Ownership Unbundling of Gas Transmission Networks – Theoretical Background and Empirical Evidence

Papier für die Jahrestagung 2009 des Vereins für Socialpolitik, Magdeburg

Christian Growitsch[1] and Marcus Stronzik[1,2]

[1] Scientific Institute for Infrastructure and Communication Services (WIK), Dept. Energy Markets and Energy Regulation, Bad Honnef, Germany

[2] Corresponding author, Scientific Institute for Infrastructure and Communication Services (WIK), Rhoendorfer Str. 68, 53604 Bad Honnef, Germany, phone: +49/2224/9225-83, fax: +49/2224/9225-69, email: m.stronzik@wik.org

January 2009

Abstract

In this paper we analyse empirically the effects of ownership unbundling of gas transmission networks on the level of end-user prices. Based on a panel out of 29 OECD countries over 18 years we apply advanced approaches like the fixed effects estimator with robust standard errors and the corrected Least Squares Dummy Variable estimator (LSDVC) by Bruno (2005). Controlling for the oil price, the GDP, structural parameters of the gas sector as well as for other regulatory variables like ownership structure, degree of market opening and third party access, we find no significant effect of ownership unbundling on prices. Instead, the variable for market opening shows significant influence in the static as well as in the dynamic setting.

Keywords: Gas, networks, regulation, ownership unbundling, panel data

JEL Codes: L95, L43, C23

1 Introduction

The topic of ownership unbundling is of high priority on the political agenda in Europe. Having investigated the gas and electricity sectors, the European Commission was quite unsatisfied with the market outcomes, especially in the gas sector. The current status of unbundling of transmission system operators was identified as one major obstacle to a well functioning market environment (European Commission 2007a), once more confirmed in their most recent benchmarking report (European Commission 2008). With ownership unbundling the company who owns and operates the transmission assets is fully separated from the rest of the system meaning that it has no further claims in retail or production and import. The usual argument for this regulation is that it fosters competition and, therefore, reduces prices being billed to end-users leading to an increased overall welfare. Based on their sector inquiry, in September 2007 the Commission tabled their third legislative package strongly arguing in favour of ownership unbundling of gas and electricity transmission networks as the preferred regulatory regime of vertical disintegration (European Commission 2007b). On the other hand, several network operators and countries, e.g. Germany, are opposing these efforts of the Commission doubting the benefits.

Focusing on gas, theoretical papers on the effects of ownership unbundling hardly exist. Considering studies on the electricity sector, they do not provide a clear picture regarding the benefits of this regulatory measure. The few existing empirical studies find that the overall liberalization of energy markets has generally led to a reduced level of end-user prices. Concerning the regulatory impact of the various measures, they identify different factors crucial for the success of these reforms. These ambiguous results are due to different empirical approaches as well as to the time periods and countries taken into account. As they all use aggregated indictors in order to map the regulatory reforms, the effects of ownership unbundling cannot be separated.

To the best of our knowledge this is the first paper which investigates the isolated effect of ownership unbundling on end-user prices in the gas sector. In doing so, we construct a panel out of 29 OECD countries spanning a time interval of 18 years. We control for the oil price, the GDP, structural parameters of the gas sector like energy supplied as well as for other regulatory variables like ownership structure, degree of market opening and third party access. Using advanced panel approaches like the fixed effects estimator with robust standard errors and the dynamic Least Squares Dummy Variable estimator (LSDVC) by Bruno (2005) which corrects for the small sample bias, we find no significant effect of ownership unbundling on prices for households. Instead, the variable for market opening shows significant influence in the static as well as in the dynamic setting.

The remainder of the paper is organized as follows. First, we start with an overview of theoretical papers analyzing the pros and cons of ownership unbundling. Furthermore,

existing studies empirically assessing regulatory reforms in the energy sector are explained. In section 3 we describe the dataset our panel is based on followed by a presentation of the two methods applied to the panel. Results as well as their interpretation are given in section 5. Finally, we conclude.

2 Literature Overview

The literature overview is divided into two parts. Firstly, we review the main arguments pro and against ownership unbundling coming from economic theory. In the second part, a survey of econometric papers is provided that have assessed empirically the outcome of market liberalisation in the energy sector.

Costs and Benefits of Ownership Unbundling

The discussions around the right organisational regime for gas networks rest on theoretical work in microeconomics with a history of at least 30 years. This research tries to shed light on the causes and consequences of different governance arrangements with the extreme cases of "make" internally through vertical integration or "buy" through the market.[1] With regard to gas transmission networks the latter translates into ownership unbundling as the most stringent form of regulation not allowing the network operator being active in the up- and / or downstream markets.

Currently, not only in the political arena the pros and cons of ownership unbundling are intensively discussed but also in economic literature. We focus on the two hottest topics, competition and investment incentives, as they are the most relevant ones for the following empirical analysis.[2] It should be noted beforehand, that no paper looks explicitly at the gas sector. Some papers deal with electricity only, while others consider more fundamental issues of unbundling not referring to a certain sector.

With regard to competition the main benefit attached to ownership unbundling is that it decreases the network operator's incentive to discriminate between affiliated and independent production and/or retail undertakings and therefore fosters competition (cf. e.g. Vickers 1995). This discrimination potential in an integrated company might be through cross-subsidisation or non-tariff measures. Especially with regard to the latter it is argued that non-discriminatory access to information cannot be assured as there is no

---

[1] In this context, two main branches of research can be distinguished. Neoclassical approaches focus primarily on vertical integration as a response to pre-existing market power problems or as a strategic move to create or enhance market power in up- or downstream markets. Organisational economics, on the other hand, recognize that companies are confronted with a variety of potential transaction costs, contractual and organisational hazards which are related to the specific characteristics of the transactions at issue. For a comprehensive overview of the relevant literature see Joskow (2005).

[2] Further topics not covered here are e.g. the ease and effectiveness of regulation, the facilitation of privatisation, transaction costs, foreign takeovers and regulatory risk. Categorisations of theoretical benefits and costs of ownership unbundling with the corresponding literature are provided by e.g. Mulder and Shestalova (2005), Baarsma et al. (2007) and Pollitt (2007).

effective means of preventing transmission system operators from releasing market sensitive information to the affiliated production or retail company. Joskow and Tirole (2000) study the interlinkage of physical and financial transmission rights and market power in the upstream sector. They show that vertical integration, i.e. if a generators concurrently hold physical transmission rights, increases the ability of the company to exercise market power through withholding of transmission capacity. Therefore, unbundling enhances competition and in turn leads to a better allocative efficiency with lower end-user prices. The stricter the unbundling regime the higher the allocative efficiency favouring ownership unbundling over legal unbundling. This line of argument is supported by a later paper of Joskow (2004). In this context, Aalbers and Baarsma (2005) as well as Mulder et al. (2007) note with regard to ownership unbundling that revenues generated through the sale of the network might be used by the incumbent to take over other companies in the production or retail business reducing competition in these sectors.

