Literature Report

张晨峰, 华东理工大学商学院

Abstract

A Word from the Editor

- Review of Environmental Economics and Policy---2015---Carlo Carraro

2015

Should Benefit–Cost Methods Take Account of High Unemployment? Symposium Introduction

- Review of Environmental Economics and Policy---2015---V. Kerry Smith

Conventional methods in benefit–cost analysis maintain that the effects of new environmental regulations should focus on long run equilibria with and without the policies being evaluated. This article introduces a symposium that considers how the employment effects of environmental regulations might be included in benefit–cost analyses. Three lessons emerge from the symposium. First, the empirical evidence to date indicates that it is difficult to measure the net employment effects of environmental regulations. The record is mixed, with support for effects at the plant level. The record is less clear for the reduced form estimates using more aggregate data. Second, it is possible to construct an ex post "analysis chain" that allows for estimation of the adjustment costs associated with a job loss. These estimates depend importantly on the assumptions made in the construction of the counterfactual baseline employment history and the outcomes after job losses. The ways in which households might adapt to a job loss are especially important for measuring adjustment costs. Finally, economy-wide evaluations of the impact of environmental regulations require a new framework to characterize the role of regulations and the associated changes in environmental quality for steady state responses to policy.

The Social Value of Job Loss and Its Effect on the Costs of U.S. Environmental Regulations

- Review of Environmental Economics and Policy---2015---Timothy Bartik

Job loss is typically not valued in benefit–cost analyses of environmental regulations. But empirical evidence suggests that involuntary job loss results in large social costs, particularly when local unemployment is high. This article presents estimates of the social costs of job loss in the United States, based on estimates of how local labor markets respond to job changes. These estimated social costs have a present value per job lost in the hundreds of thousands of dollars. However, these social costs are far less than the earnings associated with the lost jobs, because of labor market adjustments as well as some offsets from the value of

increased non-work time. An examination of major U.S. environmental regulations suggests that job losses will usually add only modestly to overall regulatory costs. However, if the magnitude of a regulation' s benefits and costs are close in monetary terms, then accounting for job loss could tip the regulatory decision. It is also important for regulatory analyses to examine the potential magnitude of gross job loss, particularly in high unemployment areas.

Environmental Regulations and the Welfare Effects of Job Layoffs in the United States: A Spatial Approach

- Review of Environmental Economics and Policy---2015---Nicolai Kuminoff,Todd Schoellman,Christopher Timmins

This article develops welfare-consistent measures of the employment effects of environmental regulation. Our analysis is based on a microeconomic model of how households with heterogeneous preferences and skills decide where to live and work. We use the model to examine how job loss and unemployment would affect workers in Northern California. Our stylized simulations produce earnings losses that are consistent with empirical evidence. They also produce two new insights. First, we find that earnings losses are sensitive to business cycle conditions. Second, we find that earnings losses may substantially understate welfare losses once we account for the fact that workers may have to commute further or live in a less desirable community after losing a job.

A Macroeconomic Perspective on Evaluating Environmental Regulations

- Review of Environmental Economics and Policy---2015---Richard Rogerson

This article examines how dynamic general equilibrium models and methods that are commonly used to evaluate macroeconomic policies can also be useful for evaluating the aggregate consequences of environmental regulations. I describe two macroeconomic models of interest that differ in the extent to which they incorporate heterogeneity and microeconomic detail. I illustrate how standard methods from macroeconomics can be applied in both models by considering calculations for a hypothetical environmental regulation.

Introductory Comment–The Green Paradox: A Supply-Side View of the Climate Problem

- Review of Environmental Economics and Policy---2015---Hans-Werner Sinn

Why have policies aimed at reducing the demand for carbon not succeeded in slowing down global carbon extraction and CO2 emissions, and why have carbon prices failed to increase over the last three decades? This comment argues that this is because of the Green Paradox, that is, the anticipation of sales by resource owners who try to preempt the destruction of their markets by green policies. Reviewing some of the conditions under which strong and weak versions of the Green Paradox may emerge, it is argued that there is little hope that green replacement technologies will impose hard price constraints that would keep long-run extraction within a fixed carbon budget and that, therefore, even strong versions of the paradox cannot easily be avoided.

An Introduction to the Green Paradox: The Unintended Consequences of Climate Policies

- Review of Environmental Economics and Policy---2015---Svenn Jensens,Kristina Mohlin,Karen Pittel,Thomas Sterner,Svenn Jensen

How important is the Green Paradox? We address this question in three ways. First, we present a simple model explaining how announcing a future climate policy may increase carbon emissions today – the Green Paradox effect. This effect is a result of fossil fuel producers increasing their extraction today as a response to a reduction in future resource rents. Second, we examine the theoretical and empirical literature to assess whether green paradoxes are likely to occur, and if they are, whether they are big enough to be of concern for policy makers. We consider several factors that affect

the existence of the green paradox, including long-term extraction costs, short-term extraction capacities, the mix of policy instruments, and potential spatial carbon leakage to countries that have no climate policy. We find that these and other factors can sometimes strengthen, but mostly weaken, the case for concern about the green paradox. Third, we identify the lessons the literature offers for policy makers. We argue that in designing climate policy, policy makers need to consider the supply side of the fossil fuel market.

The Green Paradox in Open Economies: Lessons from Static and Dynamic Models

- Review of Environmental Economics and Policy---2015---Ngo Long

This article examines how, in a world with incomplete coordination among countries, well-intentioned unilateral environmental policies may actually harm the global environment. This outcome is known as the "Green Paradox." The incentives for free-riding and the challenge of achieving an effective international environmental agreement are reviewed. I examine the various channels that lead to carbon leakage in static models of open economies, and report some simulation results. This is complemented by a review of the potential for Green Paradox outcomes in dynamic open-economy models in which forward-looking firms exploit an exhaustible resource. I show that border tax adjustments can lead to Green Paradox outcomes. I also discuss priorities for future research on environmental policies in a trading world that lacks a central enforcement agency.

Global Warming and the Green Paradox: A Review of Adverse Effects of Climate Policies

- Review of Environmental Economics and Policy---2015---Frederick (Rick) van der Ploeg,Cees Withagen

This article examines the possible adverse effects of well-intended climate policies, an outcome known as the Green Paradox. A weak Green Paradox arises if the announcement of a future carbon tax or a sufficiently fast rising carbon tax encourages fossil fuel owners to extract reserves more aggressively, thus exacerbating global warming. We argue that such policies may also encourage more fossil fuel to be locked in the crust of the earth, which can offset the adverse effects of the weak Green Paradox. We show that a subsidy on clean renewables may have similar weak Green Paradox effects. Green welfare (the converse of environmental damages) declines (i.e., the strong Green Paradox) if the beneficial climate effects of locking up more fossil fuel do not outweigh the short-run weak Green Paradox effects. Neither the weak nor the strong Green Paradox occurs for the first-best Pigouvian carbon tax. We also discuss dirty backstops, spatial carbon leakage, and green innovation.

Reflections–Managing Uncertain Climates: Some Guidance for Policy Makers and Researchers

- Review of Environmental Economics and Policy---2015---Frank J. Convery,Gernot Wagner

Climate change—and, by extension, climate policy—is beset with unknowns and unknowables. This "Reflections" article presents an overview of approaches to managing climate uncertainties, in the hopes of providing guidance for current policy decisions as well as future research. We propose the following guidance for policy makers: Treat climate change as a risk management problem; recognize that benefit-cost analysis is only the first of many steps in deciding on optimal climate policy; in assessing abatement choices, use a discount rate that declines over time; recognize the importance of framing, evidence, and connecting the dots; reward modesty. We suggest the following questions for consideration by researchers: Can we improve forecasting? Can we improve the way we address nonlinearities and possible irreversibilities? What other (sub)disciplines merit a closer look? How can we create the right incentives for updating and expanding economic damage functions and climate-economy models? What alternative decision criteria merit further exploration? What does ‘not knowing’ tell us?

A Word From the Editor

- Review of Environmental Economics and Policy---2015---Charles D. Kolstad

2015

Offshore Oil and Gas Drilling: A Review of Regulatory Regimes in the United States, United Kingdom, and Norway

- Review of Environmental Economics and Policy---2015---Lori S. Bennear

This article investigates the regulatory regimes for offshore oil and gas in the United States (U.S.), United Kingdom (U.K.), and Norway from both a positive and normative perspective. The positive analysis reveals that all three countries are converging on a similar regulatory system that combines strict liability, command-and-control, and management-based regulations for controlling site-specific risks. The timing of the adoption of each element in this regulatory system varies across the three countries and has been driven largely by accidents along the individual country's continental shelf. In particular, the adoption of the management-based approach occurred after a significant accident revealed the weaknesses of a one-size-fits–all set of prescriptive rules. Although the normative analysis reveals theoretical support for the use of both liability and management-based approaches, the empirical data are limited, and the data that do exist call into question the superiority of the management-based approach over command-and-control. More research is needed that develops and systematically evaluates incentive-compatible regulatory regimes. (JEL: Q38, Q40, Q48, K32)

Conservation Planning: A Review of Return on Investment Analysis

- Review of Environmental Economics and Policy---2015---James Boyd,Rebecca Epanchin-Niell,Juha Siikamäki

Land and natural resource conservation programs are increasingly being evaluated on the basis of their return on investment (ROI). Conservation ROI analysis quantitatively measures the costs, benefits, and risks of investments, which allows conservation organizations to rank or prioritize them. This article surveys the literature in this area. We organize our discussion around the way studies treat the core elements of ROI, which include the definition and measurement of the conservation objective, identification of relevant baselines, the types of conservation investments considered, and investment costs. We discuss the state of the art of ROI analysis, highlight some unresolved issues, and make suggestions for improvements. We also describe options for extending ROI analysis beyond biodiversity conservation, which is the typical objective. The literature indicates that conservation planning that uses ROI analysis can considerably alter the location and targets of conservation, lead to more protection and higher quality conservation outcomes, and result in significant savings. The measurement and prediction of baseline ecological conditions and threats remains a central challenge for conservation ROI analysis, as does accounting for landowner and developer responses to conservation investments. Another key priority for future research is the identification of ways to more comprehensively incorporate ecosystem services and multiple environmental objectives into the assessment framework. (JEL: Q20, Q30, Q51, Q57)

Editor's Choice The Early History of Environmental Economics

- Review of Environmental Economics and Policy---2015---Agnar Sandmo

This article traces the history of economists' treatment of environmental problems prior to the establishment of environmental economics as a separate field in the 1960s. I examine the economics literature from the late eighteenth century onward, searching for an awareness among early economists of both the effects of economic activity on the natural and social environment and the feedback from the environment to the economy. I argue that the way in which economic theory developed made it increasingly relevant for the

study of environmental issues and the design of appropriate economic policies. (JEL: B00, Q30, Q50)

Natural Gas: An Overview of a Lower-Carbon Transformation Fuel

- Review of Environmental Economics and Policy---2015---Anne Neumann,Christian von Hirschhausen

This article provides an overview of the natural gas industry, which we view as a bridge fuel toward a lower-carbon energy system in many countries and regions around the world. Based on a review of the literature, an econometric analysis of natural gas prices and contracts, and the authors' experience with the natural gas industry, this introductory article to the symposium on the Prospects for Natural Gas in a Lower-Carbon Context provides an overview of research on natural gas markets over the last decade and examines various features of the natural gas industry, including its technical structure, activities in the value-added chain, trade and market trends, short- and long-term price developments, and the geopolitical landscape. More specifically, we describe the natural gas sector and provide an overview of production, reserves, and consumption. We also examine the evolution of long-term contracts between producers and large-scale buyers of natural gas and present some recent empirical evidence. Finally, we discuss the changing geopolitics of natural gas, focusing in particular on the future roles of the United States as a potential natural gas exporter and Asia as the major importing region. (JEL: L11, L95, Q49)

