. In contrast to previous studies, I find little evidence of asymmetry for the vast majority of observations and that the asymmetry is being driven by a small number of outlying observations.

Is there an asymmetry in the response of diesel and petrol prices to crude oil price changes? Evidence from New Zealand

- Energy Economics---2010---Ming-Hua Liu, Dimitris Margaritis, Alireza Tourani-Rad

This paper examines how pre-tax petrol and diesel prices in New Zealand respond to changes in crude oil prices using an asymmetric error correction model. Our results show that oil companies adjust diesel prices upwards faster than they adjust them downwards, and the difference is statistically significant. However we find no statistical evidence for an asymmetry in the adjustment of petrol prices even though the magnitude of estimated coefficients suggests a faster response to rising prices. As diesel pricing is not as competitive as petrol pricing, calls for further government actions and monitoring of the oil market may be justified. Our findings also have important implications for the conduct of monetary policy as the pass-through of crude oil price changes can affect cost-push inflation.

Cooperation among liquefied natural gas suppliers: Is rationalization the sole objective?

- Energy Economics---2010---Olivier Mas-sol, Stéphane Tchong-Ming

This paper examines the development of cooperative strategies between countries exporting Liquefied Natural Gas (LNG) and members of the Gas Exporting Countries Forum (GECF). This economic study focuses specifically on an often-raised scenario: the emergence of a cooperative approach designed with the sole aim

of logistic rationalization, and which would not have any effect on LNG prices. We first assess the annual gains that may result from this market-power-free cooperative approach using a simple static transportation model. The numerical results obtained suggest that, in the absence of a gain redistribution policy, this cooperative strategy will probably not be adopted because cooperation would not be a rational move for some exporters. The problem of gain sharing is then formulated using cooperative game theory concepts. Several gain-sharing methods have been studied, including the Shapley value and various nucleolus-inspired concepts. Our results suggest that the choice of a redistribution policy appears relatively restricted. Out of the methods studied, only one - per capita nucleolus - satisfies two key requirements: core belonging and monotonicity (in the aggregate). Lastly, we look at how cooperation may give rise to a coordination cost and try to determine the maximum amount of this cost. In view of the low level of this amount and the relative complexity of the sharing method implemented, we consider that the credibility of a logistic cooperation scenario exempt from market power should be reappraised.

When do firms generate? Evidence on in-house electricity supply in Africa

- Energy Economics---2010---Jevgenijs Steinbuks,V. Foster

This paper attempts to identify the underlying causes and costs of own generation of electric power in Africa. Rigorous empirical analysis of 8483 currently operating firms in 25 African countries shows that the prevalence of own generation would remain high (at around 20%) even if power supplies were perfectly reliable, suggesting that other factors such as firms' size, emergency back-up and export regulations play a critical role in the decision to own a generator. The costs of own-generation are about three times as high as the price of purchasing (subsidized) electricity from the public grid. However, because these generators only operate a small fraction of the time, they do not greatly affect the overall average cost of power to industry. The benefits of generator ownership are also substantial.

Firms with their own generators report a value of lost load of less than US\$50 per hour, compared with more than US\$150 per hour for those without. Nevertheless, when costs and benefits are considered side by side, the balance is not found to be significantly positive.

A nonlinear approach to modelling the residential electricity consumption in Ethiopia

- Energy Economics---2010---Emmanuel Gabreyohannes

In this paper an attempt is made to model, analyze and forecast the residential electricity consumption in Ethiopia using the self-exciting threshold autoregressive (SETAR) model and the smooth transition regression (STR) model. For comparison purposes, the application was also extended to standard linear models. During the empirical presentation of both models, significant nonlinear effects were found and linearity was rejected. The SETAR model was found out to be relatively better than the linear autoregressive model in out-of-sample point and interval (density) forecasts. Results from our STR model showed that the residual variance of the fitted STR model was only about 65.7% of that of the linear ARX model. Thus, we can conclude that the inclusion of the nonlinear part, which basically accounts for the arrival of extreme price events, leads to improvements in the explanatory abilities of the model for electricity consumption in Ethiopia.

Electricity consumption and economic growth in Burkina Faso: A cointegration analysis

- Energy Economics---2010---Idrissa M. Ouédraogo

This study empirically establishes the direction of causality between electricity consumption and economic growth in Burkina Faso for the period 1968-2003. The bounds test yields evidence of cointegration between electricity consumption, GDP, and capital formation when electricity consumption and GDP are used as dependent variable. Causality results indicate that there is no significant causal relationship

between electricity consumption and investment. Estimates, however, detect in the long-run a bidirectional causal relationship between electricity use and real GDP. There is also evidence of a positive feedback causal relationship between GDP and capital formation. Burkina Faso is therefore an energy dependent country. It is also a country in which electricity consumption is growing with the level of income. All of this shows that electricity is a significant factor in socio-economic development in Burkina Faso; as such, energy policy must be implemented to ensure that electricity generates fewer potential negative impacts.

Energy consumption and economic development in Sub-Sahara Africa

- Energy Economics---2010---Ellene Kebede, John Kagochi, Curtis M. Jolly

Sub-Saharan African countries' economic development is dependent on energy consumption. This paper assesses total energy demand, which is composed of traditional energy (wood fuel) and commercial energy (electricity and petroleum), in the Central, East, South, and West regions of Sub-Saharan Africa. Cross-sectional time series data for 20 countries in 25 years are analyzed, and the results of the study show that wood fuel accounts for 70% of energy consumption, followed by petroleum, with most industrial activities utilizing some form of wood fuel. Regression results suggest that energy demand is inversely related to the price of petroleum and industrial development, but positively related to GDP, population growth rate, and agricultural expansion, and that price elasticity is less than one. The model results also show that there are regional differences in energy demand. In addition, the interaction of population growth rates by regions generates mixed results, and there are regional differences in the use of commercial energy consumption, and GDP growth. The findings of this study suggest that countries must diversify their energy sources and introduce energy-efficient devices and equipment at all levels of the economy to improve GDP growth rate and GDP per capita.

International light water nuclear fuel fabrication supply: Are fabrication services assured?

- Energy Economics---2010---Geoffrey Rothwell

This paper examines the cost structure of fabricating light water reactor (LWR) fuel with low-enriched uranium (LEU, with less than 5% enrichment). The LWR-LEU fuel industry is decades old, and (except for the high entry cost of designing and licensing a fuel fabrication facility and its fuel), labor and additional fabrication lines can be added at Nth-of-a-Kind cost to the maximum capacity allowed by a site license. The industry appears to be competitive: nuclear fuel fabrication capacity is assured with many competitors and reasonable prices. However, nuclear fuel assurance has become an important issue for nations now to considering new nuclear power plants. To provide this assurance many proposals equate "nuclear fuel banks" (which would require fuel for specific reactors) with "LEU banks" (where LEU could be blended into nuclear fuel with the proper enrichment) with local fuel fabrication. The policy issues (which are presented, but not answered in this paper) become (1) whether the construction of new nuclear fuel fabrication facilities in new nuclear power nations could lead to the proliferation of nuclear weapons, and (2) whether nuclear fuel quality can be guaranteed under current industry arrangements, given that fuel failure at one reactor can lead to forced shutdowns at many others.

A panel study of nuclear energy consumption and economic growth

- Energy Economics---2010---Nicholas Apergis, James Payne

This study examines the relationship between nuclear energy consumption and economic growth for sixteen countries within a multivariate panel framework over the period 1980-2005. Pedroni's (1999, 2004) heterogeneous panel cointegration test reveals there is a long-run equilibrium relationship between real GDP, nuclear energy consumption, real gross fixed capital formation, and the labor force with the respective coefficients positive and statistically significant. The results of the

panel vector error correction model finds bidirectional causality between nuclear energy consumption and economic growth in the short-run while unidirectional causality from nuclear energy consumption to economic growth in the long-run. Thus, the results provide support for the feedback hypothesis associated with the relationship between nuclear energy consumption and economic growth.

Nuclear energy consumption and economic growth in nine developed countries

- Energy Economics---2010---Yemane Wolde-Rufael,Kojo Menyah

This article attempts to test the causal relationship between nuclear energy consumption and real GDP for nine developed countries for the period 1971-2005 by including capital and labour as additional variables. Using a modified version of the Granger causality test developed by Toda and Yamamoto (1995), we found a unidirectional causality running from nuclear energy consumption to economic growth in Japan, Netherlands and Switzerland; the opposite uni-directional causality running from economic growth to nuclear energy consumption in Canada and Sweden; and a bi-directional causality running between economic growth and nuclear energy consumption in France, Spain, the United Kingdom and the United States. In Spain, the United Kingdom and the USA, increases in nuclear energy consumption caused increases in economic growth implying that conservation measures taken that reduce nuclear energy consumption may negatively affect economic growth. In France, Japan, Netherlands and Switzerland increases in nuclear energy consumption caused decreases in economic growth, suggesting that energy conservation measure taken that reduce nuclear energy consumption may help to mitigate the adverse effects of nuclear energy consumption on economic growth. In Canada and Sweden energy conservation measures affecting nuclear energy consumption may not harm economic growth.