One of the drawbacks of separately owned transmission networks is the problem of double marginalisation. Oligopolistic or monopolistic structures in other parts of the value chain might result in a double mark-up billed to consumers. Since vertically integrated or only legally unbundled companies maximize their profit over the whole holding the mark-up occurs only once. Haucap (2007) argues that the double maximisation problem especially applies to the gas sector because of the specific character of investments in long-distance pipelines connected to certain gas fields. While Vickers (1995) – comparing vertical separation vs. integration under access price regulation - finds mixed welfare effects depending on the entry conditions in the downstream market, Bolle and Breitmoser (2006) as well as Höffler and Kranz (2007) suggest that legal unbundling is superior to the other two vertical structures (integration and ownership unbundling) with regard to allocative efficiency. Whereas the argumentation in Bolle and Breitmoser is mainly based on the avoidance of the double mark-up, Höffler and Kranz additionally account for non-tariff discrimination and not only find an internalisation of the double marginalisation but also an output expansion in the downstream market. The latter effect contradicts Joskow and Tirole and is caused by the ability of the incumbent to increase output and therefore profits of the network business through a more aggressive pricing strategy in the downstream market as its true costs are lower than the actual access charge. Bolle and Breitmoser have already been criticised by Pollitt (2007) arguing that they use unrealistic assumptions. According to Pollitt they, inter alia, neglect efficiency improvements through tighter regulation and ignore the impact of unbundling on competition in the downstream market (as in Joskow and Tirole 2000). Both points also apply to Höffler and Kranz.

From a dynamic perspective, end-user prices will also be influenced by investments into the grid. Both, under- and overinvestment into the grid lead to higher end-user prices in the long run. Straight forward, overinvestment drives up network charges due to unnecessary high capital costs. On the other hand, underinvestment results in network congestion not only leading to higher congestion management costs charged to shippers

but also hindering competition especially in the wholesale business. Therefore, the crucial question is which arrangement of the vertical structure of the sector brings about the right investment incentives.

One line of argument is that under ownership unbundling the operator is free in solely optimising the grid without any restrictions imposed by other parts of the value chain. With regard to the electricity market, Léautier (2001) shows that an integrated company restrains from expanding the transmission network properly in order to keep the rents from local market power in the generation sector. The result is in line with the foreclosure argument advocating in favour of vertical separation. On the other hand, Cremer et al. (2006)[3] compare legal and ownership unbundling and conclude that the former is preferable since the transmission operator can better decide about the size of the network when taking into account the interests of its clients. However, the authors neglect the opportunity of the incumbent to discriminate. The reasoning of Cremer et al. goes along with the arguments in favour of vertical integration due to economies of scope. Here, it is with regard to informational asymmetry between the grid company and other parts of the sector as the latter (e.g. retail firms or shippers) might have better information concerning future demand and supply conditions. Last but not least, Bühler et al. (2004) investigate investment incentives in infrastructure quality under different vertical structures. In their basic model with a bilateral monopoly vertical integration has advantages over separation. Allowing for downstream competition and non-linear access charges investment incentives under both regimes become identical.

Empirical Evidence

Table 1 gives an overview of the main features of the existing empirical studies analysing the performance of regulatory reforms in the energy sector. Only the last two mentioned papers focus on gas. Concerning the indicators mapping regulatory reforms, most of the authors use the OECD International Regulation Database.[4]

Steiner (2001) is one of the first applying panel econometrics to this issue. She analyses the impact of liberalisation and privatisation on the prices and the efficiency of electricity generation. Industrial end-user prices are just used as a proxy for wholesale prices. With regard to efficiency, she constructs two measures covering production and reserve capacity. Out of the regulatory indicators the unbundling of generation and transmission, the introduction of third party access and the establishment of a power exchange have a decreasing effect on end-user prices and the ratio of industrial to residential prices, meaning that industry benefits more, while privatisation seems to drive them up both. In the context of unbundling, Steiner only distinguishes vertical integra-

---

3 Among the theoretical papers Cremer et al. (2006) is the only one touching the gas sector in some way. Nevertheless, their modelling approach is claimed at covering the whole range of network industries where gas is just one example.

4 See Conway and Nicoletti (2006) for a detailed description. Further explanations will also be given in the next chapter.

tion from all other forms of unbundling. Furthermore, the approach might suffer from endogeneity and multicollinearity problems. Concerning the former, high prices might have triggered reforms. With regard to the latter, some indicators might not behave independently, e.g. unbundling and the establishment of a power exchange. Moreover, both time variables (time to liberalization and time to privatization) are highly correlated and might be just an indication for a linear time trend.

The paper of Hattori and Tsutsui (2004) is more or less a re-evaluation of Steiner. They enlarge the covered time interval by two years and slightly modify some of the indicators and control variables; e.g., unbundling is still a dummy but now defined as taking the value of one if at least legal unbundling has been established. In contrast to Steiner, they do not regard accounting separation as a form of vertical separation. These rather small adjustments lead to partly different results. While Steiner – based on the Hausman test – prefers the random effects (RE) model for both, the price level and the price ratio, Hattori and Tsutsui advocate for the fixed effects (FE) model in the case of price ratios. Furthermore, they find reverse effects for unbundling and the introduction of a power exchange. In contrast to expectations, both seem to increase end-user prices due the loss of economies of scope as well as problems of market power as the authors argue. The expected price decreasing effect of retail access is confirmed.

Alesina et al. (2005) focus on the impact of reforms on the investment behaviour which is captured by the ratio of investments and capital stock. They look at the aggregate level of three broader sectors, i.e. utilities (electricity and gas), communication (telecommunications and post) and transportation (airlines, road freight and railways). Four indicators of regulation are constructed based on different aggregations of the indicators of the OECD database. In order to distinguish between short-term and long-term effects, lagged endogenous and exogenous variables are employed resulting in a dynamic panel estimation. Especially the reduction of market barriers shows a significant positive influence on the investment behaviour. Furthermore, the authors find non-linear effects meaning that larger regulatory changes tend to outperform several small steps.

The first study on gas is Copenhagen Economics (2005).[5] Instead of using the OECD database Copenhagen Economics develops its own indicator, the so called Market Opening Index (MOI) for each of the 15 European countries. The indicator is scaled between 0 and 1, one indicating full market opening. The MOI is constructed on the basis of nine sub-indices, covering issues like unbundling, access to the grid, tariff structure, regulation of end-user prices, degree of free choice of supplier in the retail market and some information on the market structure, which in turn are based on 48 Market Opening Milestones (MOM). Therefore, the MOM database provides information quite similar to the OECD database. Factor analysis is applied for weighting purposes

[5] The whole study covers seven network industries: electricity, natural gas, telecommunication, postal services, rail passenger transport, rail freight transport, urban transport and air transport. Copenhagen Economics (2005a) describes the fundamental methodology applied to each sector. The results for the various sectors are contained in Copenhagen Economics (2005b).

and to circumvent problems of multicollinearity among the various indicators. The explanatory variables are usually modelled with a lag of one year. Privatisation and competitive tariff structures tend to decrease end-user prices. On the other hand, regulation of these prices show an increasing effect, quite the opposite of what is usually intended with such a regulation. The two indices mapping the unbundling issue are not significant. Due to the high level of aggregation and the high complexity of the overall approach, it is difficult to identify effects of single regulatory measures like the introduction of ownership unbundling.[6] Therefore, results remain vague. Furthermore, the construction of the indicator lacks transparency and seems to be based – at least partly – on individual judgements.