A Global Perspective on the Future of Natural Gas: Resources, Trade, and Climate Constraints

- Review of Environmental Economics and Policy---2015---Franziska Holz,Philipp Richter,Rudolf Egging

Natural gas plays an important role in the global energy system as an input to power generation, heating, and industry. This article identifies key drivers and uncertainties for natural gas markets in the coming decades. These include the availability of natural gas from conventional and unconventional sources, the role of international trade, and the impact of climate policies. We build on model-based research as well as an up-to-date survey of natural gas resource availability. We find that natural gas is an abundant fossil fuel and that the Asia-Pacific region will be most important in future global natural gas markets, especially under stringent international climate change mitigation. This means that an increasingly large share of future natural gas trade flows and infrastructure expansions will be directed to the Asia-Pacific region and that the role of liquefied natural gas will continue to increase globally. (JEL: C61, L71, Q33, Q37, Q54)

Regulation of Natural Gas in the United States, Canada, and Europe: Prospects for a Low Carbon Fuel

- Review of Environmental Economics and Policy---2015---Jeff D. Makholm

The United States and Canada have seen a competitive and technological revolution in unconventional natural gas production in the 21st Century—dramatically lowering the price of gas and displacing high-carbon coal with low-carbon gas for power generation. This gas revolution came from an earlier revolution in the regulation of gas pipelines, which ended the obstruction of gas markets by pipeline interests. Neither revolution has spread to Europe, where increasingly protectionist EU legislation has effectively blocked competitive pipeline entry and related gas markets. As a result, unconventional gas is untapped, coal displaces gas for power generation, and oil-linked gas prices have cost EU consumers a staggering $425 billion more than their US counterparts have paid since 2009 for about the same quantity of gas. Europe faces a serious institutional challenge to adopting the kind of pipeline regulation that facilitates the competitive flow of natural gas supplies and the accompanying lower carbon emissions. (JEL: D23, K23, L14, L51, L95, N70, Q54)

Policy Monitor—Bonding Requirements for U.S. Natural Gas Producers

- Review of Environmental Economics and Policy---2015---Lucas Davis

Natural gas producers are constantly making tradeoffs between money, time, and environmental risk. The private costs and benefits of drilling are realized immediately, but the external costs are not. This means that by the time external costs are well understood, producers may no longer exist or may not have sufficient resources to finance necessary cleanups or to compensate those who have been adversely affected. Because producers do not face the total cost of potential external damages, they may take too many risks. This article discusses alternative regulatory approaches for mitigating moral hazard in U.S. natural gas production. Particular emphasis is given to bonding requirements, which have tended to receive less attention from policy makers than other approaches but have a long history. Although the use of bonding has important limitations, this approach is quite well suited to addressing many of the environmental risks in this market. (JEL: K32, L71, Q48, Q58)

Book Review—A Review of William Nordhaus' The Climate Casino: Risk, Uncertainty, and Economics for a Warming World

- Review of Environmental Economics and Policy---2015---Martin Weitzman

2015

A Word From the Editor

- Review of Environmental Economics and Policy---2014---Charles D. Kolstad

2014

Editor's Choice Should Governments Use a Declining Discount Rate in Project Analysis?

- Review of Environmental Economics and Policy---2014---Kenneth Arrow,Maureen Cropper,Christian Gollier,Ben Groom,Geoffrey Heal,Richard Newell,William D. Nordhaus,Robert Pindyck,William A. Pizer,Paul R. Portney,Thomas Sterner,Richard Tol,Martin Weitzman

Should governments use a discount rate that declines over time when evaluating the future benefits and costs of public projects? The argument for using a declining discount rate (DDR) is simple: if the discount rates that will be applied in the future are uncertain but positively correlated, and if the analyst can assign probabilities to these discount rates, then the result will be a declining schedule of certainty-equivalent discount rates. There is a growing empirical literature that estimates models of long-term interest rates and uses them to forecast the DDR schedule. However, this literature has been criticized because it lacks a connection to the theory of project evaluation. In benefit-cost analysis, the net benefits of a project in year t (in consumption units) are discounted to the present at the rate at which society would trade consumption in year t for consumption in the present. With simplifying assumptions, this leads to the Ramsey discounting formula, which results in a declining certainty-equivalent discount rate if the rate of growth in consumption is uncertain and if shocks to consumption are correlated over time. We conclude that the arguments in favor of a DDR are compelling and thus merit serious consideration by regulatory agencies in the United States. (JEL: D61)

Corporate Environmental Strategies in Emerging Economies

- Review of Environmental Economics and Policy---2014---Dietrich H. Earnhart,Madhu Khanna,Thomas Lyon

Many companies are adopting environmentally friendly management practices in developed countries. However, the benefits of a corporate environmental strategy are less clear in emerging (developing and transition) economies, where environmental regulations may be poorly enforced and social pressures to comply are weak. Thus it is important for business leaders, policymakers, and environmental activists to understand the

causes and consequences of corporate environmental strategy in these economies so that they are able to implement effective strategies, develop useful policies, and promote meaningful activities, respectively. Drawing on both the theoretical and empirical literature, this article examines a broad array of drivers behind corporate environmental strategies including internal characteristics of firms, market pressures, and pressures from government and civil society. The empirical findings for developing economies (i.e., those whose physical and human resources, along with institutions, are still developing) suggest that government and civil society provide weak incentives for corporate environmental compliance, foreign ownership and foreign customer pressure improve environmental management practices, and information disclosure programs offer some promise for improving corporate environmental performance. The empirical findings for transition economies (i.e., those transitioning from reliance on the government's allocation of resources to market-based allocations) also suggest a positive, albeit weaker, role for foreign ownership and foreign customer pressure in improving firms' environmental performance. However, the findings also indicate that government policies, such as stricter enforcement, granting of permits, and higher rates for emission charges, are more effective in transition economies than in developing economies. (JEL: D21, D22, K32, M14, O13, P28, P31, Q53, Q56)

Editor's Choice Long-Run Demand for Energy Services: Income and Price Elasticities over Two Hundred Years

- Review of Environmental Economics and Policy---2014---Roger Fouquet

This article investigates how the demand for energy services has changed since the Industrial Revolution. It presents evidence on the income and price elasticities of demand for domestic heating, passenger transport, and lighting in the United Kingdom over the last two hundred years. As the economy developed and energy service prices fell, income elasticities have generally followed an inverse U-shape curve, and price elasticities have generally followed a U-shape curve. However, these general trends also appear to have been affected by energy and technological transitions, which boosted demand (by either encouraging poorer consumers to fully enter the market or offering new attributes of value to wealthier consumers). The evidence presented offers insights that will be helpful for identifying likely future trends in energy use and carbon dioxide emissions, and for developing long-term climate policies. (JEL: Q41, N73, N74, D12)

The Supply of Environmentalism: Psychological Interventions and Economics

- Review of Environmental Economics and Policy---2014---Edward L. Glaeser

Long before behavioral economists began to combine economic theory with discoveries from psychology, environmentalists were nudging and framing and pushing their cause through psychological interventions. These interventions appear to have changed behavior by altering beliefs, norms, and preferences. However, because psychological interventions are often coarse, they have also resulted in inadvertent, offsetting side effects. This article discusses the interactions between environmental preference-making and economics, and then it examines three areas of environmental interest —electric cars, recycling, and local conservation efforts—where psychological interventions have created strong, widespread, and simple environmental views. However, in all three cases, simple environmental rules of thumb can lead to significant adverse environmental side effects. Local environmentalism, for example, may increase carbon emissions by pushing development from low emission areas, like coastal California, to high-emission areas elsewhere in the United States. I conclude with a discussion of a fourth issue: how economic analysis of the political supply of ideas can be helpful in understanding the remarkable disparity of views concerning climate change. (JEL: D00, Q5)

The Role of Standards in Eco-innovation: Lessons for Policymakers

- Review of Environmental Economics and Policy---2014---Herman R.J. Vollebergh,Edwin van der

Werf

This article aims to help policymakers identify how standards can contribute to the effective and cost-efficient development and deployment of eco-innovations (innovations that reduce environmental impacts). To this end, we argue that the general perception among environmental economists that standards are a very simple form of command and control regulation is too limited. Environmental policy standards often allow for flexibility. Moreover, other types of standards are often relevant for induced innovation and diffusion. Our broad perspective enables us to identify some interesting and important economic aspects of standards, such as their contribution to the diffusion of technologies with network externalities and the extent to which they are substitutes or complements to (other) environmental policy instruments. Finally, we discuss conditions for the successful use of standards by governments to stimulate eco-innovation. (JEL: Q38, Q55, Q58)

Solar Geoengineering's Brave New World: Thoughts on the Governance of an Unprecedented Technology

- Review of Environmental Economics and Policy---2014---Scott Barrett

Due to the failure of international efforts to limit atmospheric concentrations of greenhouse gases, consideration is now being given to solar geoengineering—a deliberate intervention to limit global warming without altering the atmospheric concentration of greenhouse gases. In contrast to emission cuts, geoengineering is expected to be cheap, quick to lower temperature, and feasible through the use of a single intervention. However, geoengineering is an imperfect substitute for emission reductions and will likely have undesirable side effects, only some of which can be anticipated before geoengineering is deployed. Most importantly, because geoengineering can be undertaken unilaterally, it creates issues of governance: Who gets to decide if, when, and how geoengineering should be attempted? This article provides an introduction to the key issues surrounding the governance of this unprecedented technology. (JEL: Q54, F53, K33)

Climate Engineering: Economic Considerations and Research Challenges

- Review of Environmental Economics and Policy---2014---Gernot Klepper,Wilfried Rickels

Climate engineering measures are designed to either reduce atmospheric carbon concentration (by growing trees or spreading iron in the ocean, for example) or directly influence the radiation reaching or leaving the earth (by injecting sulfur into the stratosphere or modifying cloud formations, for example) to compensate for greenhouse gas–induced warming. The former measures are termed carbon dioxide removal (CDR), which we characterize as a low-leverage causative approach, and the latter are termed radiation management (RM), which we characterize as a high-leverage symptomatic approach. There are similarities between CDR and emission control. Accordingly, benefit-cost analysis can be used to assess certain CDR measures. By contrast, high-leverage RM represents a genuinely new option in the climate change response portfolio, at first glance promising insurance against fat-tail climate change risks. However, the persistent intrinsic uncertainties of RM suggest that any cautious climate risk management approach should consider RM as a complement to (rather than a substitute for) emission control at best. Moreover, the complexity of the earth system imposes major limitations on the ability of research to reduce these uncertainties. Thus we argue that a research strategy is needed that focuses on increasing our basic understanding of the earth system and conducting comprehensive assessments of the risk(s) associated with both climate change and the deployment of climate engineering. (JEL: Q52, Q54, Q55)

How Stringent Are the US EPA's Proposed Carbon Pollution Standards for New Power Plants?