Energy consumption and income: A semiparametric panel data analysis

- Energy Economics---2010---Phu Nguyen-Van

This paper proposes a semiparametric analysis for the study of the relationship between energy consumption per capita and income per capita for an international panel dataset. It shows little evidence for the existence of an environmental Kuznets curve for energy consumption. Energy consumption increases with income for a majority of countries and then stabilizes for very high income countries. Neither changes in energy structure nor macroeconomic cycle/technological change have significant effect on energy consumption.

Dynamic modelling of energy consumption, capital stock, and real income in G-7 countries

- Energy Economics---2010---Chien-Chiang Lee,Mei-Se Chien

This paper applies an aggregate production function to examine the dynamic linkages among energy consumption, capital stock, and real income (real GDP per capita) in G-7 countries. We employ the Toda and Yamamoto (1995) Granger causality test, the generalized impulse response approach, and variance decompositions in a multivariate setting to uncover the extent and the magnitude of the relationship among variables. Our empirical results find evidence of a unidirectional relationship running from energy consumption to real income in Canada, Italy, and the UK, indicating that energy conservation may hinder economic growth in the three countries. Furthermore, the causality relationship appears to be unidirectional, but reversed, for France and Japan, implying that energy conservation in both countries may still be viable, but without being detrimental to economic growth. As to Germany and the U.S., there is no causality between the variables, which demonstrates the 'neutrality hypothesis', and in such a case economic growth will not affect energy use. We further see that the impact of capital stock is relatively higher compared with that of energy consumption. Transitory initial impacts of innovations in

energy consumption on capital stock and real income are observed.

Energy consumption and economic growth: A causality analysis for Greece

- Energy Economics---2010---Stella Tsani

This paper investigates the causal relationship between aggregated and disaggregated levels of energy consumption and economic growth for Greece for the period 1960-2006 through the application of a later development in the methodology of time series proposed by Toda and Yamamoto (1995). At aggregated levels of energy consumption empirical findings suggest the presence of a uni-directional causal relationship running from total energy consumption to real GDP. At disaggregated levels empirical evidence suggests that there is a bi-directional causal relationship between industrial and residential energy consumption to real GDP but this is not the case for the transport energy consumption with causal relationship being identified in neither direction. The importance of these findings lies on their policy implications and their adoption on structural policies affecting energy consumption in Greece suggesting that in order to address energy import dependence and environmental concerns without hindering economic growth emphasis should be put on the demand side and energy efficiency improvements.

The causality between energy consumption and economic growth: A multi-sectoral analysis using non-stationary cointegrated panel data

- Energy Economics---2010---Valeria Costantini, Chiara Martini

The increasing attention given to global energy issues and the international policies needed to reduce greenhouse gas emissions have given a renewed stimulus to research interest in the linkages between the energy sector and economic performance at country level. In this paper, we analyse the causal relationship between economy and energy by adopting a Vector Error Correction Model for non-stationary and cointegrated panel data with a large sample of developed and developing

countries and four distinct energy sectors. The results show that alternative country samples hardly affect the causality relations, particularly in a multivariate multi-sector framework.

Electricity consumption-growth nexus: Evidence from panel data for transition countries

- Energy Economics---2010---Ali Acaravcı, İlhan Öztürk

This paper investigates the long-run relationship and causality issues between electricity consumption and economic growth in 15 Transition countries (Albania, Belarus, Bulgaria, Czech Republic, Estonia, Latvia, Lithuania, Macedonia, Moldova, Poland, Romania, Russian Federation, Serbia, Slovak Republic and Ukraine) by using the Pedroni panel cointegration method for the 1990-2006 period. Results suggest that the Pedroni panel cointegration tests do not confirm a long-term equilibrium relationship between electricity consumption per capita and real GDP per capita. Moreover, since no cointegration was found, error-correction mechanisms plus causality tests cannot be run for further steps in the long-term to investigate the causality between electricity consumption and economic growth. Overall, it can be said that the electricity consumption related policies have no effect or relation on the level of real output in the long run for these countries. As a conclusion, the literature has conflicting results and there is no consensus either on the existence or the direction of causality between electricity consumption and economic growth. Thus, the findings of this study have important policy implications and it shows that this issue still deserves further attention in future research.

Electricity demand of manufacturing sector in Turkey: A translog cost approach

- Energy Economics---2010---Gülden Bölük, A. Ali Koç

This paper models factor demand for manufacturing sector in Turkey. We estimated a translog cost function with four factors consisting of capital, labor, intermediate

input and electricity over the 1980-2001. Our objective, taking in the consideration electricity as production input, was twofold: on the one hand, to estimate the price elasticity of electricity demand in manufacturing sector, and on the other hand to use cross-price and Morishima Elasticities of Substitution results for structural analysis regarding effects of electricity liberalization which initiated in 2001. Empirical result shows that electricity demand is relatively price sensitive (-0.85). Our result in terms of electricity price is consistent with the previous studies. While electricity-labor and electricity-capital inputs are complementary, results indicate the existence of substitution possibilities between electricity and intermediate input. This means that changes in electricity prices have impact on labor demand and investment demand. These results have important implications for public policy.

Income, resources, and electricity mix

- Energy Economics---2010---Paul Burke

This paper presents evidence on a national-level electricity ladder which sees countries transition toward coal and natural gas, and finally nuclear power and modern renewables such as wind power, for their electricity needs as they develop. The extent to which countries climb the electricity ladder is dependent on energy endowments. The results imply that the environmental implications of economic development differ in countries with different energy resource endowments. An effective global carbon mitigation strategy will require developing countries to leapfrog the middle rungs of the electricity ladder.

A real options based model and its application to China's overseas oil investment decisions

- Energy Economics---2010---Ying Fan,Lei Zhu

This paper applies real options theory to overseas oil investment by adding an investment-environment factor to oil-resource valuation. A real options model is developed to illustrate how an investor country (or oil company) can evaluate and compare the critical value of oil-resource investment in different countries under

oil-price, exchange-rate, and investment-environment uncertainties. The aim is to establish a broad model that can be used by every oil investor country to value overseas oil resources. The model developed here can match three key elements: 1) deal with overseas investment (the effects of investment environment and exchange rates); 2) deal with oil investment (oil price, production decline rate and development cost etc.); 3) the comparability of the results from different countries (different countries' oil-investment situation can be compared by using the option value index (OVI)). China's overseas oil investment is taken as an example to explain the model by calculating each oil-investee country's critical value per unit of oil reserves and examining the effect of different factors on the critical value. The results show that the model developed here can provide useful advice for China's overseas oil investment program. The research would probably also be helpful to other investor countries looking to invest in overseas oil resources.

The economics of allowing more U.S. oil drilling

- Energy Economics---2010---Robert Hahn,Peter Passell

This paper examines the likely impact of developing U.S. energy resources on oil prices. In addition, we examine the benefits and costs of allowing drilling in the Arctic National Wildlife Refuge and the areas of the Outer Continental Shelf that were until recently closed to drilling. We find that allowing oil drilling in ANWR and the off-limits OCS would be likely to have a very modest impact on oil prices--on the order of 1%. However, a benefit-cost analysis of developing ANWR and off-limits OCS suggests that the benefits are likely to exceed the costs.

Edgeworth cycles revisited

- Energy Economics---2010---Joseph Doyle,Erich Muehlegger,Krislert Samphantharak

Some gasoline markets exhibit remarkable price cycles, where price spikes are followed by a series of small price declines: a pattern consistent with a model of

Edgeworth cycles described by Maskin and Tirole. We extend the model and empirically test its predictions with a new dataset of daily station-level prices in 115 US cities. Consistent with the theory, and often in contrast with previous empirical work, we find the least and most concentrated markets are much less likely to exhibit cycling behavior both within and across cities; areas with more independent convenience-store gas stations are also more likely to cycle.

A general equilibrium view of global rebound effects

- Energy Economics---2010---Taoyuan Wei

How do energy efficiency gains affect energy consumption? The effects are generally called "rebound effects" in the literature. Previous studies have extensively focused on only part of the global economy to study rebound effects, e.g. energy consumption by households, one industry, or one country. However, since the global economy is highly connected among countries, these studies may lead to misleading conclusions if the rebound effects in the rest of the economy are significant. Recently Saunders (2008) analyzes the demand side by taking the global economy as a whole. Wei (2007) also provides a general analysis by using Cobb-Douglas production functions for the global economy. The present article expands Wei (2007) general analysis to explore the rebound effects from an economist's viewpoint by taking the global economy as a whole and applying general forms of production functions. The analysis provides new insights related to rebound effects: we highlight the role of energy supply as a determinant of rebound. We show that the substitution between energy resources and other productive resources is more relevant to long term rebound. We predict that long term rebound may be lower than short term rebound. And we also discover that super-conservation can happen in both the short term and the long term.