Brau et al. (2007) compare two different sources for industrial end-user prices in the gas sector, Eurostat and IEA. Nominal prices are chosen in combination with the consumer price indices as an additional explanatory variable. In order to map regulatory reforms they employ the OECD database. To circumvent endogeneity problems with lagged dependent variables, they apply the Generalized Method of Moments (GMM) first difference estimator developed by Arellano and Bond (1991) as well as the corrected Least Squares Dummy Variable (LSDVC) estimator by Bruno (2005). With regard to IEA prices vertical separation tends to reduce end-user prices with decreasing returns as the squared indicator also shows significance. This would mean that the first steps to unbundle a formerly integrated company yield higher price reductions than later stages. However, in this context the scaling of the indicator seems to be crucial. Concerning Eurostat prices, additionally public ownership becomes negatively related to price levels.

To sum up, economic theory provides for a mixed picture concerning the pros and cons of ownership unbundling which calls for an empirical assessment of the effects of this regulatory measure. Up to now – at least to the best of our knowledge – no empirical paper exists that isolates the effects of ownership unbundling and evaluates its effectiveness. With our paper we fill this gap trying to support the current discussions with empirical evidence and answering the question whether this action has brought about beneficial outcomes or not.

---

[6] For a similar argument concerning the shortcomings of the MOM database see Brau et al. (2007: 46).

Table 1: Overview of empirical studies[7]

Study	**Cover-age**			**List of Variables**			**Model**
	Countries	*Sector(s)*	*Time*	*Exogenous*	*Regulatory Indicators*	*Control Variables*	

Steiner (2001)	19 OECD	Electricity	1986 - 1996	• End-user prices
				  • Price level industry
				  • Price ratio
				• Sector performance
					• OECD Database
					• Power Exchange
					• Time
						• GDP
						• Share of nuclear power
						• Share of hydro
						• Urbanisation
							• RE
							• FE

Hattori / Tsutsui (2004)	19 OECD	Electricity	1987 - 1999	• End-user prices
				  • Price level industry
				  • Price ratio
					• OECD Database
					• Power Exchange
					• Time
						• GDP
						• Share of nuclear power
						• Share of hydro
							• RE
							• FE

Alesina et al. (2005)	21 OECD	3 Network indus-tries incl. energy	1975 - 1996	• Investments • Capital stock	• OECD Database • Lags	• Dummies (year, sector) • Value added	Dynamic Panel
Copenhagen Economics (2005)	15 EU	Gas	1993 - 2003	• End-user prices in-dustry	• MOM Database • Lags	• Price for heavy fuel oil (lagged)	• Factor analysis • FE with AR(2)
Brau et al. (2007)	15 EU	Gas	1991 - 2003	• End-user prices in-dustry (nominal)	• OECD Database • Squared indicators	• GDP • Domestic gas production • Gas imports and exports • Consumer Price index	• GMM (Arellano / Bond 1991) • LSDV (Bruno 2005)

Source: Own compilation.

[7] Due to the short time period covered (4 years) and some methodological failures (mixing data of different frequency) we neglect a study of Ernst&Young (2006) also providing for an empirical assessment of regulatory reforms in the energy sector.

3 Data

In order to analyse the impact of regulatory reforms on end-user prices with a special focus on ownership unbundling we construct a panel consisting of 29 OECD countries and encompassing the time interval 1989 until 2006. The choice has been made not only for data availability reasons but also for taking into account that changes in gas market regulations has been occurred in most of the countries very recently. In doing so, we focus on prices of household customers which form the endogenous variable in our set-up.[8] As explanatory variables we construct several indicators aiming at mapping the change of the regulatory framework in the various countries as well as some control variables.

End-user Prices

End-user prices for the OECD countries are taken from IEA (2007). The information is given with and without taxes. The latter has been chosen since it omits cross country distortions due to different tax schemes. Furthermore, to allow for comparability across countries and time prices are expressed in USD_{2000} using purchasing power parities (taken from OECD 2008a) and the U.S. consumer price index.

Figure 1 depicts the development for selected countries.[9] The overall picture across countries is rather heterogeneous. Not only the price levels differ substantially, but also the development over time varies a lot. E.g., in 1989 consumers in Ireland had to pay five times more than their counterparts in Finland. Countries like Germany, the U.K. and the U.S. are more or less in the middle of the overall range, but still showing differences in their price paths. Whereas the U.K. and the U.S. can be classified as front runners in timing and stringency regarding market liberalisation, Germany lacks behind, e.g. still struggling establishing liquid trading points that give market participants clear and efficient price signals. Ireland and New Zeeland represent the most obvious pair of contrast concerning the development over time. While the prices in Ireland diminished throughout most of the time, the opposite holds for New Zeeland. At the end of the considered period Irish consumers experienced a huge price increase, again being billed as high prices as at the beginning. New Zeeland solely relies on domestic production without any import infrastructure and residential consumers play only a minor role with a share of less than 5 % regarding nationwide natural gas consumption. Furthermore, there has been no market opening concerning households so far. In Ireland, on the other hand, end-user prices remained constant (in nominal terms) until the end of the last century due to regulation. The steep price increase has been accompanied by a stepwise mar-

---

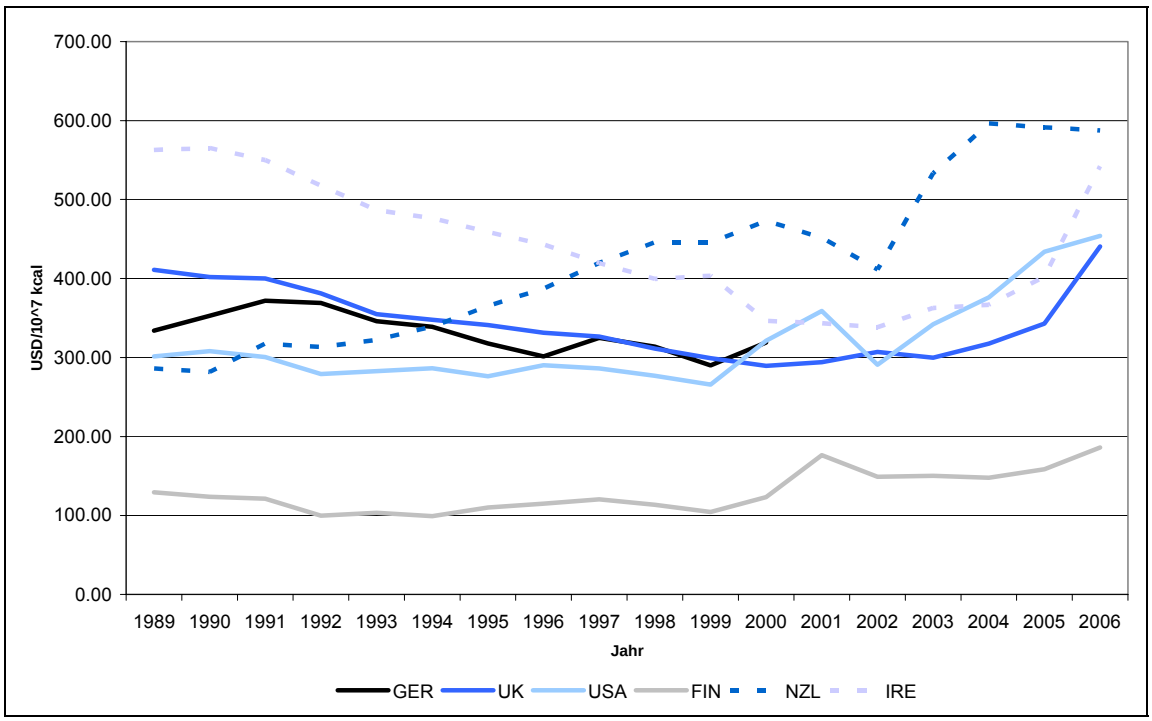
8 Usually, the market liberalisation is a step-wise process, first starting with opening up the segment of large industrial customers for competition and ending with residential consumers. Therefore, it is justified to look only at prices for households as they indicate best the effects of regulatory reforms.