- Review of Environmental Economics and Policy---2014---Matthew J. Kotchen,Erin Mansur

In the absence of legislation for a US national climate policy, regulatory responsibility has fallen to the US Environmental Protection Agency (EPA). In March 2012, the EPA announced a proposed carbon pollution standard for new power plants. Then in September 2013, the EPA withdrew the proposal upon issuing a revision as part of President Obama's Climate Action Plan. This article analyzes the stringency of the proposed emission standards for new electricity generating units relative to the emission rates of existing, recently constructed, and proposed units in the United States. No coal-fired units would come close to the emission targets unless there are future innovations in carbon capture and storage. While natural gas units designed to meet peak demand are effectively exempt, very few of them would comply on an annual basis. For the baseload natural gas units—that is, combined-cycle gas turbine units—we find that between 90 and 95 percent of the units that began operating in 2006 or later would already meet the proposed targets. Finally, we discuss differences among states regarding the characteristics of recently constructed and planned units as they relate to the proposed standards. (JEL: Q40, Q52, Q58)

Climate Policy: Science, Economics, and Extremes

- Review of Environmental Economics and Policy---2014---Anthony C. Fisher,Phu V. Le

Climate scientists, and natural scientists more generally, believe that climate change is a major, perhaps the most important, problem facing humankind this century, and that it is increasingly linked to extreme weather events. However, the impression one gets from much of the economic literature, particularly simulations from integrated assessment models used in policy analysis, is that the potential impacts of climate change are not large enough to warrant aggressive mitigation efforts in the near term. Although these models represent an important step in the needed interdisciplinary analysis of climate change by elucidating the links between climate and economy, we argue that they grossly underestimate potential impacts and associated damages because they (and the related policy analyses) fail to adequately capture extreme conditions, catastrophic events, and tipping points that trigger irreversible changes in the climate system, as well as impacts on the natural environment that cannot be monetized. Because the most severe impacts are expected in the later years of this century and beyond, discounting is crucial, and we argue that the appropriate rate is well below market rates. Moreover, we show that in the uniquely long period relevant to climate policy, the irreversibility of climate changes and impacts is more serious than the irreversibility of proposed mitigation measures. We conclude that an aggressive mitigation policy is warranted, one that holds further increases in global mean temperature to the scientific consensus on what is required to avoid the worst impacts, and that such a policy can be achieved at a cost that is well below potential damages. (JEL: Q54)

Two Decades of European Climate Policy: A Critical Appraisal

- Review of Environmental Economics and Policy---2014---Christoph Böhringer

Climate change ranks high on the policy agenda of the European Union (EU), which considers itself a leading force in the battle against anthropogenic climate change. The EU is committed to the objective of limiting the rise in global average temperature to no more than 2°C above preindustrial levels to prevent dangerous anthropogenic interference with the climate system. This article provides a critical appraisal of two decades of EU climate policy. Based on the global nature of climate change, we present three criteria for sound unilateral action and evaluate current EU climate policy against these criteria. We find that the actual implementation of EU climate policies is likely to make emission abatement much more costly than necessary. (JEL: H21, H23, Q58)

Bridging the Energy Efficiency Gap: Policy Insights from Economic Theory and Empirical Evidence

- Review of Environmental Economics and Policy---2014---Kenneth Gillingham,Karen Palmer

Despite several decades of government policies to promote energy efficiency, estimates of the costs and benefits of such policies remain controversial. At the heart of the controversy is whether there is an "energy efficiency gap," whereby consumers and firms fail to make seemingly positive net present value energy saving investments. High implicit discount rates, undervaluation of future fuel savings, and negative cost energy efficiency measures have all been discussed as evidence of the existence of a gap. We review explanations for an energy efficiency gap including reasons why the size of the gap may be overstated, neoclassical explanations for a gap, and recent evidence from behavioral economics that has potential to help us understand why a gap could exist. Our review raises fundamental questions about traditional welfare analysis, but we find the alternatives offered in the literature to be far from ready for use in policy analysis. Nevertheless, we offer several suggestions for policymakers and for future economic research. (JEL: Q38, Q41) Copyright 2014, Oxford University Press.

The Curious Treatment of the Coase Theorem in the Environmental Economics Literature, 1960--1979

- Review of Environmental Economics and Policy---2014---Steven Medema

This article examines the first two decades of the history of the Coase theorem in environmental economics, a period during which the theorem's validity was widely acknowledged but its relevance for economic analysis of environmental issues was almost universally dismissed. The repeated claims of the theorem's irrelevance and its dismissive treatment in the literature raise the question of why environmental economists were so interested in the Coase theorem in the first place. Several explanations are offered here including the roots of environmental economic theory in the theory of externalities, economists' fascination with the interesting and challenging theoretical puzzle posed by the theorem, and the normative and ideological thrust that permeated discussions of the theorem, both within and outside the field of environmental economics. (JEL: B20, D62, K32, Q50, R11) Copyright 2014, Oxford University Press.

The Economics of Dead Zones: Causes, Impacts, Policy Challenges, and a Model of the Gulf of Mexico Hypoxic Zone

- Review of Environmental Economics and Policy---2014---S. S. Rabotyagov,Catherine Kling,P. W. Gassman,N. N. Rabalais,R. E. Turner

This article reviews and analyzes the issues related to worldwide hypoxic zones and the range of economic questions sorely in need of answers. We begin by describing the extent and causes of hypoxic zones worldwide, followed by a review of the evidence concerning ecological effects of hypoxic zones and their impacts on ecosystem services. We describe what is known about abatement options and cost-effective policy design, and then focus on the large seasonally recurring hypoxic zone in the Gulf of Mexico. We offer a simple econometric model to estimate the relationship between pollutants (nutrients) and the size of the hypoxic zone. This "production function" relationship suggests that both instantaneous and historical nutrient contributions affect the size of the zone. Our results support concerns that ecologists have raised about lags in the recovery of the ecosystem and confirm the importance of multiple nutrients as target pollutants. We conclude with a discussion of the types of research and cooperation across disciplines that are needed to support the development of policies to address this important ecological and economic issue. (JEL: Q51, Q52, Q57, B4) Copyright 2014, Oxford University Press.

Rights, Rewards, and Resources: Lessons from Community Forestry in South Asia

- Review of Environmental Economics and Policy---2014---Priya Shyamsundar,Rucha Ghate

Large-scale experiments with the decentralization of forest management in South Asia have changed the relationship between forests, public institutions that manage forests, and rural households. But have these institutional changes led to reductions in forest degradation and improvements in welfare? It is important to ask this question because reducing deforestation and degradation is a public policy goal, and rural households depend on forests to meet their subsistence needs. This article examines the literature on the Joint Forest Management program in India and the Community Forestry Programme in Nepal. The emerging evidence suggests that community forest management may indeed be contributing to improved forest health in South Asia. However, the impacts on household welfare appear to be far more varied but have also been less carefully studied. The article concludes that policies that further clarify resource rights and support local monitoring would strengthen and improve community forestry. (JEL: O13, Q23, Q28, Q56) Copyright 2014, Oxford University Press.

Pay or Waive: An Economic Assessment of Property Owner Compensation Laws in the United States

- Review of Environmental Economics and Policy---2014---Cyrus Grout,Andrew J. Plantinga,William K. Jaeger

Land-use regulations are contentious everywhere because of their potential negative effects on private property values. In recent years, so-called pay or waive compensation legislation was passed in a number of US states, requiring governments to compensate property owners for losses due to land-use regulations or grant exemptions from the regulations in lieu of compensation. We provide an overview of the compensation statutes in six US states, discuss the economic issues raised by the statutes, and examine the effects of the statutes in practice. Although these laws require that "just compensation" be estimated accurately and consistently, measuring the effects of land-use regulations on property values is extremely challenging in practice. We find that rather than providing relief to property owners unfairly burdened by land-use regulations, the compensation statutes appear primarily to discourage local governments from developing and implementing land-use regulations. (JEL: Q24, R52) Copyright 2014, Oxford University Press.

Reflections

- Review of Environmental Economics and Policy---2014---Geoffrey Heal,Antony Millner

Uncertainty is intrinsic to climate change: we know that the climate is changing but not precisely how fast or in what ways. Nor do we understand fully the social and economic consequences of these changes or the options that will be available for reducing climate change. Furthermore, the uncertainty about these issues is not readily quantified in probabilistic terms: we are facing deep uncertainty rather than known risks. We argue that this may render the classical expected utility framework for decision making under uncertainty of limited value for informing climate policy. We review the sources of uncertainty about all aspects of climate change, separate these into scientific and socioeconomic components, and examine their relative importance. Then we review decision-making frameworks that may be more appropriate in the absence of unique probabilities including nonprobabilistic approaches and those based on multiple priors, and we discuss their application in the context of climate change economics.(JEL: D81, Q54) Copyright 2014, Oxford University Press.

Using Weather Data and Climate Model Output in Economic Analyses of Climate Change

- Review of Environmental Economics and Policy---2013---Maximilian Auffhammer,Solomon M. Hsiang,Wolfram Schlenker,Adam Sobel

Economists are increasingly using weather data and climate model output in analyses of the economic impacts of climate change. This article introduces weather data sets and climate models that are frequently used, discusses the most common mistakes economists make in using these products, and identifies ways to avoid these pitfalls. We first provide an introduction to weather

data, including a summary of the types of data sets available, and then we discuss five common pitfalls that empirical researchers should be aware of when using historical weather data as explanatory variables in econometric applications. We then provide a brief overview of climate models and discuss two common and significant errors often made by economists when climate model output is used to simulate the future impacts of climate change on an economic outcome of interest. (JEL: Q54) Copyright 2013, Oxford University Press.

Positive versus Normative Justifications for Benefit-Cost Analysis: Implications for Interpretation and Policy

- Review of Environmental Economics and Policy---2013---James Hammitt

What is the rationale for benefit-cost analysis (BCA)? The answer is critical for determining how BCA should be conducted and interpreted, and identifying its implications for policy. This article examines two possible justifications for BCA: positive and normative. The positive rationale is that BCA identifies policy changes whereby those who benefit could, in theory, compensate those who are harmed. The normative rationale is that BCA identifies social improvements (e.g., by approximating a utilitarian calculus or protecting against cognitive error in policy choice). The standard approach to BCA assumes that the positive and normative justifications coincide. However, when human behavior differs from what is assumed in standard economic models, these justifications may conflict. In this case, individuals may dislike a change in circumstances that economic models predict they should prefer. The positive justification for BCA is consistent with respect for individual autonomy and provides clarity about methodological choices in the analysis (i.e., that the objective is to incorporate people's apparent preferences as accurately as possible), but it may also require accepting cognitive and behavioral errors that individuals would wish to avoid. The normative justification implies rejecting policies that the population may prefer and requires determining what preferences are normatively acceptable. The article argues that the choice of justification is part of a larger issue concerning the appropriate role of representative government. (JEL: D61, D81, H40, Q50) Copyright 2013, Oxford University Press.

The Climate Policy Dilemma

- Review of Environmental Economics and Policy---2013---Robert Pindyck

Climate policy poses a dilemma for environmental economists. The economic argument for stringent greenhouse gas (GHG) abatement is far from clear. There is disagreement among both climate scientists and economists concerning the likelihood of alternative climate outcomes, the nature and extent of the uncertainty of those outcomes, and the framework that should be used to evaluate potential benefits from GHG abatement, including key policy parameters. I argue that the case for stringent abatement--if it can be made at all--cannot be based on the kinds of modeling exercises that have permeated the literature thus far, but instead must be based on the possibility of a catastrophic outcome. I discuss how an analysis that incorporates such an outcome might be conducted. (JEL: Q54; D81, Q51) Copyright 2013, Oxford University Press.

Nonregulatory Approaches to the Environment: Coasean and Pigouvian Perspectives

- Review of Environmental Economics and Policy---2013---Spencer Banzhaf,Timothy Fitzgerald,Kurt Schnier

This article introduces a symposium on decentralized approaches to environmental management. These approaches include voluntary contributions to public goods, bundling contributions with private goods, and bundling the use of the environment with private goods. The article compares and contrasts the Coasean property rights perspective on such arrangements with the Pigouvian perspective of public economic theory. It further evaluates the efficiency of such arrangements through the lens of the excludability and nonrivalry

problems, which are common to both perspectives. We conclude that both perspectives provide important insights for a comparative analysis of nonregulatory and regulatory approaches.(JEL: D23, D62, H23) Copyright 2013, Oxford University Press.