Integrating bioenergy into computable general equilibrium models -- A survey

- Energy Economics---2010---Bettina Kretschmer, Sonja Peterson

In the past years biofuels have received increased attention since they were believed to contribute to rural development, energy security and to fight global warming. It became clear, though, that bioenergy cannot be evaluated independently of the rest of the economy and that national and international feedback effects are important. Computable general equilibrium (CGE) models have been widely employed in order to study the effects of international climate policies. The main characteristic of these models is their encompassing scope: Global models cover the whole world economy disaggregated into regions and countries as well as diverse sectors of economic activity. Such a modelling framework unveils direct and indirect feedback effects of certain policies or shocks across sectors and countries. CGE models are thus well suited for the study of bioenergy/biofuel policies. One can currently find various approaches in the literature of incorporating bioenergy into a CGE framework. This paper gives an overview of existing approaches, critically assesses their respective power and discusses the advantages of CGE models compared to partial equilibrium models. Grouping different approaches into categories and highlighting their advantages and disadvantages is important for giving a structure to this rather recent and rapidly growing research area and to provide a guidepost for future work.

Vegetable oil market and biofuel policy: An asymmetric cointegration approach

- Energy Economics---2010---Massimo Peri, Lucia Baldi

The present paper analyses the long-run relationship between vegetable oil prices and conventional diesel prices in the EU for the period 2005-2007. We applied recent developments in the threshold cointegration approach to investigate the presence of asymmetric dynamic adjusting processes between the prices of rapeseed oil, sunflower oil, and soybean oil, and the price of a mineral oil: diesel. The results presented suggest a two-regime threshold cointegration model only for the rapeseed oil-diesel price pair. Thus, the rapeseed oil price adjusts rapidly to its long-run equilibrium,

determined by fossil diesel prices, but this adjustment is asymmetric: it differs if the divergence between the two prices is above or below a critical threshold. Consequently, rapeseed oil appears particularly exposed to external shocks deriving from global political scenarios, suggesting the reassessment of the high quota (80%) of EU biodiesel represented by this vegetable oil.

The case of co-firing: The market level effects of subsidizing biomass co-combustion

- Energy Economics---2010---Jussi Lintunen,Hanna-Liisa Kangas

Biomass combustion in co-firing power plants has been treated differently in renewable electricity promoting policy schemes. Some policy schemes subsidize biomass co-combustion while some do not. In this study, we analyze the impacts of a policy choice on the fuel uses, investment decisions, CO₂ emissions, and on the values of renewable electricity promoting policy instruments. In particular, we look at the impacts of feed-in tariff and a subsidy to renewable energy, both together with CO₂ emissions price. We present an electricity and heat market model, where all the solid fossil fuel power plants are able to co-fire biomass and fossil fuel. In the numerical application, the model is used to analyze the differences caused by the policy instruments. The results show that subsidizing biomass combustion in a co-firing power plant decreases the investments in pure renewable technology. However, the use of solid fossil fuels is not increased significantly. Also, the CO₂ intensity levels of electricity production are nearly equal whether biomass co-combustion is subsidized or not.

What trends in energy efficiencies? Evidence from a robust test

- Energy Economics---2010---Yannick Le Pen,Benoît Sévi

A proper modeling of the long-run behavior of energy and oil intensities is crucial in many respects. This paper aims at checking whether this long-run behavior should be modelled as a deterministic or a stochastic trend or both. We first apply a test for a deterministic

trend robust to uncertainty about the stochastic trend. Our results indicate that, for the period 1960-2004, energy intensities of only 8 OECD countries out of 25 include a negative deterministic trend, 3 include a positive one and 14 seem to be better modelled by a stochastic trend only. When considering a sample of 73 non-OECD countries on the period 1971-2004, we show that only 22 exhibit a deterministic trend (negative for 15 countries and positive for 7 countries). A similar analysis for oil intensity leads to reject the hypothesis of an insignificant deterministic trend for 7 OECD countries out of 23 for the period 1965-2004 and 11 non-OECD countries out of 40 for the period 1971-2004. In the next step, we apply standard unit root tests and find that the unit root hypothesis is not very often rejected. We conclude that a main feature of energy intensities is the presence of a stochastic trend.

Valuing a gas-fired power plant: A comparison of ordinary linear models, regime-switching approaches, and models with stochastic volatility

- Energy Economics---2010---Somayeh Heydari,Afzal Siddiqui

Energy prices are often highly volatile with unexpected spikes. Capturing these sudden spikes may lead to more informed decision-making in energy investments, such as valuing gas-fired power plants, than ignoring them. In this paper, non-linear regime-switching models and models with mean-reverting stochastic volatility are compared with ordinary linear models. The study is performed using UK electricity and natural gas daily spot prices and suggests that with the aim of valuing a gas-fired power plant with and without operational flexibility, non-linear models with stochastic volatility, specifically for logarithms of electricity prices, provide better out-of-sample forecasts than both linear models and regime-switching models.

Investment in transport infrastructure, regulation, and gas-gas competition

- Energy Economics---2010---Farid Gasmi,Juan Oviedo

This paper develops a simple model in which a regulated (upstream) transporter provides capacity to a marketer competing in output with an incumbent in the (downstream) gas commodity market. The equilibrium outcome of the firms' interaction in the downstream market is explicitly taken into account by the regulator when setting the transport charge. We consider various forms of competition in this market and derive the corresponding optimal transport charge policies. We then run simulations that allow us to perform a comparative welfare analysis of these transport infrastructure investment policies based on different assumptions about the intensity of the competition that prevails in the gas commodity market.

Interfuel substitution in the United States

- Energy Economics---2010---Apostolos Serletis, Govinda Timilsina, Olexandr Vasetsky

In this paper, we use the locally flexible translog functional form to investigate the demand for energy and interfuel substitution in the United States and to provide a comparison of our results with most of the existing empirical energy demand literature. Motivated by the widespread practice of ignoring theoretical regularity, we follow Barnett's (2002) suggestions and estimate the model subject to theoretical regularity, using methods developed by Diewert and Wales (1987) and Ryan and Wales (2000), in an attempt to produce inference consistent with neoclassical microeconomic theory. Moreover, we use the most recent data, published by the U.S. Energy Information Administration (EIA), and in addition to investigating interfuel substitution possibilities in total U.S. energy demand, we follow Serletis et al. (2009) and also examine interfuel substitution possibilities in energy demand by sector. Moreover, we test for weak separability, with the objective of discovering the structure of the functional form in total energy demand as well as energy demand by sector.

Allocating the CO₂ emissions of an oil refinery with Aumann-Shapley prices: A reply

- Energy Economics---2010---Axel Pierru

In this reply, I oppose and further debate some of the points raised in Mr Tehrani's comment (2010). In addition, I show that, when dealing with short-run linear-programming models with not-adjusted-to-demand capacities, Aumann-Shapley prices can be considered as an attempt to recreate long-run marginal costs.

Portfolio diversification in energy markets

- Energy Economics---2010---Valentina Galvani, Andre Plourde

This paper's results indicate that futures for crude oil, natural gas and unleaded gasoline fail to enhance the performance of representative energy stocks in terms of return to risk, but do decrease the overall level of risk exposure borne by passive equity investors. Our findings suggest that futures contracts on energy commodities are valuable to market participants with an interest in hedging against price fluctuations in energy markets by buy-and-hold strategies. However, this conclusion is reversed when one takes the perspective of traders whose core interests can be better approximated through the return to risk-bearing. In fact, this paper documents that return-to-risk maximizing agents are unlikely to profit from trading energy futures in addition to energy stocks. Moreover, futures for energy commodities fail to offer significant diversification gains with respect to energy stocks once investors adopt simple dynamic trading strategies that rely on readily available pricing information.

Time-dependent correlations in electricity markets

- Energy Economics---2010---Jose Alvarez-Ramirez, Rafael Escarela-Perez

In the last years, many electricity markets were subjected to deregulated operation where prices are set by the action of market participants. In this form, producers and consumers rely on demand and price forecasts to decide their bidding strategies, allocate assets, negotiate bilateral contracts, hedge risks, and plan facility investments. A basic feature of efficient

market hypothesis is the absence of correlations between price increments over any time scale leading to random walk-type behavior of prices, so arbitrage is not possible. However, recent studies have suggested that this is not the case and correlations are present in the behavior of diverse electricity markets. In this paper, a temporal quantification of electricity market correlations is made by means of detrended fluctuation and Allan analyses. The approach is applied to two Canadian electricity markets, Ontario and Alberta. The results show the existence of correlations in both demand and prices, exhibiting complex time-dependent behavior with lower correlations in winter while higher in summer. Relatively steady annual cycles in demand but unstable cycles in prices are detected. On the other hand, the more significant nonlinear effects (measured in terms of a multifractality index) are found for winter months, while the converse behavior is displayed during the summer period. In terms of forecasting models, our results suggest that nonlinear recursive models (e.g., feedback NNs) should be used for accurate day-ahead price estimation. In contrast, linear models can suffice for demand forecasting purposes.