9 Descriptive statistics for all countries can be found in the Annex.

ket opening. Among the countries depicted in Figure 1, only in the U.K. (since 1997) and the U.S. (since 1993) the transmission network is owned by someone not also active in other areas of the value chain (retail and/ or production). In the other countries, different stages of unbundling regimes can be observed. While New Zeeland and Ireland still have vertically integrated transmission network operators, Germany introduced legal unbundling in 2006. Finland, still exempted from the European Gas Directive due to the isolated structure of the system, has implemented an accounting separation in 2001.

This brief survey highlights that there is no straight forward relationship between regulatory reforms and the development of end-user prices for residential customers. Rather, several factors, country specific as well as worldwide, have to be taken into account.

Figure 1: End-user prices of household customers [USD/10^7 kcal]



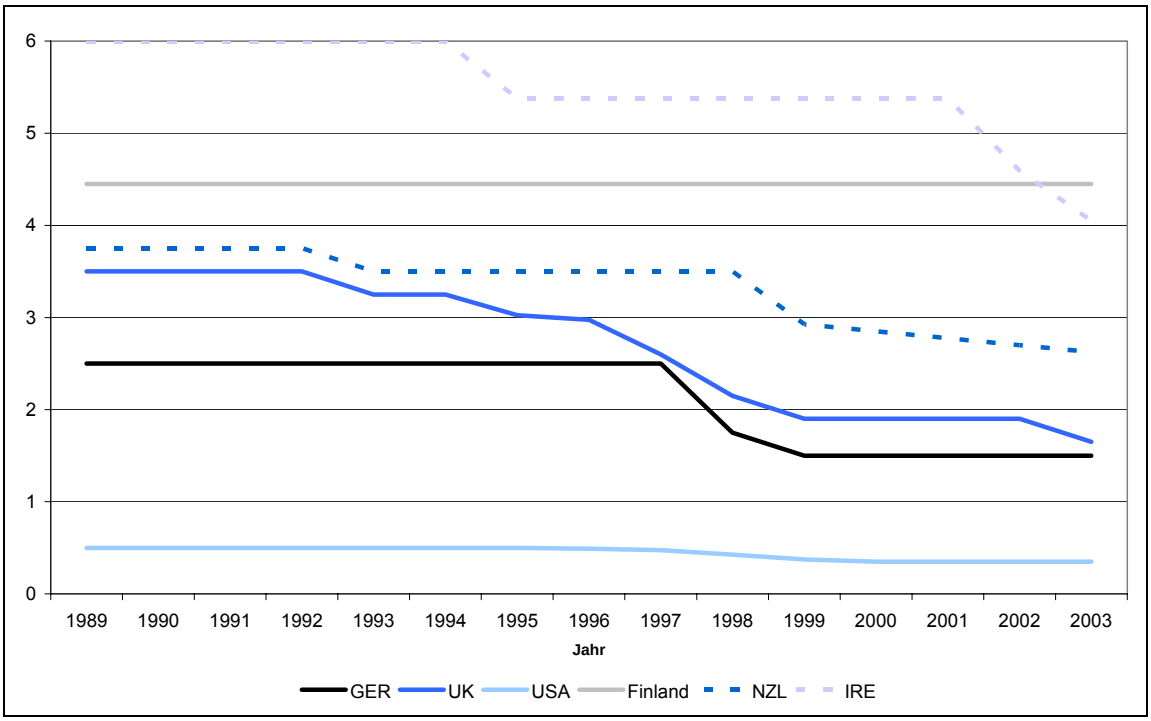
Source: Own calculations based on IEA (2007).

Regulatory Indicators

Starting point is the OECD International Regulation Database as it is used by most of the aforementioned empirical studies and the only database capturing not only European countries. Therefore, it provides for the opportunity to put the analysis on a broader empirical basis and concurrently secures data consistency. In contrast to most of the existing studies we use directly the information contained in the basic questions

underlying the four sub-indicators and not their aggregates.[10] One reason can be gathered from Figure 2, which shows the development of the aggregate OECD indicator for the countries already depicted in Figure 1. The indicator is scaled between 0 and 6, with the highest score of 6 meaning that the sector has been hardly liberalised. Most obvious, Germany has a better score compared to U.K. over the whole interval, which is in contradiction with the discussions within Europe.[11] The beneficial score for Germany is, inter alia, due to the diverse structure of gas suppliers. Around 700 companies serve the German market, but it can be hardly seen as a competitive structure as most of them still act as regional monopolists. Besides the questionable relevance of some individual indicators and the more or less arbitrarily chosen weighting structure, using aggregate indicators don't exploit the whole information provided for by the database.[12] Moreover, effects of a certain regulatory measure cannot be identified. Since this paper tries especially to evaluate the effects of ownership unbundling, we concentrate in the setup of our regulatory indicators on the information provided by the basic questions underlying the overall OECD indicator and amend this data where necessary.

Figure 2: Development of the OECD indicator for selected countries



[10] The overall indicator consists of four sub-indicators (entry regulation, public ownership, vertical integration and market structure), each being based on three basic questions. For aggregation the OECD uses equal weights with one exemption concerning the sub-indicator vertical integration. For a full description see Conway and Nicoletti (2006).

[11] E.g., in their fourth benchmarking report on the implementation of the gas and electricity internal market the European Commission (2005: 7) concludes with respect to gas that "progress in Germany and Austria is still very disappointing" while the U.K. "has a mature competitive structure".

[12] A simple correlation analysis of household prices and the aggregate indicator for each country supports this argument. The whole range can be observed: strong positive correlation (e.g. U.K.), hardly any relationship (e.g. Finland) and a strong negative correlation (e.g. New Zeeland).