Transaction Costs and Environmental Markets: The Role of Entrepreneurs

- Review of Environmental Economics and Policy---2013---Terry L. Anderson,Dominic Parker

At the core of environmental economics is the potential for a divergence between private and social costs (based on the work of A. C. Pigou) and the potential for private contracts to shrink this divergence (based on the work of Ronald Coase). A close examination of Pigou and Coase reveals that the two are not so far apart, with Pigou emphasizing "technical difficulties" and Coase emphasizing transaction costs as the reason that private actors do not account for all costs and benefits. Building from this emphasis on transaction costs, we identify environmental entrepreneurship as an important but underappreciated force for improving resource allocation. Entrepreneurs guide the evolution of property rights, which in turn can lower the transaction costs of using markets to solve environmental problems. We define three types of entrepreneurs--those who contract over existing property rights in innovative ways, those who create new environmental property rights, and those who elicit private payments for public goods--and provide examples of how these entrepreneurs have improved resource allocation. These examples offer lessons about how government can encourage or discourage entrepreneurship. (JEL: Q2, Q5, D23, L26) Copyright 2013, Oxford University Press.

Voluntary- and Information-Based Approaches to Environmental Management: A Public Economics Perspective

- Review of Environmental Economics and Policy---2013---Matthew Kotchen

Interest in decentralized approaches to environmental management has grown significantly in recent years. Along with the standard instruments of environmental policy--quantity, price, and technology regulations--is a growing number of voluntary--and information-based approaches (VIBAs) that includes more decentralized policies, programs, and market trends. This article offers a perspective on VIBAs through the lens of public economic theory. The unifying theme is that many VIBAs are based on the creation of impure public goods and/or clubs. The innovation of these arrangements is the way in which jointly produced private benefits effectively subsidize the voluntary provision of public goods. From this perspective, VIBAs can be viewed as a property rights approach because they privatize an aspect of public good provision in order to make such provision more incentive compatible with firm or individual preferences for decision making. Although VIBAs have the potential to promote environmental protection and economic efficiency, these outcomes are not assured. However, a more careful examination of the theoretical basis for VIBAs can help us identify the circumstances under which these approaches hold the greatest promise for efficient environmental policy. (JEL: H41, Q58) Copyright 2013, Oxford University Press.

Policy Monitor

- Review of Environmental Economics and Policy---2013---Aparna Sawhney

As part of its efforts to pursue a low-carbon growth path, India has made a commitment to increase the use of clean energy in electricity generation. This article examines the evolution of India's renewable energy policy as a way to address the twin goals of reducing energy poverty and mitigating climate change. I review India's regulatory reforms and policy instruments and compare them with those adopted in China in order to highlight the key policy features that have helped China emerge as a global leader in the renewable energy sector. India's recent initiatives for clean energy under the National Action Plan on Climate Change, including promoting trade in renewable energy certificates across states in order to comply with renewable purchase obligations, reflect a more integrated approach

to building an efficient renewable energy-based power sector. The current rapid expansion of the renewable power sector, especially solar energy, suggests that for the foreseeable future India will continue to be one of the world's fastest growing renewable energy markets. (JEL: Q42, Q48, Q54) Copyright 2013, Oxford University Press.

Reflections--Carbon Pricing in Practice *

- Review of Environmental Economics and Policy---2013---Tom H. Tietenberg

Carbon pricing is a broad term that encompasses two policy approaches: emissions trading and carbon taxation. Emissions trading places a cap on the aggregate emission level and allows the market to determine the price, whereas carbon taxation sets the price and allows the market to determine the aggregate level of emissions. Although programs to address climate change based on pricing carbon are relatively new, programs to price pollution more generally are not. Various forms of emissions trading and pollution fees (or taxes) have been around for some time. Existing carbon pricing programs provide a wealth of experience from which we can draw insights about the effectiveness of particular design options and how and why context can be important. This "Reflections" reviews these operating programs and identifies some of the chief lessons from this experience. (JEL: Q53, Q58) Copyright 2013, Oxford University Press.

A Word from the Editor

- Review of Environmental Economics and Policy---2013---Charles Kolstad

2013

The Porter Hypothesis at 20: Can Environmental Regulation Enhance Innovation and Competitiveness?

- Review of Environmental Economics and Policy---2013---Stefan Ambec,Mark Cohen,Stewart Elgie,Paul Lanoie

Some twenty years ago, Harvard Business School economist and strategy professor Michael Porter challenged conventional wisdom about the impact of environmental regulation on business by declaring that well-designed regulation could actually enhance competitiveness. The traditional view of environmental regulation held by virtually all economists until that time was that requiring firms to reduce an externality like pollution necessarily restricted their options and thus by definition reduced their profits. After all, if profitable opportunities existed to reduce pollution, profit-maximizing firms would already be taking advantage of them. Over the past twenty years, much has been written about what has since become known simply as the Porter Hypothesis. Yet even today, we continue to find conflicting evidence concerning the Porter Hypothesis, alternative theories that might explain it, and oftentimes a misunderstanding of what the Porter Hypothesis does and does not say. This article examines the key theoretical foundations and empirical evidence concerning the Porter Hypothesis, discusses its implications for the design of environmental regulations, and outlines directions for future research on the relationship between environmental regulation, innovation, and competitiveness. (JEL:Q58, O38, F18) Copyright 2013, Oxford University Press.

Developing a Social Cost of Carbon for US Regulatory Analysis: A Methodology and Interpretation

- Review of Environmental Economics and Policy---2013---Michael Greenstone,Elizabeth Kopits,Ann Wolverton

The US government recently developed a range of values representing the monetized global damages associated with an incremental increase in carbon dioxide (CO 2) emissions, commonly referred to as the social cost of carbon (SCC). These values are currently used in benefit--cost analyses to assess potential federal regulations. For 2010, the central value of the SCC is $21 per ton of CO 2 emissions, with sensitivity analyses to be conducted at $5, $35, and $65 per ton of CO 2 (2007 dollars). This article summarizes the methodology and

interagency process used to develop these SCC values, offers our own commentary on how the SCC can be used to inform regulatory decisions, and identifies priorities for further research. (JEL: Q54, Q51, and Q58) Copyright 2013, Oxford University Press.

The Economics of International Policy Agreements to Reduce Emissions from Deforestation and Degradation

- Review of Environmental Economics and Policy---2013---Suzi Kerr

This article synthesizes the key conceptual insights from economics for the design of international policies to reduce deforestation and forest degradation and increase reforestation (known as REDD+) as part of the international climate change mitigation effort. Most of the emphasis is on the contribution of economics to the effective design of results-based policies that introduce a price incentive for "strong" states (i.e., those with the institutional capacity to respond effectively to such policies) to address deforestation, degradation, and reforestation. The article also emphasizes how large-scale agreements can minimize leakage and adverse selection, the importance of allocating uncertainty with care, and the need to differentiate clearly among potentially conflicting objectives. It explores the conflicts between cost sharing and efficiency that arise because of private information and the inability of states to make long-term commitments. The article also examines policies that complement price incentives, and, for weak states, policies that can substitute for results-based agreements. (JEL: Q23, Q54, Q56, Q58) Copyright 2013, Oxford University Press.

The Potential for REDD+: Key Economic Modeling Insights and Issues

- Review of Environmental Economics and Policy---2013---Ruben N. Lubowski,Steven K. Rose

This article takes stock of economic modeling tools and findings related to reducing greenhouse gas emissions from deforestation and forest degradation as well as other forestry activities in developing countries (REDD+), and discusses priorities for future research. The economics literature has identified opportunities for significant cost-effective climate change mitigation from both reducing deforestation and enhancing forest carbon stocks. Several studies estimate that including REDD+ could reduce the costs of achieving climate policy goals over both the near and longer terms. Studies also suggest that the near-term potential for REDD+, especially reduced deforestation, could be valuable in support of near-term emissions reduction strategies, hedging against uncertainties, and dampening future carbon market price volatility. However, the literature is evolving. Most early and many recent studies of REDD+ provide optimistic benchmark estimates, based on ideal, but unrealistic, assumptions about policies and institutions. The more recent literature, which analyzes dynamics; interactions among forestry activities, regions, and economic sectors; implementation requirements and costs; policy designs; and uncertainties suggests a more limited and nuanced mitigation role for REDD+, especially in the near future. There are also important modeling challenges. Together, these real-world complexities and modeling challenges indicate that the actual costs and net environmental benefits of potential REDD+ activities are uncertain and highly dependent on policy and implementation features. (JEL: O13; Q11; Q23; Q24; Q28; Q54; Q58; R14) Copyright 2013, Oxford University Press.

Designing and Implementing Effective REDD + Policies: A Forest Transition Approach

- Review of Environmental Economics and Policy---2013---Arild Angelsen,Thomas K. Rudel

Effective policies to halt deforestation depend critically on the forest context. This article uses a forest transition framework to discuss three forest contexts: remote (core) forest areas, frontier forests, and forest-agriculture mosaics. Just as the drivers and capabilities differ across these three contexts or stages, so too do the appropriate government policies. The first stage represents forests that are protected passively by their

remote location, where the challenge is to maintain low deforestation rates. Thus high priority should be given to avoiding or redesigning infrastructure developments, resettlements, and other large-scale projects that can accelerate deforestation. Clarifying tenure and local forest rights and creating protected areas can also be helpful. In frontier forests, well-defined property rights, if present, provide a basis for using direct incentive and compensation schemes such as payments for environmental services. Avoiding perverse government policies, such as subsidized credit for deforesting activities, would also reduce the high deforestation rates that characterize this second stage. In largely settled forest-agriculture mosaics, government policies can augment emerging market-based incentives to plant trees. Improved agricultural technologies, which at early stages tend to stimulate agricultural land expansion, can also be important at later stages by increasing food production on existing agricultural land. (JEL: O13, Q28, Q54) Copyright 2013, Oxford University Press.

Realistic REDD: Improving the Forest Impacts of Domestic Policies in Different Settings

- Review of Environmental Economics and Policy---2013---Alexander Pfaff,Gregory S. Amacher,Erin O. Sills

Both theory and evidence regarding forest-relevant decisions by various agents suggest that there are significant constraints on the effectiveness of domestic policies for REDD (i.e., in facilitating a reduction in emissions from deforestation and forest degradation). Economic theory and empirical research identify many factors that affect the incentives for forest clearing, thereby limiting the impact of policies intended to alter any one factor. We summarize three theoretical frameworks that could be employed to gain insights into how to improve REDD policy design. Economists commonly use these frameworks to model decisions in many settings that are relevant for forests and REDD: (1) producer profit maximization given market integration, focusing on the spatial distributions of competing land uses; (2) rural household optimization given incomplete markets and household heterogeneity, to explain uses of land and forest; and (3) public optimization given production and corruption responses by private firms, which we illustrate with harvesting concessions and which is affected by decentralization. We also review empirical evidence concerning the impacts of forest conservation, forest-relevant development, and decentralization within the settings described by these models. Both the theory and the evidence suggest that REDD outcomes can be improved by designing policy to match its setting--the relevant local agents and institutions. (JEL: Q15, Q24, Q28, Q38, Q54, Q56, Q57, O13, O21, R12, R14, H4) Copyright 2013, Oxford University Press.

Policy Monitor A Preliminary Assessment of the American Recovery and Reinvestment Act's Clean Energy Package -super-1

- Review of Environmental Economics and Policy---2013---Joseph Aldy

The American Recovery and Reinvestment Act included more than $90 billion in strategic clean energy investments intended to promote job creation and deployment of low-carbon technologies. In terms of spending, the clean energy package has been described as the nation's "biggest energy bill in history." This article provides a preliminary assessment of the Recovery Act's clean energy package through a review of the act's rationale, design, and implementation. The article first surveys the policy principles for a clean energy stimulus and describes the process of crafting the clean energy package during the 2008--9 presidential transition. Then the article reviews the initial employment, economic activity, and energy outcomes associated with these energy investments, and it provides a more detailed case study of the Recovery Act's support for renewable power through grants and loan guarantees. The article concludes with a discussion of lessons learned.(JEL: E61, Q48, Q54) Copyright 2013, Oxford University Press.