Integration and shock transmissions across European electricity forward markets

- Energy Economics---2010---Derek W. Bunn, Angelica Gianfreda

New results are presented relating to the integration of the French, German, British, Dutch and Spanish power markets at day-ahead, week-ahead, one month-ahead and two month-ahead lead times. Overall, there is evidence of market integration, increasing over time, despite an underlying inefficiency in each market with respect to the forward and spot price convergence. The spatial analysis, on a financial dimension, is undertaken using causality tests, cointegration and impulse-response techniques, for both price levels and volatilities. In general we find less influence of the size and proximity of neighbouring markets than other studies, more integration at baseload than peak, and, surprisingly, less integration in forwards than spot prices.

Feedback, competition and stochasticity in a day ahead electricity market

- Energy Economics---2010---Paolo Giabardo, Marco Zugno, Pierre Pinson, Henrik Madsen

Major recent changes in electricity markets relate to the process for their deregulation, along with increasing participation of renewable (stochastic) generation e.g. wind power. Our general objective is to model how feedback, competition and stochasticity (on the production side) interact in electricity markets, and eventually assess what their effects are on both the participants and the society. For this, day ahead electricity markets are modeled as dynamic closed loop systems, in which the feedback signal is the market price. In parallel, the Cournot competition model is considered. Mixed portfolios with significant share of renewable energy are based on stochastic threshold cost functions. Regarding trading strategies, it is assumed that generators are looking at optimizing their individual profits. The point of view of the society is addressed by analyzing market behavior and stability. The performed simulations show the beneficial effects of employing long term bidding strategies for both generators and society. Sensitivity analyses are performed in order to evaluate the effects of demand elasticity. It is shown that increase in demand elasticity reduces the possibility for the generators to exploit their market power. Furthermore, the results suggest that introduction of wind power generation in the market is beneficial both for the generators and the society.

Analysis of model implied volatility for jump diffusion models: Empirical evidence from the Nordpool market

- Energy Economics---2010---Nikos K. Nomikos, Orestes A. Soldatos

In this paper we examine the importance of mean reversion and spikes in the stochastic behaviour of the underlying asset when pricing options on power. We propose a model that is flexible in its formulation and captures the stylized features of power prices in a parsimonious way. The main feature of the model is that

it incorporates two different speeds of mean reversion to capture the differences in price behaviour between normal and spiky periods. We derive semi-closed form solutions for European option prices using transform analysis and then examine the properties of the implied volatilities that the model generates. We find that the presence of jumps generates prominent volatility skews which depend on the sign of the mean jump size. We also show that mean reversion reduces the volatility smile as time to maturity increases. In addition, mean reversion induces volatility skews particularly for ITM options, even in the absence of jumps. Finally, jump size volatility and jump intensity mainly affect the kurtosis and thus the curvature of the smile with the former having a more important role in making the volatility smile more pronounced and thus increasing the kurtosis of the underlying price distribution.

On the market impact of wind energy forecasts

- Energy Economics---2010---Tryggvi Jónsson, Pierre Pinson, Henrik Madsen

This paper presents an analysis of how day-ahead electricity spot prices are affected by day-ahead wind power forecasts. Demonstration of this relationship is given as a test case for the Western Danish price area of the Nord Pool's Elspot market. Impact on the average price behaviour is investigated as well as that on the distributional properties of the price. By using a non-parametric regression model to assess the effects of wind power forecasts on the average behaviour, the non-linearities and time variations in the relationship are captured well and the effects are shown to be quite substantial. Furthermore, by evaluating the distributional properties of the spot prices under different scenarios, the impact of the wind power forecasts on the price distribution is proved to be considerable. The conditional price distribution is moreover shown to be non-Gaussian. This implies that forecasting models for electricity spot prices for which parameters are estimated by a least squares techniques will not have Gaussian residuals. Hence the widespread assumption of Gaussian residuals from electricity spot price models is shown to be inadequate for these model types. The

revealed effects are likely to be observable and qualitatively similar in other day-ahead electricity markets significantly penetrated by wind power.

A comment on: Storage and the electricity forward premium

- Energy Economics---2010---Adriaan Bloys van Treslong, Ronald Huisman

This paper examines the robustness of the results found by Douglas and Popova (2008). They examine the electricity forward premium in relation to gas storage inventories and find that, although electricity is not directly storable, electricity forward premiums are lower when gas storage inventories are higher, especially on days with high temperatures. Douglas and Popova (2008) derive their results from a forward premium model that is an extension of the Bessembinder and Lemmon (2002) model. We examine whether the gas storage inventory results hold under a different specification of the forward risk premium. Our results support the results found by Douglas and Popova (2008) and show that their results are not influenced by the specification of the forward premium model.

Pumped storage and cost saving

- Energy Economics---2010---Claude Crampe, Michel Moreaux

The pump storage technique allows the use of cheap thermal electricity at periods of low demand to restore water resources that can be used to generate electricity at periods of peak demand. When the thermal plant and the hydro plant are managed by the same operator, the two plants are used in an efficient way to substitute low cost fuel for high cost fuel. The paper first analyzes the efficient use of the technology when the outputs at each period are given. We determine the frontier between the storage and no-storage solutions and its sensibility to cost variations. We then determine the optimal dispatch given the intertemporal preferences of electricity consumers. The model gives emphasis to the economic driver of the technology that is the

net social gain from transferring social surplus from off peak to peak period.

The dynamics of crude oil price differentials

- Energy Economics---2010---Bassam Fattouh

Crude oil price differentials are modelled as a two-regime threshold autoregressive (TAR) process using the method proposed by Caner and Hansen [Caner, M., Hansen, B.E. Threshold autoregression with a unit root. *Econometrica* 2001; 69; 1555-1596.]. While standard unit root tests suggest that the prices of crude oil of different varieties move closely together such that their price differential is stationary, the TAR results indicate strong evidence of threshold effects in the adjustment process to the long-run equilibrium. These findings suggest that crude oil prices are linked and thus at the very general level, the oil market is 'one great pool' (Adelman, M.A. International oil agreements. *The Energy Journal* 1984; 5; 1-9.). However, differences in the dynamics of adjustment suggest that within this one pool, oil markets are not necessarily integrated in every time period and hence the dynamics of crude oil price differentials may not follow a stationary process at all times. Although the development of a liquid futures market around the crude oil benchmarks has helped make some distant markets more unified, arbitrage is not costless or risk-free and temporary breakdowns in the benchmarks can lead to decoupling of crude oil prices.

Jump dynamics with structural breaks for crude oil prices

- Energy Economics---2010---Yen-Hsien Lee, Hsu-Ning Hu, Jer-Shiou Chiou

Abstract This study investigates the joint phenomena of permanent and transitory components in conditional variance and jump intensity along with verification of structural breaks for crude oil prices. We adopt a Component-ARJI model with structural break analysis, utilizing daily data on West Texas Intermediate crude oil spot and futures contracts. The analytical results verify the existence of permanent and transitory

components in conditional variance, with the permanent component of conditional variance increasing with the occurrence of a sudden major event (such as the Iraqi Invasion of Kuwait, Operation Desert Storm and the war between the US and Iraq), and a relatively greater increase in the transitory component over the same period. Notably, jump intensity fluctuates with an increase in the transitory component of conditional variance in response to abnormal events. It is the transitory component which serves as the primary influential factor for jumps in returns; therefore, speculators are willing to take large risks, particularly with respect to anticipating future price movements, or gambling, in the hopes of rapidly making substantial gains; thus, speculators prefer the temporary volatility component and engage in trade activities. However, investors prefer the permanent volatility component, because they may well be better off relocating their assets into more stable portfolios to outperform the market portfolio over the long run.

Dynamics of oil price, precious metal prices, and exchange rate

- Energy Economics---2010---Ramazan Sari, Shawkat Hammoudeh, Ugur Soytas

This study examines the co-movements and information transmission among the spot prices of four precious metals (gold, silver, platinum, and palladium), oil price, and the US dollar/euro exchange rate. We find evidence of a weak long-run equilibrium relationship but strong feedbacks in the short run. The spot precious metal markets respond significantly (but temporarily) to a shock in any of the prices of the other metal prices and the exchange rate. Furthermore, we discover some evidence of market overreactions in the palladium and platinum cases as well as in the exchange rate market. In conclusion, whether there are overreactions and readjustments or not, investors may diversify at least a portion of the risk away by investing in precious metals, oil, and the euro. Policy implications are provided.