Source: Based on Conway and Nicoletti (2006).

The first indicator deals with third party access to the grid (variable *tpa*). Instead of the OECD scaling we use a discrete variable with zero indicating regulated access, one negotiated access and two otherwise. As regulated third party access is usually seen as the most favourable condition concerning competition we expect a positive sign of the variable, i.e. the lower the characteristic value of *tpa* the lower, ceteris paribus, the end-user prices households have to pay.

In order to measure the effect of giving customers access to alternative suppliers so that they have the choice between different offers, we create the variable *liberal.* The data is directly taken from OECD database using the original information on the degree of market opening. The higher the share of customers who can choose among several suppliers the higher the competitive pressure in this segment resulting in lower end-user prices. Therefore, for the variable *liberal* a negative sign is being expected.[13]

The privatisation efforts of the various countries is contained in the indicator *ownership* which gives the percentage of the overall sector owned by public facilities. The OECD provides data for three different categories which have been aggregated by simple averaging since they contain more or less the same information. The given ranges of the shares owned by public bodies are transformed into a discrete variable (0 = 0 %, 1= < 25 %, 2 = < 50 %, 3 = < 75 % and 4 otherwise). Usually, private enterprises should perform better than public entities (positive sign).

Furthermore, the market structures in the competitive parts of the value chain are taken into account. The OECD provides for ranges indicating the importance of the largest player.[14] In order to create the two variables *structure_production* and *structure_retail* the OECD data has been discretised. Zero indicates that the largest utility has a share of less than 50 % in the relevant sector, one with a share between 50 and 90 %, and two otherwise. For the market structure variables a positive sign can be expected.

Compared to electricity the gas transmission network is much less interconnected. Moreover, the physical characteristics of the commodity are different from those of electricity. Not only gas can be (economically) stored, but also the actual transport over long distances is of greater importance due to a lower flow rate.[15] Therefore, the transmission network plays a crucial role regarding the establishment of a competitive framework in the whole sector. This specific issue is not adequately addressed by the OECD database concerning the question of unbundling as it contains no explicit information on

---

13 Please note that we omit the information of one further question under the sub-indicator entry regulation of the OECD database as we don't see the adequacy of this category.

14 The third category of the OECD, the market structure in the gas transmission sector, has been neglected due to the questionable relevance and data inconsistencies.

15 This was also the reason for abstaining from incorporating an indicator for hubs or virtual trading points. Moreover, it is quite likely that the pure existence of a hub is not sufficient to foster competition.

the unbundling status of transmission networks. Therefore and in line with the focus of our paper, we create a new dummy variable *ou* indicating whether a country has introduced ownership unbundling in the transmission sector (*ou* = 1) or not (*ou* = 0).[16] Assuming that ownership unbundling fosters competition, we expect a negative sign of this dummy.

The expected signs of the mentioned regulatory indicators are summarised in Table 2.

Table 2: Expected signs of regulatory indicators

Variable	Expected sign
Third Party Access *tpa*	positive
Market opening *liberal*	negative
Ownership *public*	positive
Structure production *structure_production*	positive
Structure retail *structure_retail*	positive
Ownership Unbundling *ou*	negative

Control variables

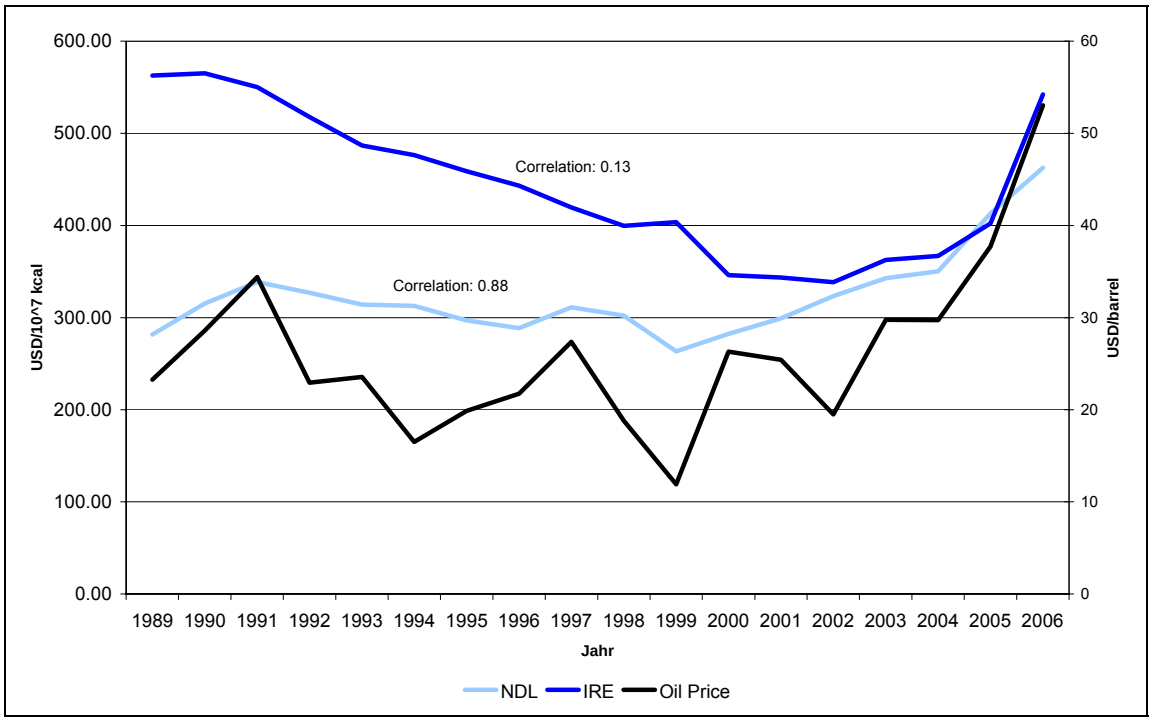
In order to avoid misspecifications of our model we consider several control variables which might have an influence on end-user prices for residential customers.[17] First of all, the relationship between gas and oil prices has to be taken into account. The most prominent example for the linkage of these two commodities is Europe where still a large share of the gas sold is based on long-term take-or-pay contracts. According to these contracts, the current price of gas delivered is determined by a pricing formula that links the current gas price to the price of relevant oil-based substitutes. Conse-

[16] It should be noted that no distinction has been made whether the ownership unbundling was caused by regulatory measures or by entrepreneurial decision which, in turn, might have been a result of other regulations not directly targeting at the separation of transmission networks. The criteria for the dummy is that the owner of the transmission network is not concurrently active in the retail and/or production business. The information has been collected from various sources. The most relevant ones have been the IEA publication series “Energy Policies of IEA Countries”, various benchmarking reports of the European Commission as well as Global Competition Review (2006). As far as possible, the information has been cross checked by directly contacting the responsible regulatory bodies of the OECD countries. The complete list of countries having established ownership unbundling is contained in the Annex.