Reflections--Shaping Water Policy: What Does Economics Have to Offer?

- Review of Environmental Economics and Policy---2013---Frank Convery

This article examines the extensive and evolving literature regarding the economics of water policy. It offers policymakers a way of thinking and a set of skills to (1) identify the least-cost way to reach a particular water quantity or quality objective or set of objectives (e.g., cost effectiveness); (2) assess the benefits--both market related and nonmarket--and costs to society of alternatives (i.e., benefit--cost analysis); (3) understand the role of water prices (providing incentives for conservation and innovation, giving consumers freedom of choice, generating revenues), the level at which they should be set (long-run marginal cost), and the levels at which they are actually set; and (4) create markets for water within and between sectors, recognizing many preconditions must be met if water markets are to work effectively. The article advises policymakers that they can use economics to support the case for those investments and policy initiatives that are likely to yield substantial net benefits and to argue against those that are not, and that prices can be used to manage water resources efficiently. (JEL: H2, H3, Q2, Q3) Copyright 2013, Oxford University Press.

U.S. Cap-and-Trade Markets: Constraining Participants, Transactions, and Prices

- Review of Environmental Economics and Policy---2012---Terry Dinan,Andrew Stocking

The U.S. Congress has recently considered legislation to establish a cap-and-trade program to reduce greenhouse gas emissions. Critics of such a program have raised concerns about its ability to identify allowance prices that minimize the cost of achieving a given reduction and the ultimate acceptability of those prices, even if they are cost minimizing. As a result, legislation has been proposed that includes policies to limit the cap-and-trade market through restrictions on participants, transactions, or allowance prices. Some of these restrictions are in place in other cap-and-trade programs around the world. This article evaluates those limits according to whether they accomplish their desired objective and the extent to which they might generate unintended consequences. We conclude that prohibitions on participants and transactions are unlikely to achieve their objectives and could, in fact, generate costly unintended consequences; however, some restrictions could prove useful. The use of price controls may achieve policymakers' objectives but, depending on how they are implemented, might also have unanticipated and undesirable effects. (JEL: D02, D78, G18, H23, P48) Copyright 2012, Oxford University Press.

Alternative Policies to Increase Recycling of Plastic Water Bottles in the United States

- Review of Environmental Economics and Policy---2012---W Viscusi,Joel Huber,Jason Bell

Using an original, nationally representative sample of plastic water bottle users, this article examines the efficacy of various policy mechanisms to increase recycling. We evaluate the impact of bottle deposits and the stringency of a state's recycling laws on the provision of recycling opportunities and on recycling rates. Using household-level data and controlling for the type of recycling legal regime as well as the bottle deposit policies in each state, we find that mandated separation of recyclables, the availability of a recycling center in the community, and the provision of curbside pickup at houses or recycling locations at apartments increase recycling rates. Furthermore, we show that recycling opportunities are substitutes for each other. For example, although deposits for plastic water bottles and curbside recycling separately increase recycling rates, their impacts are each less pronounced if both policies are in place. Moreover, the efficacy of these policies exhibits a discontinuous effect on household behavior, with effective laws and deposit policies transforming nonrecyclers into diligent recyclers. An examination of two states before and after their deposit laws were altered to include plastic water bottles shows that changes in recycling laws do generate changes in recycling behavior. (JEL: Q28, K32) Copyright 2012, Oxford University Press.

Introduction to the Symposium on Rights-Based Fisheries Management

- Review of Environmental Economics and Policy---2012---Christopher Costello

Increasing levels of fisheries collapse are now widely believed to be the consequence of ineffective centralized management of the common pool. In theory, realigning incentives for ecologically sustainable and economically prosperous fisheries requires assigning property rights to the resource, which will then encourage owners to internalize the effects on sustainability of current resource management decisions. In fisheries, property rights can be assigned in a variety of ways, including rights to harvest a certain fraction of the allowable catch (individual transferable quotas, ITQs), rights to exclusive harvest within a given geographic region (territorial use rights fisheries, TURFs), and rights to manage a resource stock collaboratively through a group with well-defined membership (cooperatives). The relative performance of each of these approaches will, at least in principle, depend on the specifics of the fishery in question, suggesting that correctly designing property rights institutions to match the fishery context is crucial to success. Copyright 2012, Oxford University Press.

Property Rights in Fisheries: How Much Can Individual Transferable Quotas Accomplish?

- Review of Environmental Economics and Policy---2012---Ragnar Arnason

Individual transferable quotas (ITQs) are one of the property rights instruments that have been employed to improve economic efficiency in fisheries. ITQs are not high-quality property rights in the basic fundamental marine resources on which fisheries are based. As a result ITQs cannot be expected to generate full efficiency in the use of these resources. This article examines to what extent ITQs are capable of generating economic efficiency in fisheries. It is shown that ITQs can greatly improve efficiency in fishing. Moreover, by including recreational fishers in the system, ITQs can strike an efficient balance between commercial and recreational fishing. On the negative side, it is shown that on their own, ITQs are not capable of generating full efficiency in fisheries. In particular, ITQs are not sufficient for setting the socially optimal total allowable catch, ensuring the optimal use of the ecosystem, or harmonizing fishing with conflicting uses of marine resources such as marine tourism, mining, and conservation. Potentially counteracting these limitations, ITQ holders as a group have an incentive to manage overall ecosystem use for the long-term benefit of their fishery and negotiate the adjustment of their fishing activity toward the interests of conflicting uses of the marine resources. (JEL: Q2, Q22, Q26, Q3). Copyright 2012, Oxford University Press.

The Economics of Territorial Use Rights Fisheries, or TURFs

- Review of Environmental Economics and Policy---2012---James Wilen,José Cancino,Hirotsugu Uchida

The most recent stage in the evolution of fisheries management institutions has been the adoption of so-called rights-based management schemes that grant secure rights of access to users so they are not forced to compete wastefully under open access conditions. The most common rights-based system is the individual transferable quota that grants fishermen rights to a share of a biologically determined total harvest. Another rights-based system is the harvester cooperative that grants access rights to a group. Unlike these species-based rights systems, territorial use rights fisheries, known as TURFs, are place-based, allocating some or all resources within a designated coastal zone to one or more agents. This article discusses the deficiencies of species-based systems and the advantages of place-based systems and reviews experience with TURFs in Japan and Chile. We argue that the success of TURFs depends not only on their physical design and placement, but also on the governing institutions that make internal resource use decisions. In most applications, TURFs are governed by harvester cooperatives that generate value by mitigating common property incentives and resolving internal coordination

problems not otherwise addressed by species-based instruments. (JEL: Q2, Q22, Q28) Copyright 2012, Oxford University Press.

Fishery Management by Harvester Cooperatives

- Review of Environmental Economics and Policy---2012---Robert T. Deacon

Managing fisheries by delegating authority to an association of users, often organized as a cooperative, is gaining increased attention as a strategy for implementing rights-based reform. Assigning rights to groups rather than individuals can facilitate coordination and collective action and enable efficiency gains similar to those achieved when a firm organizes inputs centrally. Evidence from developed country fisheries managed by cooperatives indicates that coordination gains can be substantial. Furthermore, these gains often take forms overlooked in the traditional fishery reform literature, including those from enhanced product recovery and quality, improved spatial and temporal deployment of effort, and reduced environmental damage. In developing countries, assigning management responsibility to user groups can facilitate user-based provision of public goods in situations where governments do not function well. Developing country fishery cooperatives commonly provide monitoring and enforcement of access limitations, limits on fishing effort, and actions to conserve shared stocks. This article reviews empirical evidence on the performance of fishery cooperatives in developed and developing countries. A key conclusion is that using a combination of rights-based instruments can achieve efficiencies that cannot be captured by any single instrument. (JEL: Q20, Q22, D23). Copyright 2012, Oxford University Press.

Policy Monitor

- Review of Environmental Economics and Policy---2012---Robin R. Jenkins,Heather Klemick,Elizabeth Kopits,Alex Marten

Over the past five decades, the U.S. government has enacted laws and developed regulations to respond to actual and threatened releases of hazardous substances. This article describes a relatively understudied component of the nation's response capability: the Superfund Emergency Response and Removal Program. This program addresses a wide range of threats, complicating efforts to assess its net benefits. We examine a new dataset of 113 recent removal actions at 88 sites in the U.S. Mid-Atlantic region and find a great deal of diversity across sites, from the causes of contamination to the types of risks and the cleanup strategy. Contamination most frequently resulted from improper disposal, handling, or storage of materials. Soil, air, groundwater, and surface water contamination were prevalent at these sites, but risks from not yet released contained contaminants and potential fire or explosion were also common. We describe the involvement of potentially responsible parties and examine EPA expenditures on removal actions. Finally, we consider challenges for future research into the net benefits of the program. (JEL: H1, Q5) Copyright 2012, Oxford University Press.

Reflections--In Search of Crosswalks between Macroeconomics and Environmental Economics

- Review of Environmental Economics and Policy---2012---V. Smith

This article considers the challenges for efforts to introduce environmental quality into modern macro models. These models describe the economy as a dynamic general equilibrium, often using a representative agent to characterize consumers. Macro models are calibrated using a composite of existing parameter estimates, accepted features of developed economies, and data on the economy of interest together with the conditions for a decentralized dynamic equilibrium. The task of introducing non-market goods into these models requires using consistent aggregate measures of environmental quality. This Reflections column focuses on the issues associated with this research challenge. It also examines the static general equilibrium analysis used in EPA's 2011 Prospective Analysis as a way to highlight the importance of addressing these issues. (JEL: Q50, Q58). Copyright 2012, Oxford University Press.

Progress and Challenges in Valuing Coastal and Marine Ecosystem Services

- Review of Environmental Economics and Policy---2012---Edward Barbier

Coastal and marine ecosystems (CMEs) generate some of the most important services to humankind, but they are endangered from overexploitation and loss. The widespread decline in CME services suggests that it is important to understand what is at stake in terms of the critical benefits and values of these services. This article examines how environmental and resource economics has contributed to our knowledge of CME services and discusses progress as well as challenges in valuing these services. The article highlights case studies in which the economic valuation of key CME services has influenced policy decisions concerning the management of CMEs. Two key features of CME benefits are also examined. First, the natural spatial variability in these systems can influence the economic value of CME services. Second, because they occur at the interface between watersheds, the coast, and open water, CMEs can produce cumulative and synergistic benefits across the entire seascape that are much more significant and unique than the services provided by any single ecosystem. Copyright 2012, Oxford University Press.

Forest Figures: Ecosystem Services Valuation and Policy Evaluation in Developing Countries

- Review of Environmental Economics and Policy---2012---Paul Ferraro,Kathleen Lawlor,Katrina L. Mullan,Subhrendu Pattanayak

We review the evidence on the economic values of forest ecosystem services in developing nations and the effectiveness of policies aimed at protecting these services. We conclude that, despite a plethora of publications, the literature is thin, with few well-designed studies that can provide a coherent picture of ecosystem values or policy effectiveness. Although ecologists coined the term ecosystem services and have led much of the recent research, ecosystem services is fundamentally an economic concept. This offers economists a unique and important opportunity to contribute to the emerging literature on ecosystem valuation and policy effectiveness. Most importantly, we conclude that the most fruitful path for future inquiry is to more tightly integrate policy and research by conducting studies that combine nonmarket valuation and impact evaluation (i.e., valuation estimates based on observed impacts in the context of real-world programs). We believe that investing scarce research funds in such an integrated approach will increase the likelihood that future research on ecosystem services will yield high-quality evidence of practical use to policymakers. Copyright 2012, Oxford University Press.