Oil price dynamics and speculation: A multivariate financial approach

- Energy Economics---2010---Giulio Cifarelli,Giovanna Paladino

This paper assesses empirically whether speculation affects oil price dynamics. The growing presence of financial operators in the oil markets has led to the diffusion of trading techniques based on extrapolative expectations. Strategies of this kind foster feedback trading that may cause considerable departures of prices from their fundamental values. We investigate this hypothesis using a modified CAPM following Shiller (1984) and Sentana and Wadhvani (1992). First, a univariate GARCH(1,1)-M is estimated assuming the risk premium to be a function of the conditional oil price volatility. The single factor model, however, is outperformed by the multifactor ICAPM (Merton, 1973), which takes into account a larger investment opportunity set. Analysis is then carried out using a trivariate CCC GARCH-M model with complex nonlinear conditional mean equations where oil price dynamics are associated with both stock market and exchange rate behavior. We find strong evidence that oil price shifts are negatively related to stock price and exchange rate changes and that a complex web of time-varying first and second order conditional moment interactions affects both the CAPM and feedback trading components of the model. Despite the difficulties, we identify a significant role played by speculation in the oil market, which is consistent with the observed large daily upward and downward shifts in prices -- a clear evidence that it is not a fundamental-driven market. Thus, from a policy point of view - given the impact of volatile oil prices on global inflation and growth - actions that monitor speculative activities on commodity markets more effectively are to be welcomed.

Modeling global and local dependence in a pair of commodity forward curves with an application to the US natural gas and heating oil markets

- Energy Economics---2010---Steve Ohana

The goal of this paper is to present a model for the

joint evolution of correlated commodity forward curves. Each forward curve is directed by two state variables, namely slope and level, and the model is meant to capture both the local and global dependence structures between slopes and levels. Our framework can be interpreted as an extension of the concept of cointegration to forward curves. The model is applied to a US database of heating oil and natural gas futures prices over the period February 2000-February 2009. We find the long-run slope and level relationships between natural gas and heating oil markets, analyze the lead and lag properties between the two energy commodities, the volatilities and correlations between their daily co-movements and evaluate the robustness of these observations to the turmoil experienced by energy markets since 2003.

Financial market pressure, tacit collusion and oil price formation

- Energy Economics---2010---Finn Roar Aune,Klaus Mohn,Petter Osmundsen,Knut Einar Rosendahl

We explore a hypothesis that a change in investment behaviour among international oil companies (IOC) towards the end of the 1990s had long-lived effects on OPEC strategies, and on oil price formation. Coordinated investment constraints were imposed on the IOCs through financial market pressures for improved short-term profitability in the wake of the Asian economic crisis. A partial equilibrium model for the global oil market is applied to compare the effects of these tacitly collusive capital constraints on oil supply with an alternative characterised by industrial stability. Our results suggest that even temporary economic and financial shocks may have a long-term impact on oil price formation.

Oil price fluctuations and U.S. dollar exchange rates

- Energy Economics---2010---Radhamés A. Lizardo,Andre Mollick

Adding oil prices to the monetary model of exchange rates, we find that oil prices significantly explain move-

ments in the value of the U.S. dollar (USD) against major currencies from the 1970s to 2008. Our long-run and forecasting results are remarkably consistent with an oil-exchange rate relationship. Increases in real oil prices lead to a significant depreciation of the USD against net oil exporter currencies, such as Canada, Mexico, and Russia. On the other hand, the currencies of oil importers, such as Japan, depreciate relative to the USD when the real oil price goes up.

Macroeconomic factors and oil futures prices: A data-rich model

- Energy Economics---2010---Paolo Zagaglia

I study the dynamics of oil futures prices in the NYMEX using a large panel dataset that includes global macroeconomic indicators, financial market indices, quantities and prices of energy products. I extract common factors from the panel data series and estimate a Factor-Augmented Vector Autoregression for the maturity structure of oil futures prices. I find that latent factors generate information that, once combined with that of the yields, improves the forecasting performance for oil prices. Furthermore, I show that a factor correlated to purely financial developments contributes to the model performance, in addition to factors related to energy quantities and prices.

Optimal fossil-fuel taxation with backstop technologies and tenure risk

- Energy Economics---2010---Jon Strand

The paper derives the global welfare-optimizing time path for a tax on fossil fuels causing a negative stock externality (climate change), under increasing marginal extraction cost, and in the presence of an unlimited backstop resource causing no externality. In a basic competitive case, the optimal tax equals the Pigou rate, equivalent to the present discounted value of marginal damage costs. We consider two separate types of tenure insecurity for resource owners, and their impact on the tax implementing the optimal policy. When insecure control is with respect to future ownership to the resource, competitive extraction is

higher than otherwise, and the efficiency-implementing tax exceeds the Pigou rate. When tenure insecurity instead implies possible expropriation ("holdup") of investment in extraction capacity, it deters extraction, and the optimal tax is lower than the Pigou rate.

The performance of composite forecast models of value-at-risk in the energy market

- Energy Economics---2010---Yen-Chen Chiu,I-Yuan Chuang,Jing-Yi Lai

This paper examines a comparative evaluation of the predictive performance of various Value-at-Risk (VaR) models in the energy market. This study extends the conventional research in literature, by proposing composite forecast models for applying to Brent and WTI crude oil prices. Forecasting techniques considered here include the EWMA, stable density, Kernel density, Hull and White, GARCH-GPD, plus composite forecasts from linearly combining two or more of the competing models above. Findings show Hull and White to be the most powerful approach for capturing downside risk in the energy market. Reasonable results are also available from carefully combining VaR forecasts.

Time-varying risk aversion: An application to energy hedging

- Energy Economics---2010---John Cotter,Jim Hanly

Risk aversion is a key element of utility maximizing hedge strategies; however, it has typically been assigned an arbitrary value in the literature. This paper instead applies a GARCH-in-Mean (GARCH-M) model to estimate a time-varying measure of risk aversion that is based on the observed risk preferences of energy hedging market participants. The resulting estimates are applied to derive explicit risk aversion based optimal hedge strategies for both short and long hedgers. Out-of-sample results are also presented based on a unique approach that allows us to forecast risk aversion, thereby estimating hedge strategies that address the potential future needs of energy hedgers. We find that the risk aversion based hedges differ significantly from

simpler OLS hedges. When implemented in-sample, risk aversion hedges for short hedgers outperform the OLS hedge ratio in a utility based comparison.

Futures hedging effectiveness under the segmentation of bear/bull energy markets

- Energy Economics---2010---Chiao-Yi Chang,Jing-Yi Lai,I-Yuan Chuang

This article undertakes eight hedging models (Regression, MD-GARCH, BEKK-GARCH, CCC-GARCH, ECM-MD, ECM-BEKK, ECM-CCC, and state space models) to investigate hedging effectiveness of different price scenarios in energy futures markets. Different models have systematically evidenced that hedging effectiveness is higher in an increasing pattern (termed "bull markets") than in a decreasing pattern (termed "bear markets") for crude oil and gasoline futures. That is, findings show asymmetric hedging performance between upward and downward price trends consistently from the most popular hedging models in literature. Out-of-sample examination also suggests that the ranking of hedging effectiveness of different hedging models is not parallel in different price patterns across futures contracts, implying that investors should adjust their hedging strategies accordingly.

Evaluating long term forecasts

- Energy Economics---2010---George M. Lady

The U.S. Department of Energy's Energy Information Administration (EIA), and its predecessor organizations, has published projections of U.S. energy production, consumption, distribution and prices annually for over 30 years. A natural issue to raise in evaluating the projections is an assessment of their accuracy compared to eventual outcomes. A related issue is the determination of the sources of "error" in the projections that are due to differences between the actual versus realized values of the associated assumptions. One way to do this would be to run the computer-based model from which the projections are derived at the time the projected values are realized, using actual rather than assumed values for model assumptions;

and, compare these results to the original projections. For long term forecasts, this approach would require that the model's software and hardware configuration be archived and available for many years, possibly decades, into the future. Such archival creates many practical problems; and, in general, it is not being done. This paper reports on an alternative approach for evaluating the projections. In the alternative approach, the model is run many times for cases in which important assumptions are changed individually and in combinations. A database is assembled from the solutions and a regression analysis is conducted for each important projected variable with the associated assumptions chosen as exogenous variables. When actual data are eventually available, the regression results are then used to estimate the sources of the differences in the projections of the endogenous variables compared to their eventual outcomes. The results presented here are for residential and commercial sector natural gas and electricity consumption.

Corporate hedging under a resource rent tax regime

- Energy Economics---2010---Dennis Frestad

In addition to the ordinary corporate income tax, special purpose taxes are sometimes levied to extract abnormal profits arising from the use of natural resources. Such dual tax regimes exist in Norway for oil and hydropower, where the corresponding special purpose tax bases are unaffected by any derivatives payments. Dual tax firms with hedging programs therefore face the risk of potentially large discrepancies between the tax bases for corporate income tax and special purpose tax. I investigate how this tax base asymmetry influences the extent of hedging of value-maximizing firms facing hedgeable as well as unhedgeable risk. Dual tax firms facing deadweight costs in low-profit events generally demand less hedging than ordinary firms, but otherwise respond similarly to characteristics of the underlying risk exposures. The special purpose tax does not influence firms' hedge portfolios in the absence of deadweight cost.