[17] An overview can be found in the Annex.

quently, fluctuations in oil prices are passed through to producers of gas.[18] These long-term contracts include the possibility of price re-negotiations to adjust the oil price every three to six months resulting in a lagged adjustment process (cf. e.g. Siliverstovs et al. 2005). As we have yearly observations and following most of the other empirical studies (cf. e.g. Copenhagen Economics 2005) we use a lag of one year. The West Texas Intermediate (WTI) has been chosen to map the world's oil price because it has been widely applied in international comparisons (cf. e.g. Brown and Yücel 2007).

Figure 3: Oil price compared to end-user prices



Source: Own calculations based on IEA (2007) and OECD (2008b).

For the considered time period Figure 3 plots the WTI price (right hand axis) against the Dutch and Irish end-user prices (left hand axis). Whereas the Dutch price shows a high correlation, it is rather low for Ireland. Even in Europe, not all countries follow the world's oil price.

Therefore, besides the oil price, other more country-specific factors might play a role regarding their influence on end-user prices. First of all, the GDP per capita is accounted for to map different levels of wealth. The substitutability of gas and oil in the heating sector is accounted for by including the price for light heating oil into the panel. On the supply side, domestic production might be adjusted to certain gas price devel-

[18] While the producer takes over the price risk, the buyer is exposed to volume risk.

opments.[19] Therefore, we consider the indigenous production in relation to gas consumption. Two other variables coping with supply-side factors are the total energy supplied expressed in relation to GDP and per capita.[20]

To sum up the data issue, Table 3 contains the descriptive statistics for all considered variables over the whole panel. The number of observations points at an unbalanced panel.

Table 3: Descriptive statistics for all variables over the whole panel

Variable	No. Of observations	Mean	Standard-deviation	Minimum	Maximum
Endogenous					
End-user prices households	368	414.52	173.45	73.15	973.60
Regulatory Indicators					
Ownership Unbundling	479	0.10	0.30	0	1
Ownership	421	2.19	1.59	0	4
Market Opening	422	13.26	27.40	0	100
Third Party Access	422	1.53	0.77	0	2
Market Structure Production	421	1.55	0.68	0	2
Market Structure Retail	421	1.15	0.63	0	2
Control Variables					
GDP	486	22,675.57	8,623.61	5,791.09	61,939.09
Oil Price World	521	26.08	8.87	11.89	53.04
Price Heating Oil	400	341.71	150.31	129.40	949.44
Energy Supply/GDP	493	0.20	0.06	0.11	0.43
Energy Supply/Capita	493	4.21	1.88	0.90	10.67
Pruduction/Consumption	378	1.14	2.51	0.00	16.77

Source: Own calculations.

4 Approach

In the existing literature dealing with the empirical assessment of regulatory reforms in the energy sector static as well as dynamic approaches have been used. Therefore, we apply both in order to compare results and get somehow more robust results regarding the impact of ownership unbundling which is of special focus.

To avoid inconsistency problems due to possibly cluster-correlated data a robust variance estimator is used in the static setting (cf. Froot 1989 and Williams 2000). This estimator allows for heteroscedasticity, both between and within clusters, and serial corre-

[19] In this context one could also think of gas storage facilities. Unfortunately, appropriate data on installed capacity was not available.

[20] The three variables energy supply per GDP, energy supply per capita and GDP per capita are per definition partially multicollinear. Therefore, we take the logarithm of the latter.

lation. Approaches that assume independence of observations – like the traditional fixed effects and random effects estimator – generally underestimate the true variance leading to inflated t-statistics. The log end-user price for residential costumers y_{it} of country i and period t is modelled as a function of the current and one year lagged oil price X_{it}, other control variables Z_{it} and the regulatory indicators R_{it}.

$$(1) \qquad y_{it} = \alpha + X_{it}^{'}\beta + Z_{it}^{'}\delta + R_{it}^{'}\rho + \eta_i + \varepsilon_{it} .$$

ηi captures unobserved heterogeneity across countries and ε_{it} is the error term satisfying the usual assumptions.

The dynamic setting additionally allows for some gas price dynamics by introducing the one year lagged end-user price as a further explanatory variable.

$$(2) \qquad y_{it} = \gamma y_{it-1} + X_{it}^{'}\beta + Z_{it}^{'}\delta + R_{it}^{'}\rho + \eta_i + \varepsilon_{it} .$$

As it is well known, the traditional Least Squares Dummy Variable (LSDV) estimator for dynamic panels is inconsistent for a finite time horizon T and a large number of cross-sectional dimensions N (Nickell 1981). Furthermore, with only 29 countries we face a small sample bias problem. Therefore, consistent Instrumental Variable (IV) estimators like Anderson and Hsiao (1982) and Generalized Method of Moments (GMM) estimators like Arellano and Bond (1991) are not applicable here (Kviet 1995). Kiviet (1995, 1999) as well as Bun and Kiviet (2003) provide for techniques to approximate the small sample bias but deliver consistent results only for balanced panels. With the unbalanced nature of our panel, adopting those corrections would lead to a high loss of information as they would in fact require discarding the cross-sections or time series causing the unbalancedness. Therefore, we apply the corrected Least Squares Dummy Variable (LSDVC) estimator by Bruno (2005) whose approach avoids the aforementioned shortcomings. The small sample bias is approximated via bootstrapping.

5 Results

The results of the two model specifications evaluating the impact of regulatory reforms, and ownership unbundling in particular, on end-user prices of residential customers are listed in Table 4. Out of the regulatory indicators only market opening is significant.[21] This outcome is confirmed by both models with a higher level of significance in the fixed effects estimation with robust standard errors. The coefficient has the expected negative sign meaning that a higher degree of market opening leads to a reduction in end-

[21] The two indicators dealing with the market structures in the retail and production sector are omitted as they are insignificant in all specifications and tend to lead to an overspecification resulting in a lower R^2. Furthermore, we also tested for lagged indicators in order to map adjustment processes. Up to a lag of three years, the presented results are robust. Due to the loss of observations lags of more than three years seem to be crucial concerning the goodness of fit.

user prices. While in the static setup an additional percentage point of market opening leads to a price reduction by 0.2 %, the dynamic model produces a slightly lower value of 0.08%. For the other indicators no significant effects have been detected in both approaches. Therefore, ownership unbundling seems to have no significant impact on the level of end-user prices for households. This result somehow confirms Copenhagen Economics (2005) detecting no significant effects in the European context and Brau et al. (2007) who find decreasing returns to vertical separation in the gas sector looking at industrial end-user prices, but contrasts Alesina et al. (2005) who report increasing returns of regulatory reform policies at a more aggregate level. Furthermore, four out of seven countries with ownership unbundled gas transmission networks have established this measure only very recently. Therefore, the outcome with regard to ownership unbundling should be treated with care. To get a clearer picture on this issue a re-evaluation might be carried out in a few years time.