Evaluating Policies to Increase Electricity Generation from Renewable Energy

- Review of Environmental Economics and Policy---2012---Richard Schmalensee

Building on a review of experience in the United States and the European Union, this article advances four main propositions concerning policies aimed at increasing electricity generation from renewable energy. First, who bears the short-run costs of programs to subsidize the generation of electricity from renewable sources varies with the organization of the electric power industry, and this variation may be a significant contributor to such programs' political attractiveness in U.S. states. Second, despite the greater popularity of feed-in tariff schemes worldwide, renewable portfolio standard (RPS) programs may involve less long-run social risk. Third, in contrast to the European Union's approach to reducing carbon dioxide emissions, its renewables program is almost certain not to minimize the cost of achieving its goals. Fourth, state RPS programs in the United States are also almost certain to cost more than necessary, even though most use market mechanisms. To support this last proposition I provide a fairly detailed description of actual markets for renewable energy credits and their shortcomings. Copyright 2012, Oxford University Press.

Three Key Elements of a Post-2012 International Climate Policy Architecture

- Review of Environmental Economics and Policy---2012---Sheila M. Olmstead,Robert Stavins

This article describes three essential elements of an effective post-2012 international climate policy architecture: a framework to ensure that key industrialized and developing nations are involved in differentiated but meaningful ways, an emphasis on an extended time path for emissions targets, and the inclusion of flexible market-based policy instruments to keep costs down and facilitate international equity. This overall architecture is consistent with fundamental aspects of the science, economics, and politics of global climate change; addresses specific shortcomings of the Kyoto Protocol; and builds on the foundation of the United Nations Framework Convention on Climate Change. Copyright 2012, Oxford University Press.

Politically Feasible Emissions Targets to Attain 460 ppm CO 2 Concentrations

- Review of Environmental Economics and Policy---2012---Valentina Bosetti,Jeffrey Frankel

A new climate change treaty must address three current gaps: the absence of emissions targets extending far into the future; the absence of participation by the United States, China, and other developing countries; and the absence of reasons to expect compliance. Moreover, to be politically acceptable, a post-Kyoto treaty must recognize certain constraints regarding country-by-country economic costs. This article presents a framework for assigning quantitative emissions allocations across countries, one budget period at a time, through a two-stage plan: (a) China and other developing countries accept targets at business-as-usual (BAU) levels in the coming budget period, and, during the same period, the United States agrees to cuts below BAU; (b) all countries are asked to make further cuts in the future in accordance with a formula that includes a Progressive Reductions Factor, a Latecomer Catch-up Factor, and a Gradual Equalization Factor. An earlier proposal (Frankel 2009) for specific parameter values in the formulas achieved the environmental goal that carbon dioxide (CO 2) concentrations plateau at 500 ppm by 2100. It met our political constraints by keeping every country's economic cost below thresholds of Y = 1 percent of income in Present Discounted Value, and X = 5 percent of income in the worst period. The framework proposed in this article attains a stricter concentration goal of 460 ppm CO 2 but only by loosening the political constraints. Copyright 2012, Oxford University Press.

Linking Policies When Tastes Differ: Global Climate Policy in a Heterogeneous World

- Review of Environmental Economics and Policy---2012---Gilbert Metcalf,David Weisbach

In this article we discuss the mechanics of linking different types of climate change policies and identify areas where linkage will be difficult. Our goal is to identify opportunities for constructive linkage and policy choices that may limit or hinder linkage. We argue that the basic approach underlying emission reduction credit systems like the Kyoto Clean Development Mechanism (CDM) and Joint Implementation can be extended to create linkage opportunities in diverse emission control systems in ways that do not necessarily suffer from the shortfalls of the current CDM. Moreover, although emission reduction credit systems are designed to work with market-based systems like cap and trade, we describe ways in which they can also interact with tax systems as well as certain regulatory systems. Copyright 2012, Oxford University Press.

U.S. Environmental Protection Agency Valuation of Surface Water Quality Improvements

- Review of Environmental Economics and Policy---2012---Charles Griffiths,Heather Klemick,Matt Massey,Chris Moore,Steve Newbold,David Simpson,Patrick Walsh,William Wheeler

Since 1982, the U.S. Environmental Protection Agency has used benefit-cost analysis to evaluate many of its surface water quality regulations. Early regulations

were aimed at controlling conventional and toxic pollutants that were directly linked to highly visible water quality problems. More recent regulations have focused on "unconventional" water quality stressors or more subtle distinctions in water quality. While a number of national-scale water quality models have been used over the years, there has been less exploration of economic models to estimate benefits. This article addresses three issues that have been particularly challenging in estimating the benefits from water quality improvement: defining standardized measures of water quality improvement, measuring benefits arising from ecological protection and restoration, and measuring nonuse benefits. Copyright 2012, Oxford University Press.

Reflections--Defining and Measuring Sustainability

- Review of Environmental Economics and Policy---2012---Geoffrey Heal

I review the concept of sustainability and the various approaches to quantifying it. My focus is on the role that natural capital plays in supporting human welfare, the extent to which there are substitutes for it in this role, and how this is reflected in sustainability measures. Copyright 2012, Oxford University Press.

A Word from the Editor

- Review of Environmental Economics and Policy---2011---Charles Kolstad

2011

Divergences in Long-Run Trends in the Prices of Energy and Energy Services

- Review of Environmental Economics and Policy---2011---Roger Fouquet

This article presents new evidence on very long-run trends in the prices of energy and energy services, such as heat, power, transport, and light, using seven hundred years of data for the United Kingdom. The article has two main findings. First, it shows that, in general, there was an upward trend in average energy prices before the Industrial Revolution and a decline afterward, which was associated with the shift from traditional energy sources to fossil fuels. In the second half of the twentieth century, however, average energy prices did rise, reflecting not so much rising resource scarcity as greater value to consumers, as consumers shifted to energy sources that provided the desired services more efficiently. Second, the article highlights the dangers of focusing on the price of energy rather than the price of energy services when considering the long run. The price of energy ignores major technological improvements and their benefits to the consumer. This failure to focus on energy services is likely to lead to incorrect estimates of consumer responsiveness to changes in price and income. The article suggests that the inclusion of service prices and consumption variables would lead to more reliable models of long-run energy demand and forecasts of carbon dioxide emissions. (Copyright 2011, Oxford University Press.

An Integrated Assessment of Water Markets: A Cross-Country Comparison

- Review of Environmental Economics and Policy---2011---R. Quentin Grafton,Gary Libecap,Samuel McGlennon,Clay Landry,Bob O'Brien

This article presents an integrated framework for assessing water markets in terms of their institutional foundations, economic efficiency, and environmental sustainability. This framework can be a tool for (a) comparing different water markets, (b) tracking performance over time, and (c) identifying ways in which water markets might be adjusted by policy makers to achieve desired goals. The framework is used to identify the strengths and limitations of five water markets: (a) Australia's Murray-Darling Basin, (b) the western United States, (c) Chile (in particular the Limarí Valley), (d) South Africa; and (v) China (in particular, the North). The framework helps identify which of these water markets are currently able to contribute to integrated water resource management, which criteria underpin these markets, and which features of these markets may require further development. The find-

ings for each market, as well as comparisons between them, provide general insights into water markets and how water governance can be improved. Copyright 2011, Oxford University Press.

The Economics of Tail Events with an Application to Climate Change

- Review of Environmental Economics and Policy---2011---William Nordhaus

From time to time, something occurs that is outside the range of what is normally expected. This is called a tail event in the sense that it is way out the tail of a probability distribution. This article considers the implications of tail events for economic policy and climate change economics. This issue has been analyzed by Martin Weitzman , who has proposed a dismal theorem. The theorem's general point is that under limited conditions concerning the structure of uncertainty and preferences, society has an indefinitely large expected loss from high-consequence, low-probability events and that standard economic analysis does not apply. The present article is intended to put the dismal theorem in context and examine the extent of its relevance with regard to climate change. There are indeed deep uncertainties about virtually every aspect of the natural and social sciences of climate change, and the only way these uncertainties can be resolved is through continued careful consideration and analysis of all data and theories. I conclude that tail events are important phenomena that require careful analysis and attention. At the same time, I find that there is no universal rule for determining when benefit--cost analysis should or should not be applied. (JEL: Q5, D8, D8) Copyright 2011, Oxford University Press.

Fat Tails, Thin Tails, and Climate Change Policy

- Review of Environmental Economics and Policy---2011---Robert Pindyck

Climate policy is complicated by the considerable uncertainties concerning the benefits and costs of abatement. We do not even know the probability distributions for future temperatures and impacts, making benefit--cost analysis based on expected values challenging to say the least. There are good reasons to believe that those probability distributions are fat-tailed, which implies that if social welfare is based on the expectation of a constant relative risk aversion utility function, then we should be willing to sacrifice close to 100 percent of gross domestic product to reduce greenhouse gas emissions. I argue that unbounded marginal utility makes little sense and that once we put a bound on marginal utility, this implication of fat tails goes away: Expected marginal utility will be finite even if the distribution for outcomes is fat-tailed. Furthermore, depending on the bound on marginal utility, the index of risk aversion, and the damage function, a thin-tailed distribution can actually yield a higher expected marginal utility (and thus a greater willingness to pay for abatement) than a fat-tailed one. Copyright 2011, Oxford University Press.

Fat-Tailed Uncertainty in the Economics of Catastrophic Climate Change

- Review of Environmental Economics and Policy---2011---Martin Weitzman

In this article, I revisit some basic issues concerning structural uncertainty and catastrophic climate change. My target audience here are general economists, so this article could also be viewed as a somewhat less technical exposition that supplements my previous work. Using empirical examples, I argue that it is implausible that low-probability, high-negative impact events would not much influence an economic analysis of climate change. I then try to integrate the empirical examples and the theory together into a unified package with a unified message that the possibility of catastrophic climate change needs to be taken seriously. Copyright 2011, Oxford University Press.

Policy Monitor--Greenhouse Gas Regulation under the Clean Air Act: A Guide for Economists

- Review of Environmental Economics and Policy---2011---Dallas Burtraw,Art Fraas,Nathan Richardson

Until recently, most attention to U.S. climate policy has focused on legislative efforts to introduce a price on carbon through cap and trade. In the absence of such legislation, the Clean Air Act is a potentially effective vehicle for achieving reductions in greenhouse gas (GHG) emissions. Decisions regarding existing stationary sources will have the greatest effect on emissions reductions. Although the magnitude of reductions is uncertain, it is plausible that a 10 percent reduction in GHG emissions from 2005 levels could be achieved at moderate costs by 2020. This is comparable to domestic emissions reductions that would have been achieved under the Waxman--Markey legislation. These measures do not include the switching of fuels, which could yield further reductions. The ultimate cost of regulation under the Act hinges on the stringency of standards and the flexibility allowed. A broad-based tradable performance standard is legally plausible and would provide incentives comparable to the proposed legislation, at least in the near term. Copyright 2011, Oxford University Press.

Reflections--In Praise of Consilience

- Review of Environmental Economics and Policy---2011---Tom Tietenberg

Consilience refers to the linking together of principles from different disciplines to form new constructs. How important has consilience been in bringing new ideas to the management of natural resources and the environment? To what extent has it influenced modes of analysis and policy? These are the questions I examine in this "Reflections" column. Ultimately, I find that the cross-fertilization of ideas has been quite important in creating a number of innovative new methodologies, new perspectives, and even new policy instruments. Using a host of specific examples, I show not only how economics has been enriched by ideas that originated in other disciplines but also how economics has enriched other disciplines concerned with the management of natural resources and the environment. I close by sharing some thoughts on the conditions under which consilience can prosper as well as some thoughts on the future. Copyright 2011, Oxford University Press.