Resource price turbulence and macroeconomic adjustment for a resource exporter: A conceptual framework for policy analysis

- Energy Economics---2010---Grant M. Cox, Charles Harvie

Increased global demand for energy and other resources, particularly from the rapidly developing economies of China and India and the opening up of global resource markets to global investors and speculative activity, has resulted in considerable recent turbulence in resource prices. The recent magnitude of change in resource prices, both positive and negative, and their macroeconomic implications is of considerable contemporary importance to both resource importing and exporting economies. For a resource exporting economy, such as that of Australia, the recent resource price boom has resulted in: increased government taxation revenue, increased employment and wages in the resource and resource related sectors, increased spending in the domestic economy that contributed to buoyant economic growth, increased resource exports to the booming economies of China and India and contributed to a stronger domestic currency with beneficial effects upon inflation. On the other hand these developments have had adverse effects on the non-resource sector by: subjecting it to more intense competition for limited resources, contributing to a loss of international competitiveness and reduced exports arising from a stronger exchange rate, reducing employment in the relatively more labour intensive non-resource sector, and contributing to an eventual slow down in the overall economy. These positive and negative effects, and the overall impact of a resource price boom, require a fundamentally closer analysis of the structure of the economy under scrutiny. In this context the policy response by government is likely to be pivotal in determining the overall macroeconomic outcomes from a resource price boom. The aim of this paper is to develop a generic analytical framework to appraise economic outcomes in the wake of a resource price boom for a resource producing and exporting economy. To this end a dynamic long run macroeconomic model is developed, emphasising the important

role and contribution of government fiscal policy in influencing subsequent macroeconomic outcomes. The adjustment process in the model arising from a resource price shock emphasises a spending (or wealth) effect, an income effect, a revenue effect, a current account effect and an exchange rate effect, which facilitate a robust analysis of subsequent macroeconomic outcomes from such a shock as well as related policy responses.

Do higher oil prices push the stock market into bear territory?

- Energy Economics---2010---Shiu-Sheng Chen

This paper investigates whether a higher oil price pushes the stock market into bear territory, by using time-varying transition-probability Markov-switching models. It examines different measures of oil price shocks. Empirical evidence from monthly returns on the Standard & Poor's S&P 500 price index suggests that an increase in oil prices leads to a higher probability of a bear market emerging.

Nonlinearity and intraday efficiency tests on energy futures markets

- Energy Economics---2010---Tao Wang, Jian Yang

Using high frequency data, this paper first time comprehensively examines the intraday efficiency of four major energy (crude oil, heating oil, gasoline, natural gas) futures markets. In contrast to earlier studies which focus on in-sample evidence and assume linearity, the paper employs various nonlinear models and several model evaluation criteria to examine market efficiency in an out-of-sample forecasting context. Overall, there is evidence for intraday market inefficiency of two of the four energy future markets (heating oil and natural gas), which exists particularly during the bull market condition but not during the bear market condition. The evidence is also robust against the data-snooping bias and the model overfitting problem, and its economic significance can be very substantial.

Editorial

- Energy Economics---2010---Beng Wah Ang, Richard Tol, John P. Weyant

2010

Solving discretely-constrained MPEC problems with applications in electric power markets

- Energy Economics---2010---Steven A. Gabriel, Florian Leuthold

Many of the European energy markets are characterized by dominant players that own a large share of their respective countries' generation capacities. In addition to that, there is a significant lack of cross-border transmission capacity. Combining both facts justifies the assumption that these dominant players are able to influence the market outcome of an internal European energy market due to strategic behavior. In this paper, we present a mathematical formulation in order to solve a Stackelberg game for a network-constrained energy market using integer programming. The strategic player is the Stackelberg leader and the independent system operator (including the decisions of the competitive fringe firms) acts as follower. We assume that there is one strategic player which results in a mathematical program with equilibrium constraints (MPEC). This MPEC is reformulated as mixed-integer linear program (MILP) by using disjunctive constraints and linearization. The MILP formulation gives the opportunity to solve the problems reliably and paves the way to add discrete constraints to the original MPEC formulation which can be used in order to solve discretely-constrained mathematical programs with equilibrium constraints (DC-MPECs). We report computational results for a small illustrative network as well as a stylized Western European grid with realistic data.

Cost efficiency and optimal scale of electricity distribution firms in Taiwan: An application of metafrontier analysis

- Energy Economics---2010---Yi-Ju Huang, Ku-Hsieh Chen, Chih-Hai Yang

This paper analyzes the cost efficiency and optimal scale of Taiwan's electricity distribution industry. Due to the substantial difference in network density, firms may differ widely in production technology. We employ the stochastic metafrontier approach to estimate the cost efficiency of 24 distribution units during the period 1997-2002. Empirical results find that the average cost efficiency is overestimated using the traditional stochastic frontier model, especially for low density regions. The average cost efficiency of the high density group is significantly higher than that of the low density group as it benefits from network economies. This study also calculates both short-term and long-term optimal scales of electricity distribution firms, lending policy implications for the deregulation of the electricity distribution industry.

Account for sector heterogeneity in China's energy consumption: Sector price indices vs. GDP deflator

- Energy Economics---2010---Chunbo Ma

A common practice in decomposition analyses is to deflate output indicators to purge the impact of inflation by using a general deflator. This practice fails to account for sector heterogeneity and can be hazardous. Although the general identified patterns are largely correct, the calculated magnitudes can be misleading or even wrongly signed. Instead, it is strongly recommended that sector heterogeneity is accounted for by using individual sector price indices for all relevant sectors instead of one general (GDP) deflator. This paper analyzes this advanced decomposition using Chinese data and compares to the usual method of using only one deflator. It is found that while most differences are only of quantitative quality, some show even a qualitative difference. Furthermore, the rising energy intensity in the early 2000s, which has been discussed by previous studies, vanishes completely.

An integrated approach to energy prospects for North America and the rest of the world

- Energy Economics---2010---Andrea M. Bassi, Robert Powers, William Schoenberg

Many international organizations and research institutions have released recently unequivocal scenarios on energy's future prospects. The peak in global oil production is likely to happen in the next ten to fifteen years, if it hasn't already happened, and decisions to be made in the near future are likely to have large impacts on our quality of life in the coming decades. This study presents an integrated tool for national energy planning customized to North America. The authors analyzed the impact of world oil production on economic, social and environmental indicators. Two cases of global ultimate recoverable oil reserves are considered, a low and medium estimate within current research. Three sets of policy directions were chosen: Business As Usual (Market Based), Maximum Push for Renewables, and Low Carbon Emissions. Results of the simulations show that without restrictions on emissions coal becomes the dominant energy in the longer term. On the other hand, if US policymakers are able to effectively implement the necessary policies, such as a 20% RPS by 2020 and increased CAFE Standards, along with increased energy conservation and efficiency, the medium to longer-term economic impacts of a global peak in oil production can be mitigated, while a sustained reduction in emissions would require a larger effort.

Solow meets Leontief: Economic growth and energy consumption

- Energy Economics---2010---Marcelo Arbex, Fernando Perobelli

This paper proposes a methodology that integrates a growth model with an input-output model to analyze the impacts of economic growth on the consumption of energy. The integration between the models is carried out by calibrating the growth module, which incorporates energetic inputs (renewable and nonrenewable) in the production function, and implementing shocks by the supply side (capital, labor, renewable and non-renewable energy) in the input-output model. This allows us to verify the pattern of energy consumption for each sector in the input-output matrix. We apply this methodology to study the energy consumption of

eleven economic sectors in Brazil, using data from the Brazilian National Accounts and Input-Output Matrix (IBGE) and the National Energy Report (BEN). We conduct experiments involving changes in technological progress growth rate, extraction and regeneration rates of both renewable and nonrenewable resources and population growth to analyze the impact of changes in the parameters of the model on the sectoral output growth rate and, consequently, on the consumption of energy in each economic sector.

Gasoline demand in Europe: New insights

- Energy Economics---2010---Markus Pock

This study utilizes a panel data set from 14 European countries over the period 1990-2004 to estimate a dynamic model specification for gasoline demand. Previous studies estimating gasoline consumption per total passenger cars ignore the recent increase in the number of diesel cars in most European countries leading to biased elasticity estimates. We apply several common dynamic panel estimators to our small sample. Results show that specifications neglecting the share of diesel cars overestimate short-run income, price and car ownership elasticities. It appears that the results of standard pooled estimators are more reliable than common IV/GMM estimators applied to our small data set.