Looking at the control variables, the oil price is significant in both estimations. The positive sign is in line with expectations as the oil price should control for the fact that still many contracts link the gas price to the development of the oil price. The effect is of similar magnitude in both approaches. As both variables are modelled as logs, end-user prices are raised by about 1 %If the oil price increases by 10 %. The lagged adjustment process embedded in long-term gas contracts is represented by the significance of the lagged oil price in the FE estimation. Instead, in the dynamic LSDVC this effect is covered by the lagged end-user price for households.

The trade-off between industrial and residential end-user prices as shown by Steiner (2001) as well as by Hattori and Tsutsui (2004) cannot be confirmed in the FE model. However, the dynamic approach indicates that high industrial prices go along with higher household prices.

Out of the variables controlling for country specific characteristics only the GDP per capita and the energy supply per US$ GDP are considered here.[22] Differences in economic performance across countries have no significant impact on end-user prices. The negative sign of the other control variable, which accounts for structural differences in the energy sectors, indicates that a higher amount of energy supplied leads to lower end-user prices. An outcome that is completely in line with economic theory However, this relationship is not confirmed by the dynamic model.

Nevertheless, both specifications, the static FE estimation with robust standard errors and the dynamic LSDVC, lead to similar results. In particular, neither of the two approaches detect a significant effect of ownership unbundling on the level of end-user prices for residential customers.

Table 4: Results of the panel estimation

---

[22] All other control variables tend to reduce the goodness of fit.

Dependent Variable End-user price households (log)	Model	
	Fixed Effects	**LSDVC**
Regulatory Indicators		
Third Party Access *tpa*	-0.0452 [0.0339]	-0.0047 [0.0208]
Market Opening *liberal*	-0.0020 *** [0.0007]	-0.0008 * [0.0004]
Ownership *public*	-0.0091 [0.0252]	-0.0194 [0.0130]
Ownership Unbundling *ou*	-0.0494 [0.0355]	0.0343 [0.0456]
Control Variables		
End-user prices households (-1, log) *price_hh_lag*	--	0.5846 *** [0.0452]
Oil Price (log) *oil*	0.0934 * [0.0449]	0.1106 *** [0.0268]
Oil Price (-1, log) *oil_lag*	0.0707 ** [0.0285]	0.0031 [0.0274]
End-user price Industry (log) *price_ind*	0.0633 [0.1497]	0.0685 ** [0.0340]
GDP per capita (log) *gdp*	-0.5221 [0.3211]	0.0763 [0.1307]
Energy Supply per US$ GDP *energysupply*	-5.4430 *** [0.9354]	-0.0520 [0.5792]
Constant	11.4452 *** [3.4720]	--
R^2	0.3348	--
No. of Observations	251	232

Source: Own calculations, remarks:
Standard errors in parentheses;
significance levels *** p < 1 %, ** p < 5 %, * p < 10 %;
standard errors of LSDVC via bootstrapping (1,000 runs).

6 Conclusions

The issue of ownership unbundling, i.e. the complete separation of transmission assets from other parts of the sector, is high on the political agenda in Europe. As especially in the European gas sector competition is meant to be at a rather premature state, intense discussions are going on whether or not this farthest-reaching measure of vertical separation brings about beneficial outcomes. This paper contributes to this discussion by empirically assessing the impact of ownership unbundling on end-user prices of residential customers.

Based on a panel out of 29 OECD countries over 18 years, we apply static as well as dynamic panel estimation techniques. In the static setup we use the fixed effects estimator with robust standard errors and in the dynamic setting the Least Squares Dummy Variable estimator (LSDVC) by Bruno (2005) which corrects for the small sample bias. We control for the oil price, the GDP, structural parameters of the gas sector like energy supplied as well as for other regulatory variables like ownership structure, degree of market opening and third party access. No significant effect of ownership unbundling is detected on end-user prices for households in both estimations. Instead, the variable for

market opening shows significant influence in the static as well as in the dynamic setting.

Against the background of the current political discussions the results indicate that regulatory measures should concentrate more on the overall market opening instead of taking the vertical disintegration a step further. However, since the majority of countries with ownership unbundled gas transmission networks have established this measure only very recently, a re-evaluation is being suggested in a few years time in order to get a clearer picture on this issue.

References

Aalbers, R. F. T. and B. E. Baarsma (2005), Unbundling of Energy Companies Reduces Competition, *Economisch Statistische Berichten* 90 (4468), 356-357.

Alesina, A., S. Ardagna, G. Nicoletti and F. Schiantarelli (2005), Regulation And Investment, *Journal of the European Economic Association* 3 (4), 791-825.

Anderson, T.W. and C. Hsiao (1982), Formulation and Estimation of Dynamic Models Using Panel Data, *Journal of Econometrics* 18, 47-82.

Arellano, M. and S. Bond (1991), Some Tests of Specification for Panel Data: Monte Carlo Evidence and an Application to Employment Equations, *Review of Economic Studies* 58, 277-297.

Baarsma, B., M. de Nooij, W. Koster and C. van der Weijden (2007), Divide and rule. The economic and legal implications of the proposed ownership unbundling of distribution and supply companies in the Dutch electricity sector, *Energy Policy* 35 (3), 1785-1794.

Bolle, F. and Y. Breitmoser (2006), *On the Allocative Efficiency of Ownership Unbundling*, Europa-Universität Viadrina Frankfurt (Oder), Department of Business Administration and Economics, Discussion Paper No. 255; http://www.wiwi.euv-frankfurt-o.de/de/forschung/discussionpaper/255_Bolle_Breitmoser.pdf.

Brau, R., R. Doronzo, C.V.Fiorio and M. Florio (2007), *Welfare effects of gas industry reforms in the european union: an empirical analysis*, Working Paper, Universität Padua.

Brown, S.P.A. and M.K. Yücel (2007), *What Drives Natural Gas Prices?*, Working Paper 0703, Federal Reserve Bank of Dallas.

Bruno, G.S.F. (2005), Approximating the bias of the LSDV estimator for dynamic unbalanced panel data models, *Economics Letters* 87 (3), 361-366.

Bühler, St., A. Schmutzler and M.-A. Benz (2004), Infrastructure quality in deregulated industries: is there an underinvestment problem?, *International Journal of Industrial Organization* 22 (2), 253-267.

Bun, M.J.G. and J.F Kiviet (2003), On the diminishing returns of higher order terms in asymptotic expansions of bias, *Economics Letters* 79, 145-152.

Conway, P. and G. Nicoletti (2006), *Product Market Regulation in the Non-Manufacturing Sectors of OECD Countries: Measurement and Highlights*, OECD Economics Department Working Paper, No. 530, Paris.

Copenhagen Economics (2005a), *Market Opening in Network Industries: Part I: Final Report*, Copenhagen Economics for DG Internal Market.

Copenhagen Economics (2005b), *Market Opening in Network Industries: Part II: Sectoral Analyses*, Copenhagen Economics for DG Internal Market.

Cremer, H., J. Crémer and P. de Donder (2006), *Legal vs. Ownership Unbundling in Network Industries*, University of Toulouse (IDEI and GREMAQ), July 3, 2006; http://ddata.over-blog.com/xxxyyy/0/09/45/99/legal-ownership.pdf.