The Impact of REEP

- Review of Environmental Economics and Policy---2011---Charles Kolstad,Carlo Carraro,Mathew E. Kahn,Robert Stavins

2011

The Effectiveness of Environmental Monitoring and Enforcement: A Review of the Empirical Evidence

- Review of Environmental Economics and Policy---2011---Wayne Gray,Jay Shimshack

Regulatory punishment for pollution violations is a mainstay of nearly every industrialized nation's environmental policy. This article reviews the existing empirical evidence on the impacts of environmental monitoring and enforcement actions. We first provide context by investigating the U.S. regulatory setting. We then briefly discuss how economists think about environmental enforcement. We next consider recent empirical evidence linking regulator actions to subsequent pollution discharges and compliance behavior. Since the literature primarily studies U.S. institutions, our review focuses mainly on the effects of Environmental Protection Agency and U.S. state activities. The consistent findings from this literature review are as follows: (1) environmental monitoring and enforcement activities generate substantial specific deterrence, reducing future violations at the targeted firm; (2) environmental monitoring and enforcement activities generate substantial general deterrence, reducing future violations at facilities other than the targeted one; and (3) environmental monitoring and enforcement activities generate not only reductions in violations but also significant reductions in emissions. We conclude by discussing policy implications and identifying gaps in the current state of knowledge. Copyright 2011, Oxford University Press.

Carbon Allowance Auction Design: An Assessment of Options for the United States

- Review of Environmental Economics and Policy---2011---Giuseppe Lopomo,Leslie M. Marx,David

McAdams,Brian Murray

Carbon allowance auctions are a component of existing and proposed regional cap-and-trade programs in the United States and are also included in recent proposed bills in the U.S. Congress that would establish a national cap-and-trade program to regulate greenhouse gases ("carbon"). We discuss and evaluate the two leading candidates for auction format: a uniform-price sealed-bid auction and an ascending-bid dynamic auction, either of which could be augmented with a "price collar" to ensure that the price of allowances is neither too high nor too low. We identify the primary trade-offs between these two formats as applied to carbon allowance auctions and suggest additional auction design features that address potential concerns about efficiency losses from collusion and other factors. We conclude that, based on currently available evidence, a uniform-price sealed-bid auction is more appropriate for the sale of carbon allowances than the other leading auction formats, in part because it offers increased robustness to collusion without significant sacrifice of price discovery. Copyright 2011, Oxford University Press.

What Long-Term Road Transport Future? Trends and Policy Options

- Review of Environmental Economics and Policy---2011---Stef Proost,Kurt Van Dender

This article examines long-term trends and broad policy options and challenges related to the road transport sector and its congestion and environmental impacts. A brief review of long-term projections of demand for road transport suggests that problems related to road network congestion and greenhouse gas (GHG) emissions are likely to become more pressing in the future than they are now. Next we review, from a macroscopic perspective, three policy measures aimed at addressing these problems: stimulating shifts in transport modes to decrease congestion and GHG emissions, boosting low-carbon technology adoption to reduce GHG emissions, and regulating land use to reduce road transport volumes. We find that although these policies can produce tangible results, they may also have unintended and costly consequences. Copyright 2011, Oxford University Press.

Reducing Urban Road Transportation Externalities: Road Pricing in Theory and in Practice

- Review of Environmental Economics and Policy---2011---Alex Anas,Charles Lindsey

Urban road transportation creates several externalities, the most important of which are congestion (time delay and extra fuel consumption), accidents, pollution, and greenhouse gas emissions. Road pricing is widely promoted as a tool to reduce these externalities. Based on a review of theory as well as experience with existing schemes, this article draws four conclusions about urban road pricing: (1) the benefits of road pricing exceed the costs; (2) the benefits of congestion relief are larger than the benefits of improvements in environmental quality; (3) success depends in part, but only to a limited extent, on the presence of public transit and on how service is adjusted; and (4) the distributional effects and public acceptance of road pricing pose important challenges for policy design. Copyright 2011, Oxford University Press.

Automobile Fuel Economy Standards: Impacts, Efficiency, and Alternatives

- Review of Environmental Economics and Policy---2011---Soren Anderson,Ian Parry,James Sallee,Carolyn Fischer

This article discusses automobile fuel economy standards in the United States and other countries. We first describe how these programs affect the automobile market, including impacts on fuel consumption and other dimensions of the vehicle fleet. We then review two different methodologies for assessing the costs of fuel economy programs--engineering and market-based approaches--and discuss what the results of these assessments imply for policy. Next we compare the welfare effects of fuel economy standards and fuel taxes and discuss whether these two types of policies can be complementary. Finally, we review arguments for transi-

tioning away from fuel economy regulations and toward a "feebate" system, a policy approach that imposes fees on vehicles that are fuel inefficient and provides rebates to those that are fuel efficient. Copyright 2011, Oxford University Press.

Invention and Transfer of Climate Change--Mitigation Technologies: A Global Analysis

- Review of Environmental Economics and Policy---2011---Antoine Dechezleprêtre,Matthieu Glachant,Ivan Haščič,Nick Johnstone,Yann Ménière

This article uses the European Patent Office Worldwide Patent Statistical Database to examine the geographic distribution and global diffusion of inventions in thirteen climate-mitigation technologies since 1978. The data suggest that until 1990 innovation was driven mostly by energy prices. Since then, environmental policies, and, more recently, climate policies, have accelerated the pace of innovation. The data also indicate that innovation is highly concentrated in three countries--Japan, Germany, and the United States--which together account for 60 percent of total inventions. Surprisingly, the contribution of emerging economies is far from negligible as China and Brazil together account for about 10 percent of total inventions. However, inventions from emerging economies are less likely to find markets beyond their borders, suggesting that inventions from emerging economies have less value. More generally, international transfers occur mostly between developed countries (73 percent of all exported inventions). Exports from developed countries to emerging economies are still limited (22 percent) but are growing rapidly, especially to China. Copyright 2011, Oxford University Press.

International Technology Transfer, Climate Change, and the Clean Development Mechanism

- Review of Environmental Economics and Policy---2011---David Popp

As the developed world begins efforts to limit its emissions of greenhouse gases, economic growth in developing countries is causing increased emissions from the developing world. Reducing these emissions while still enabling developing countries to grow requires the use of climate-friendly technologies in these countries. In most cases, these technologies are first created in high-income countries. Thus, the challenge for climate policy is to encourage the transfer of these climate-friendly technologies to the developing world. This article reviews the economic literature on environmental technology transfer and discusses the implications of this literature for climate policy, focusing on the Clean Development Mechanism (CDM). A key point is that technology diffusion is gradual. Early adoption of policy by developed countries leads to the development of new technologies that make it easier for developing countries to reduce pollution as well. Since clean technologies are first developed in the world's leading economies, international trade and foreign investments provide access to these technologies. Moreover, evidence suggests that some technologies, such as those enhancing energy efficiency, will diffuse to developing countries even without the aid of policy prescriptions, such as the CDM. This is important for assessing the potential emissions reductions of proposed CDM projects. Copyright 2011, Oxford University Press.

Managing Natural Catastrophe Risk: State Insurance Programs in the United States

- Review of Environmental Economics and Policy---2011---Carolyn Kousky

This article surveys state-mandated programs in the United States aimed at providing natural catastrophe insurance to property owners and businesses unable to find policies in the private market. The article provides an overview of ten state programs that offer wind or earthquake coverage and outlines the motivation for establishing such programs. The implications of design and operation decisions, such as pricing strategies and contract options, are discussed, as well as how these programs interact with the private property insurance market. Finally, the article examines whether such

programs can handle a truly catastrophic loss year and describes proposals for federal support of these programs. Copyright 2011, Oxford University Press.

Reflections--Energy Efficiency Literature for Those in the Policy Process

- Review of Environmental Economics and Policy---2011---Frank Convery

It is important for policy makers to understand the extent to which the purported benefits of energy efficiency are real, and how they can be achieved. This "reflections" aims to help the policy community understand how the literature can assist them in assessing the opportunities, challenges, and choices they face as they consider how to develop and implement an energy efficiency policy agenda. The article examines what is meant by energy efficiency, how energy performance is generally evaluated, and why energy efficiency is generally presented as such a great opportunity. This is followed by discussions of the importance of understanding market failures and addressing the external benefits of energy efficiency, and the importance of understanding prices and price expectations. The article concludes with some guidelines for designing coherent and effective energy efficiency policies. Because the article is aimed particularly at assisting policymakers, much of the discussion, especially the lessons for policy, are directed to "you," the reader as policymaker. Copyright 2011, Oxford University Press.

Euthanizing the Value of a Statistical Life

- Review of Environmental Economics and Policy---2010---Trudy Cameron

For economists, the term "value of a statistical life" (VSL) is an eminently reasonable label for the concept it describes. However, outside our discipline, this terminology has been singularly unhelpful. This article argues that there could be a considerable reduction in wasted resources if economists were to change this terminology to something less incendiary, and that this could help to increase the acceptance of benefit--cost analysis as an input to the decision-making process for environmental, health, and safety regulations. I propose that we change our standard unit of measurement and replace the VSL terminology with "willingness to swap (WTS) alternative goods and services for a microrisk reduction in the chance of sudden death." Analogous terminology would be used for other types of risks to life and health. I also argue that economists' continual pursuit of a single number for "the" VSL is misguided and can be misleading, especially if individual WTS is correlated with the magnitudes of the risk changes. Such "one-size-fits-all" VSLs also hinder our ability to understand the distributional consequences of risk-reducing policies or interventions. Estimates of aggregate risk reduction benefits need to reflect the particular type of risk reduction as well as the characteristics of the affected populations. Copyright 2010, Oxford University Press.

The Economics of Managing Scarce Water Resources

- Review of Environmental Economics and Policy---2010---Sheila M. Olmstead

This article surveys the literature on the economics of water scarcity and water demand. We examine demand estimation in diverted uses (urban, agricultural, and industrial), as well as the demand for instream uses such as recreation and habitat preservation. The article also assesses what is known about efficient water pricing, water allocation, and water trading within and across sectors. The literature examining the efficiency and distributional impacts of large water projects such as dams for irrigation and hydroelectric power is also discussed. Water conservation is examined from the perspective of efficiency and cost-effectiveness. We highlight water management issues to which economics has made important contributions, as well as areas where further research is needed. Copyright 2010, Oxford University Press.

The Role of the Organization for Economic Cooperation and Development in Environmental Policy Making

- Review of Environmental Economics and Policy---2010---Kenneth G. Ruffing

This article examines the role of the Organization for Economic Cooperation and Development (OECD) in providing information, analysis, and recommendations to facilitate effective and efficient environmental policy making in its member countries. It describes the OECD's organizational and operational structure and processes in the environmental area. Past and current efforts to promote environmental and economic policy integration are also discussed, including the role of political economy issues, as well as policy principles and instruments such as the polluter-pays principle, the user-pays principle, benefit--cost analysis, and the OECD's approach to sustainable development. OECD activities to generate and disseminate data and other information for environmental decision making are described. The article also examines legal instruments used by the OECD to encourage member countries to improve their environmental performance as well as experience with peer pressure, and the environmental performance peer review program in particular, in ensuring compliance with OECD recommendations. The article concludes by suggesting ways in which the OECD can better assist member and nonmember partner countries to improve the effectiveness and efficiency of their environmental policies in the future. Copyright 2010, Oxford University Press.

Microeconomic Analysis of Innovative Environmental Programs in Developing Countries

- Review of Environmental Economics and Policy---2010---Jeffrey R. Vincent

Environmental management programs that attempt to cope with institutional weaknesses in developing countries by being less reliant on governments' formal regulatory apparatus are becoming increasingly common. Three leading examples of such innovative programs are (1) public disclosure and voluntary programs to address industrial pollution; (2) programs that inform households about environmental health risks; and (3) payments for environmental services. Although (1) and (2) have reduced emissions of industrial pollutants and household exposure to environmental health risks in some cases, the reductions are small relative to the size of the problems. Conservation benefits from (3) have been similarly small so far. Evidence on the effectiveness of these programs is limited, both because the programs are relatively new and because there has been limited use of rigorous impact evaluation methods. Despite this weak performance record, continued experimentation with innovative programs appears to be warranted, especially if the opportunity cost is not too high in terms of redirecting resources away from formal environmental management programs and if rigorous impact evaluations are built in to determine whether and why innovative programs have worked. Future research needs to pay attention to the great heterogeneity among developing countries (i.e., successful implementation in one country is no guarantee of success elsewhere), and to the relationship of innovative programs to formal environmental management programs. Copyright 2010, Oxford University Press.