Short- and long-run adjustments in U.S. petroleum consumption

- Energy Economics---2010---Hillard Huntington

Long-run adjustments in petroleum consumption are not only larger than short-run adjustments. They may also be motivated by entirely different price events. This analysis shows that new price peaks have both short-run and long-run consumption responses, a result that is starkly different than price changes that track previous price paths. It also establishes significant trend effects where gasoline and residual fuel oil consumption decline over time. The analysis explores these adjustments by establishing long-run cointegrating relationships for different petroleum product groupings.

An important implication is that price increases above historical levels may be providing substantially greater incentives for significant long-run demand adjustments than would be the case otherwise.

Estimating petroleum products demand elasticities in Nigeria: A multivariate cointegration approach

- Energy Economics---2010---Akin Iwayemi,Adeola Adenikinju,M. Adetunji Babatunde

This paper formulates and estimates petroleum products demand functions in Nigeria at both aggregative and product level for the period 1977 to 2006 using multivariate cointegration approach. The estimated short and long-run price and income elasticities confirm conventional wisdom that energy consumption responds positively to changes in GDP and negatively to changes in energy price. However, the price and income elasticities of demand varied according to product type. Kerosene and gasoline have relatively high short-run income and price elasticities compared to diesel. Overall, the results show petroleum products to be price and income inelastic.

Estimating the effect of urban density on fuel demand

- Energy Economics---2010---Niovi Karathodorou,Daniel Graham,Robert Noland

Much of the empirical literature on fuel demand presents estimates derived from national data which do not permit any explicit consideration of the spatial structure of the economy. Intuitively we would expect the degree of spatial concentration of activities to have a strong link with transport fuel consumption. The present paper addresses this theme by estimating a fuel demand model for urban areas to provide a direct estimate of the elasticity of demand with respect to urban density. Fuel demand per capita is decomposed into car stock per capita, fuel consumption per kilometre and annual distance driven per car per year. Urban density is found to affect fuel consumption, mostly through variations in the car stock and in the distances

travelled, rather than through fuel consumption per kilometre.

A semiparametric model of household gasoline demand

- Energy Economics---2010---Zia Wadud,Robert Noland,Daniel Graham

Gasoline demand studies typically generate a single price and income elasticity for a country. It is however possible that these elasticities may differ among various socio-economic groups. At the same time, parametric gasoline demand models may not be flexible enough to capture the changes in price elasticities with different levels of income. This paper models US gasoline demand using more flexible semiparametric techniques, accommodating the possibility of differences in responses among households. The econometric model employs a non-parametric bivariate smoothing for price and income and a parametric representation of other explanatory variables. Possible heterogeneity in price and income elasticities is modelled through interacting price and income with demographic variables. Results show that price responses do vary with demographic variables such as income, multiple vehicle holding, presence of multiple wage earners or rural or urban residential locations. Households' responses to a price change decrease with higher income. Multiple vehicle and multiple earner households also show higher sensitivity to a price change. Households located in urban areas reduce consumption more than those in rural areas in response to an increase in price. Comparison of the flexible semiparametric model with a parametric translog model, however, reveals no significant differences between results, and the parametric models have the advantage of lower computational requirements and better interpretability.

Driving for fun? Comparing the effect of fuel prices on weekday and weekend fuel consumption

- Energy Economics---2010---Manuel Frondel,Colin Vance

Focusing on individual motorists in car-owning households in Germany, this paper investigates the determinants of automobile travel, with the specific aim of quantifying the effects of fuel prices and person-level attributes on travel conducted over a five-day week and weekend. Our analysis is predicated on the notion that car use is an individual decision, albeit one that is dependent on intra-household allocation processes, thereby building on a growing body of literature that has identified the importance of socioeconomic factors such as employment status, gender, and the presence of children in determining both access to and use of the car. To capture this two-stage decision process, we employ the two-part model, which consists of probit and OLS estimators, and derive elasticity estimates that incorporate both the discrete and continuous choices pertaining to car use. With fuel price elasticity estimates ranging between -0.45 and -0.50 , our results suggest raising prices via fuel taxes to be a promising energy conservation and climate protection measure.

An estimation of U.S. gasoline demand: A smooth time-varying cointegration approach

- Energy Economics---2010---Sung Y. Park,Guochang Zhao

In this paper the U.S. gasoline demand from 1976 to 2008 is estimated using a time-varying cointegrating regression. We find that price elasticity increased rapidly during the late 1970s and then decreased until 1987. After a relatively small-scaled "increase-decrease" cycle from 1987 to 2000, the price elasticity rose again after 2000. The time-varying change of the elasticities may be explained by the proportion of gasoline consumption to income and fluctuation of the degree of necessity. The result of the error correction model shows that a deviation from a long-run equilibrium is corrected quickly, and the welfare analysis illustrates there may be a gain by shifting the tax scheme from income tax to gasoline tax.

Do Americans want ethanol? A comparative contingent-valuation study of willingness to pay for E-10 and E-85

- Energy Economics---2010---Daniel Petrolia, Sanjoy Bhattacharjee, Darren Hudson, Cary W. Herndon

A nationwide contingent-valuation survey of consumer preferences for consumer fuel blends E-10 (a blend of 10% ethanol and 90% gasoline for use in standard vehicles) and E-85 (a blend of 85% ethanol and 15% gasoline for use in flex-fuel vehicles) was conducted to estimate willingness to pay (WTP) and identify key characteristics driving demand. Results indicate that overall perceptions of ethanol are positive, but ethanol is not the globally-preferred transportation-energy alternative, even among consumers with a positive WTP. Results indicate also that demand for E-85 is more price inelastic than E-10, with this result driven by consumers with no preference for E-10 but strong preferences for E-85. Finally, results also indicate that those consumers who are unsure about the micro-level benefits of E-85 are nonetheless more inclined to pay a premium.

Willingness-to-pay for renewable energy: Primary and discretionary choice of British households' for micro-generation technologies

- Energy Economics---2010---Riccardo Scarpa, Ken Willis

This paper documents the policy context of renewable energy production in the European Union. The research adopts a choice experiment approach to investigate households' WTP for these renewable energy technologies in the UK. The micro-generation technologies comprise solar photovoltaic, micro-wind, solar thermal, heat pumps, and biomass boilers and pellet stoves. The study compares the results from conditional and mixed logit models, which estimate the distribution of utility coefficients and then derives WTP values as a ratio of the attribute coefficient to the price coefficient, with a model in which the WTP distribution is estimated directly from utility in the money space. The results suggest that whilst renewable energy adoption

is significantly valued by households, this value is not sufficiently large, for the vast majority of households, to cover the higher capital costs of micro-generation energy technologies.

Do economic, financial and institutional developments matter for environmental degradation? Evidence from transitional economies

- Energy Economics---2010---Artur Tamazian,B. Rao

Several studies have examined the relationship between environmental degradation and economic growth. However, most of them did not take into account financial developments and institutional quality. Moreover, Stern [Stern, D., 2004. The rise and fall of the environmental Kuznets curve. *World Development* 32(8): 1419-1439.] noted that there are important econometric weaknesses in the earlier studies, such as endogeneity, heteroscedasticity, omitted variables, etc. The purpose of this paper is to fill this gap in the literature by investigating the linkage between not only economic development and environmental quality but also financial development and institutional quality. We employ the standard reduced-form modelling approach to control for country-specific unobserved heterogeneity and GMM estimation to control for endogeneity. Our study considers 24 transition economies and panel data for 1993-2004. Our results support the EKC hypothesis while confirming the importance of both institutional quality and financial development for environmental performance. We also found that financial liberalization may be harmful for environmental quality if it is not accomplished in a strong institutional framework.

A metafrontier approach for measuring an environmentally sensitive productivity growth index

- Energy Economics---2010---Dong-hyun Oh

This paper presents an alternative environmentally sensitive productivity growth index to incorporate

group heterogeneities into a conventional Malmquist-Luenberger productivity growth index. The proposed approach allows the calculation of both efficiency and technical changes, for economic agents operating under different technologies. Moreover, it also enables the computation of changes in the technological gap between regional and global frontier technologies. The proposed index is employed in measuring productivity growth and its decomposed components in 46 countries between 1993 and 2003. The main finding is that Europe has taken the lead in the world frontier technology and that Asia has attempted to move towards the frontier technology. Subsequent policy implications are provided based on some empirical studies.

Toxic releases: An environmental performance index for coal-fired power plants

- Energy Economics---2010---Rolf Färe,Shawna Grosskopf,Carl Pasurka

In order to assess the performance of electric power plants that produce both good and bad outputs, this study uses data from the toxic release inventory to construct an Environmental Performance Index (EPI). Färe, Grosskopf, and Pasurka (2006) demonstrated that for the one good output and one air pollutant case, the EPI simplifies to the ratio of good to bad output. In this paper, we extend the EPI to include an index of multiple bad outputs. After deriving the index as a Malmquist Quantity Index, we assemble data from 1998 to 2005 on releases of selected toxic chemicals and electricity generation for a sample of coal-fired power plants in the United States to demonstrate how the EPI can provide initial perspectives on trends in releases of toxic chemicals by coal-fired power plants.

Input-output analysis of CO2 emissions embodied in trade: The effects of sector aggregation

- Energy Economics---2010---Bin Su,H.C. Huang,B.W. Ang,Peng Zhou

Energy-related CO2 emissions embodied in international trade have been widely studied by researchers

using the input-output analysis framework. These studies are often conducted at a specific level of sector aggregation and the choice made to a large extent is dictated by economic and energy data availability. We investigate analytically the possible effects of sector aggregation on the study results. We conduct empirical studies using the data of China and Singapore where energy-related CO₂ emissions embodied in their exports are estimated at different levels of sector aggregation. A finding from the studies is that levels around 40 sectors appear to be sufficient to capture the overall share of emissions embodied in a country's exports. Another finding is that in approximating the "ideal" situation the hybrid data treatment approach produces better results than the uniformly distributed data treatment approach. Other findings and some recommendations are also presented.

The impact of household consumption patterns on emissions in Spain

- Energy Economics---2010---Rosa Duarte,Alfredo Mainar,Julio Sánchez-Chóliz,Julio Sanchez Choliz

The aim of this paper is to analyse the relationship between household consumption patterns and pollution in the Spanish economy. The analysis was carried using a Social Accounting Matrix (SAM) for the Spanish economy prepared for 1999. Taking the final demand of households as the exogenous account in the SAM framework and combining this with the information provided by the Household Budget Continuous Survey on income and consumption (INE, 1999), we analyse the pollution produced by both the economy and households in order to satisfy consumption requirements. We also consider the effects of income inequality on expenditure levels, establishing a link between income level, consumption patterns, propensity to consume and CO₂ emissions.

Supply-side structural effect on carbon emissions in China

- Energy Economics---2010---Youguo Zhang

This paper carries out a structural decomposition analysis (SDA) of production-related carbon emissions in China from 1992 to 2005 by adopting the Ghosh input-output model. It finds that the supply-side structure, measured by sectoral shares in value added, increased production-related carbon emissions in 1992-2002, mainly due to the rapid growth of manufacturing sectors, but reduced them in 2002-2005 thanks to the decreased shares of carbon-intensive sectors. Whatever the supply-side structure, forward carbon multipliers of each sector or changes in supply-side sectoral shares and related emissions effects calculated by adopting the Ghosh input-output model were different from their demand-side counterparts estimated by adopting the Leontief input-output model. The results suggest optimizing the supply-side structure and lowering the forward carbon multipliers to control carbon emissions in the future.

Total factor carbon emission performance: A Malmquist index analysis

- Energy Economics---2010---Peng Zhou,B.W. Ang,J.Y. Han

This paper introduces a Malmquist CO₂ emission performance index (MCPI) for measuring changes in total factor carbon emission performance over time. The MCPI is derived by solving several data envelopment analysis models. Bootstrapping MCPI is proposed to perform statistical inferences on the MCPI results. Using the index the emission performance of the world's 18 top CO₂ emitters from 1997 to 2004 is studied. The results obtained show that the total factor carbon emission performance of the countries as a whole improved by 24% over the period and this was mainly driven by technological progress. The results of a cross-country regression analysis to investigate the determinants of the resulting MCPI are presented.

Impact of a possible environmental externalities internalisation on energy prices: The case of the greenhouse gases from the Greek electricity sector

- Energy Economics---2010---Dimitrios A. Georgakellos

The present paper is concerned with the impact of the internalisation of environmental externalities on energy prices. In this context, its aim is to quantify the external cost of greenhouse gases (specifically carbon dioxide) generated during electricity production in the thermal power plants in Greece and to estimate the impact on the electricity production cost and on the electricity prices of a possible internalisation of this external cost by the producers. For this purpose, this paper applies the EcoSenseLE online tool to quantify the examined externalities. This research finds that the calculated external cost is significantly high (compared to the corresponding production cost) mainly in lignite-fired power plants. Specifically, a possible internalisation of this external cost would increase the production cost by more than 52% (on average), which, in turn, would affect similarly the electricity prices. This finding could be important for decision makers in the electricity sector to develop strategies for emission reduction and to develop environmental and energy policies. The general limitation of the external cost methodology applies to this work as it uses the standard method developed for the Externe project. Similarly, the data limitations as well as assumptions related to the costs and exclusions/ omissions of cost elements affect the results.

Greenhouse gas emissions in Hawaii[modifier letter turned comma]i: Household and visitor expenditure analysis

- Energy Economics---2010---Denise Konan,Hing Ling Chan

This paper focuses on petroleum use and greenhouse gas emissions associated with economic activities in Hawai'i. Data on economic activity, petroleum consumption by type (gasoline, diesel, aviation fuel, resid-

ual, propane), and emissions factors are compiled and analyzed. In the baseline year 1997, emissions are estimated to total approximately 23.2 million metric tons of carbon, 181 thousand metric tons of nitrous oxide, and 31 thousand metric tons of methane in terms of carbon-equivalent global warming potential over a 100-year horizon. Air transportation, electricity, and other transportation are the key economic activity responsible for GHG emissions associated with fossil fuel use. More than 22% of total emissions are attributed to visitor expenditures. On a per person per annum basis, emission rates generated by visitor demand are estimated to be higher than that of residents by a factor of 4.3 for carbon, 3.2 for methane, and 4.8 for nitrous oxide.

Impacts of integration of production of black and green energy

- Energy Economics---2010---Huizhong Zhou,Meszaros Matyas Tamas

As the mandate for minimum renewable sources renders Tradable Green Certificates (TGCs) an essential input for power generation, it may induce mergers between power companies of conventional and renewable sources. Such mergers enable the integrated firms to extend market power from the TGC market to the physical energy market. We find that the price of TGCs is indeed higher in the integrated market than the disintegrated market, indicating the presence of market power leveraging. However, despite higher TGC price, the total supply of electricity is greater under integration than disintegration, reflecting efficiency gains from vertical integration, which eliminates double marginalization. The thrust of this paper is that market changes induced by environmental policies will in turn affect environmental and economic regulations. For example, increased supply resulting from integration induced by the renewable source mandate may reduce the effectiveness of programs that promote energy saving behavior, but at the same time creates room for raising the minimum of renewable sources without unduly depressing production and consumption.

Is fuel-switching a no-regrets environmental policy? VAR evidence on carbon dioxide emissions, energy consumption and economic performance in Portugal

- Energy Economics---2010---Alfredo Pereira,Rui Pereira

The objective of this paper is to estimate the impact of carbon dioxide emissions from fossil fuel combustion activities on economic activity in Portugal in order to evaluate the economic costs of policies designed to reduce carbon dioxide emissions. We find that energy consumption has a significant impact on macroeconomic activity. In fact, a one ton of oil equivalent permanent reduction in aggregate energy consumption reduces output by [euro]6340 over the long term, an aggregate impact which hides a wide diversity of effects for different fuel types. More importantly, and since carbon dioxide emissions are linearly related to the amounts of fuel consumed, our results allow us to estimate the costs of reductions in carbon dioxide emissions from different energy sources. We estimate that marginal abatement costs for carbon dioxide are [euro]45.62 per ton of carbon dioxide per year for coal, [euro]66.52 for oil, [euro]91.07 for gas, [euro]191.13 for electricity and [euro]254.23 for biomass. An important policy implication is that, once the overall economic costs of reducing carbon dioxide emissions are considered, fuel switching is a no-regrets environmental policy capable of reducing carbon dioxide emissions without jeopardizing economic activity and indeed with the potential for generating favorable economic outcomes.

Allocating the CO2 emissions of an oil refinery with Aumann-Shapley prices: Comment

- Energy Economics---2010---Alireza Tehrani Nejad Moghaddam

The allocation of CO2 emissions of petroleum refineries to their oil products is a necessary step in the retrospective Well-to-Tank (WTT) analysis. These allocated emissions are used to evaluate the environmental impacts of automotive fuels' production within the refinery. Oil refining is a complex joint production

system and there exists no simple and unique answer to this allocation question. Recently, Pierru proposed adapting the Aumann-Shapley cost sharing method to deal with this issue. Our paper aims at describing the conceptual and technical difficulties of this adaptation to the WTT context. Moreover, we show that this approach, as proposed by Pierru, is not applicable to any real-type refinery model. Different suggestions are provided to improve its applicability (when it is possible) in real situations. A simple numerical example as well as a real-type refinery case study is provided for illustrations. Finally, we discuss an alternative allocation approach which we believe more adapted to the WTT context.

Technical efficiency of thermoelectric power plants: An apology

- Energy Economics---2010---Carlos Barros,Nicolas Peypoch

2010