Alternative Pollution Control Policies in Developing Countries

- Review of Environmental Economics and Policy---2010---Allen Blackman

Weak environmental regulatory institutions in developing countries often undermine conventional command-and-control pollution control policies. As a result, these countries are increasingly experimenting with alternative approaches aimed at leveraging nonregulatory "green" pressures applied by local communities, capital markets, and consumers. This article reviews three strands of the empirical literature on this trend. The first examines the direct impact of nonregulatory pressures on the environmental performance of developing-country firms. The second and third strands analyze policy innovations in developing countries reputed to leverage these pressures--public disclosure and

voluntary regulation. Overall, these three strands of literature do not provide widespread compelling evidence that alternative pollution control policies spur significant improvements in environmental performance. A handful of reasonably rigorous studies--particularly those concerning public disclosure--present positive results, but are overshadowed by a larger number of studies that present negative, inconclusive, or unconvincing results. Therefore, policy makers would do well to exercise caution in promoting and implementing alternative pollution control tools in developing countries: they are only likely to be effective in certain forms and situations. Copyright 2010, Oxford University Press.

Show Me the Money: Do Payments Supply Environmental Services in Developing Countries?

- Review of Environmental Economics and Policy---2010---Subhrendu Pattanayak,Sven Wunder,Paul Ferraro

Many of the services supplied by nature are externalities. Economic theory suggests that some form of subsidy or contracting between the beneficiaries and the providers could result in an optimal supply of environmental services. Moreover, if the poor own resources that give them a comparative advantage in the supply of environmental services, then payments for environmental services (PES) can improve environmental and poverty outcomes. While the theory is relatively straightforward, the practice is not, particularly in developing countries where institutions are weak. This article reviews the empirical literature on PES additionality by asking, "Do payments deliver environmental services, everything else being equal, or, at least, the land-use changes believed to generate environmental services?" We examine both qualitative case studies and rigorous econometric quasi-experimental analyses. We find that government-coordinated PES have caused modest or no reversal of deforestation. Case studies of smaller-scale, user-financed PES schemes claim more substantial impacts, but few of these studies eliminate rival explanations for the positive effects. We conclude by discussing how the dearth of evidence about PES impacts, and unanswered questions about institutional preconditions and motivational "crowding out," limit the prospects for using international carbon payments to reduce emissions from deforestation and degradation. Copyright 2010, Oxford University Press.

Effects of Information on Environmental Quality in Developing Countries

- Review of Environmental Economics and Policy---2010---E. Somanathan

How does information on environmental risks obtained by individuals in developing countries affect environmental quality? The literature reveals that for issues like water quality and pesticides, information affects individual behavior and risks are reduced through individual action. However, even if information were to become widely available in developing countries, unless regulation is also strengthened, environmental risks will remain at high levels relative to developed countries. While education appears to raise the demand for environmental quality, there is no systematic developing-country evidence that this demand translates into increased supply through the political process and government regulation. Copyright 2010, Oxford University Press.

Policy Monitor

- Review of Environmental Economics and Policy---2010---Hendrik Wolff,Lisa Perry

The European Union (EU) Clean Air Directive is currently among the strictest acts of legislation worldwide concerning PM10 air pollution. The most visible result of the new PM10 legislation has been the rapid adoption of "Low Emission Zones" (LEZs), which define areas that vehicles may enter only if they are classified as low PM10 emitting vehicles. High-polluting vehicles are not allowed to be driven into LEZs. This article describes recent developments in Europe concerning clean air legislation, focusing in particular on particulate matter (PM). The article begins with a discussion of the health impacts of PM, and then traces

the history of ambient PM standards in the EU. After comparing ambient PM standards in the EU with those in the United States, we discuss Germany's implementation of LEZs, including public reaction to the policy. We also provide a brief overview of other urban traffic-related policies aimed at reducing air pollution. Copyright 2010, Oxford University Press.

Reflections--Legacies, Incentives, and Advice

- Review of Environmental Economics and Policy---2010---V. Smith

Lessons from the early literature in environmental economics are used to assess the impact of an early contributor, Ralph C. d'Arge; discuss the prospects for designing incentive-based approaches to encourage private adaptation to climate change; and comment on reforming current practices concerning benefit--cost analyses of major federal rules. Copyright 2010, Oxford University Press.

Introduction to the Issue

- Review of Environmental Economics and Policy---2010---Charles Kolstad

2010

The Environmental Kuznets Curve: Seeking Empirical Regularity and Theoretical Structure

- Review of Environmental Economics and Policy---2010---Richard Carson

In the early 1990s the attention of economists was captured by empirical evidence suggesting that rising income levels in developing countries could be good rather than bad for the environment. This evidence drove a stake into the heart of those opposing growth on environmental grounds. Ultimately, the view that income growth by itself eventually will be good for the environment also appears to be wrong because a causal relationship between income and environmental quality cannot be demonstrated. The original empirical estimates appear fragile at best compared to estimates using more representative datasets, higher-quality data, and more appropriate econometric techniques. More plausible explanations for the observed data revolve around good government, effective regulation, and diffusion of technological change. These factors tend to be related in a diffuse manner with higher income and suggest it is likely, but not inevitable, that a society will choose to reduce pollution levels as it becomes wealthier. Copyright 2010, Oxford University Press.

The Role of Environmental Economics in Recent Policy Making at the European Commission

- Review of Environmental Economics and Policy---2010---J. Delbeke,G. Klaassen,T. van Ierland,P. Zapfel

This article examines the use of environmental economics at the European Commission in recent policy making concerning climate change, energy, and air pollution. In particular, we describe economic analysis of policy options designed to help the European Union (EU) to achieve its objective of reducing greenhouse gas emissions by 20 percent and increasing the share of renewable energy to 20 percent by 2020. This analysis looked at cost-effectiveness and emission trading options as well as equity issues. We also discuss an economic analysis of policy options for including carbon capture and storage (CCS) in the EU Emissions Trading Scheme. The analysis finds that CCS could result in significant cost savings. The additional costs of making CCS mandatory or using subsidies were also estimated. Economic assessments prepared for the revision of the national emission ceiling directive suggest that air pollution objectives can be met at modest costs and that monetary benefits exceed costs. The assessments also find that limiting the additional costs for poorer Member States does not increase overall costs significantly and that when limited to regional zones, emissions trading of air pollutants could save costs but might lead to hot spots. Copyright 2010, Oxford University Press.

The Economics of Water Quality

- Review of Environmental Economics and Policy---2010---Sheila M. Olmstead

This article surveys selected contributions of economics to the literature on water pollution and the regulation of water quality. While not a comprehensive review, the article highlights water pollution issues to which economics has made important contributions, as well as areas in which further research might illuminate critical questions from the perspective of theory, empirics, or applied policy analysis. The focus is on drinking water regulation and provision; water quality standards in local, national, and transboundary settings; and the issue of policy instrument choice for water quality regulation. Copyright 2010, Oxford University Press.

Offshoring Pollution: Is the United States Increasingly Importing Polluting Goods&quest

- Review of Environmental Economics and Policy---2010---Arik Levinson

The question posed by the title of this article has been at the heart of debates about pollution havens, industrial flight to developing countries, and now carbon "leakage." Is the United States increasingly importing goods whose production generates relatively more pollution, rather than manufacturing those goods domestically? The consensus seems to be "yes," at least judging by the many public policies designed to counteract this offshoring of pollution. The evidence, however, is mixed, at least in part because empirical research has focused on a slightly different set of questions. After reviewing this research, I present a simple methodology for answering the specific question asked in the title. Using the World Bank's 1987 inventory of industry-specific U.S. air pollution emissions intensities, Bureau of Economic Analysis input--output tables, and data on U.S. imports, I show that from 1972 to 2001 the composition of U.S. imports shifted toward relatively clean goods, rather than polluting goods. Perhaps more surprising, this "green" shift of U.S. imports is even larger than the corresponding green shift of U.S. domestic manufacturing. Based on this analysis, the article concludes that over the past thirty years, the United States does not appear to have been offshoring pollution by importing polluting goods. Copyright 2010, Oxford University Press.

Should Trade Agreements Include Environmental Policy?

- Review of Environmental Economics and Policy---2010---Josh Ederington

This article examines the extent to which environmental and trade policies should be treated equally, or symmetrically, in international negotiations. It reviews the recent economics literature on trade and the environment to address two questions. First, should trade negotiations include negotiations over environmental policies and the setting of binding environmental standards? Second, if there are grounds for international environmental negotiations, should environmental agreements be explicitly linked to existing trade agreements in the world trading system? Copyright 2010, Oxford University Press.

Does Trade Help or Hinder the Conservation of Natural Resources?

- Review of Environmental Economics and Policy---2010---Carolyn Fischer

Trade exerts important influences on the exploitation and protection of natural resources. Indeed, recognition of this influence is codified in the General Agreement on Tariffs and Trade, which allows exceptions to treaty obligations for measures "relating to the conservation of exhaustible natural resources," motivates the Convention on International Trade in Endangered Species, and underlies the Convention on Biological Diversity. Trade impacts operate through several channels. Trade liberalization changes relative prices, which affects exploitation incentives. Trade can also have broader effects, such as impacts on labor markets and incomes, which may affect demand for resource-intensive products--or for ecosystem services. Trade interacts with, and can influence, the institutions governing the management of natural resources. Finally, trade can also introduce threats to ecosystems, in the form of invasive species. All of these potential impacts pose special challenges for the conservation of renewable resources, which inherently involves dynamic economic and ecological processes. This article

reviews and takes stock of the lessons from the recent economics literature on the links between trade and the conservation of natural resources. Copyright 2010, Oxford University Press.

Policy Monitor

- Review of Environmental Economics and Policy---2010---Bryan Hubbell,Richard V. Crume,Dale M. Evarts,Jeff M. Cohen

The management of air quality in the United States has evolved into a sophisticated array of rules, strategies, and initiatives since the landmark Clean Air Act (CAA) legislation of 1970 and the subsequent creation of the U.S. Environmental Protection Agency (EPA). In particular, the CAA Amendments of 1990 introduced several new programs that have substantially reshaped the nation's approach to air pollution control. This article describes the 1990 CAA Amendments, regulations issued by EPA following their passage, progress made in air quality management in the nearly twenty years since their enactment, and the likely future direction of U.S. air quality management programs at the federal level. Copyright 2010, Oxford University Press.

Reflections--The Economics of Renewable Energy in the United States

- Review of Environmental Economics and Policy---2010---Geoffrey Heal

Greater use of renewable energy is seen as a key component of any move to combat climate change, and is being aggressively promoted as such by the new U.S. administration. Yet there has been little economic analysis of renewable energy. This article surveys the literature on the economics of renewable energy and adds to it. The conclusion is that the main renewables face a major problem because of their intermittency (the wind doesn't always blow nor does the sun always shine) and that this has not been adequately factored into discussions of their potential. Without new storage technologies that can overcome this intermittency problem, much of the decarbonization of the economy will have to come from nuclear, carbon capture and storage (CCS), and energy efficiency, with geothermal and biofuels making small contributions. Nuclear and CCS are not without their problems. New energy storage technologies could greatly increase the role of renewables, but none are currently in sight. Copyright 2010, Oxford University Press.