Ernst&Young (2006), *The case for Liberalisation*, Final Report for the Department of Trade and Industry, London.

European Commission (2005), *Annual Report on the Implementation of the Gas and Electricity Internal Market*, COM(2004) 863 Final, 5.1.2005, Brussels.

European Commission (2007a), Inquiry pursuant to Article 17 of Regulation (EC) No 1/2003 into the European fas and electricity sectors (Final Report), Communication from the Commission, COM(2006) 851 final, 10.01.2007, Brussels.

European Commission (2007b), Proposal for a Directive of the European Parliament and of the Council amending Directive 2003/55/EC concerning common rules for the internal market in natural gas, COM(2007) 529 final, 19.09.2007, Brussels.

European Commission (2008), Progress in creating the internal gas and electricity market, Report from the Commission to the Council and the European Parliament, COM(2008) 192 final, 15.04.2008, Brussels.

Froot, K.A. (1989), Consistent covariance matrix estimation with cross-sectional dependence and heteroscedasticity in financial data, *Journal of Financial and Quantitative Analysis* 24, 333-355.

Global Competition Review (2006), *Gas Regulation 2006*, Law Business Research Ltd., London.

Hattori, T. and M. Tsutsui (2004), Economic Impact of Regulatory Reforms in the Electricity Supply Industry: A Panel Data Analysis for OECD Countries, *Energy Policy* 32 (6), 823-832.

Haucap, J. (2007), The Costs and Benefits of Ownership Unbundling, *Intereconomics* 42 (6), 301-305.

Höffler, F. and S. Kranz (2007), *Legal Unbundling can be a Golden Mean between Vertical Integration and Separation*, December 2007; http://teaching.coll.mpg.de/econwork/H%F6ffflerKranz.pdf.

IEA [International Energy Agency] (2007), *Energy Prices & Taxes*, Paris.

Joskow, P. L. (2004), *Transmission Policy in the United States*, AEI Brookings Joint Center for Regulatory Studies. Washington D.C.

Joskow, P. L. (2005), Vertical Integration, in Ménard, C. and M.M Shirly (eds.), *Handbook of New Institutional Economics*, Berlin, 319-348.

Joskow, P. L. and J. Tirole (2000), Transmission rights and market power on electric power networks, *RAND Journal of Economics* 31 (3), 450-487.

Kiviet, J.F. (1995), On bias, inconsistency and efficiency of various estimators in dynamic panel data models, *Journal of Econometrics* 68, 53–78.

Kiviet, J.F. (1999), Expectation of Expansions for Estimators in a Dynamic Panel Data Model; Some Results for Weakly Exogenous Regressors, in: Hsiao, C., K. Lahiri, L.-F. Lee und M.H. Pesaran (Hrsg.), *Analysis of Panel Data and Limited Dependent Variables*, Cambridge University Press, Cambridge, 199-225.

Léautier, Th.-O. (2001), Transmission Constraints and Imperfect Markets for Power, *Journal of Regulatory Economics* 19 (1), 27-54.

Mulder, M. and V. Shestalova (2005), *Costs and benefits of vertical separation of the energy distribution industry: the Dutch case*; http://www.infraday.tu-berlin.de/fileadmin/documents/infraday/2005/papers/mulder_shestalova_Costs_and_benefits_of_Vertical_Separation.pdf.

Mulder, M., V. Shestalova and G. Zwart (2007), Vertical Separation of the Dutch Energy Distribution Industry: an Economic Assessment of the Political Debate, *Intereconomics* 42 (6), 305-310.

Nickell, S.J. (1981), Biases in Dynamic Models with Fixed Effects, *Econometrica* 49, 1417-1426.

OECD [Organisation for Economic Co-operation and Development] (2008a), *Purchasing Power Parity for GDP – Historical Series*, http:/www.oecd.org/std/ppp/.

OECD [Organisation for Economic Co-operation and Development] (2008b), *OECD.StatExtracts*, http://stats.oecd.org/WBOS/default.aspx?DatasetCode=CSP2007.

Pollitt, M. (2007), *The arguments for and against ownership unbundling of energy transmission networks*, Working Paper, ESRC Electricity Policy Research Group, University of Cambridge, Cambridge.

Siliverstovs, B., G. L'Hégaret, A. Neumann and C. Von Hirschhausen (2005), International market integration for natural gas? A cointegration analysis of prices in Europe, North America and Japan, *Energy Economics* **27**(4), 605-615.

Steiner, F. (2001), Regulation, industry structure and performance in the electricity supply industry, *OECD Economic Studies* 32, 143-182.

Vickers, J. (1995), Competition and Regulation in Vertically Related Markets, *The Review of Economic Studies* 62 (1), 1-17.

Williams, R.L. (2000), A Note on Robust Variance Estimation for Cluster-Correlated Data, *Biometrics* 56, 645-646.

Annex

Table A- 1: End-user prices for household customers

Country	# Observations	Maximum [USD/10^7 kcal]	Minimum [USD/10^7 kcal]	Mean [USD/10^7 kcal]
Australia	0	na	na	na
Austria	18	447.97	298.66	357.13
Belgium	12	410.49	317.31	367.53
Canada	0	na	na	na
Czech Republic	17	620.92	277.33	420.99
Denmark	17	526.00	239.84	391.56
Finland	18	186.01	99.14	129.53
France	18	447.02	329.62	382.62
Germany	12	372.09	289.90	331.65
Greece	8	558.48	377.14	427.70
Hungary	16	434.81	234.09	327.64
Ireland	18	565.23	338.34	443.61
Italy	12	644.80	405.42	496.38
Japan	17	973.60	828.01	880.48
Korea	3	548.99	496.08	515.16
Luxembourg	18	377.76	231.88	280.29
Mexico	3	740.29	685.68	708.06
Netherlands	18	462.78	263.49	323.61
New Zealand	18	596.28	281.59	420.48
Norway	0	na	na	na
Poland	17	645.72	73.15	457.14
Portugal	5	947.11	887.86	906.75
Slovak Republic	14	687.94	181.54	320.68
Spain	18	935.03	536.79	657.34
Sweden	0	na	na	na
Switzerland	18	442.35	316.34	370.28
Turkey	18	575.41	353.42	457.91
United Kingdom	18	440.70	289.47	344.34
United States	18	454.02	265.85	318.40

Source: Own calculations based on IEA (2007).

Table A- 2: Countries with ownership unbundling of gas transmission networks

Country	Ownership Unbundling
Canada	Since 1985
Denmark	Since 2005
Netherlands	Since 2005
Spain	Since 2006
Sweden	Since 2006
U.K.	Since 1997
U.S.	Since 1993

Note: No information was available for Greece and Norway; for Mexico and New Zeeland missing data since 2004.

Table A- 3: Overview of control variables

	GDP/Capita [USD_{2000} / capita]		Heating Oil [USD_{2000}]		Energy Supply/Capita [toe / capita]		Energy Supply/GDP [toe / 1,000 USD_{2000}]		Production/Consumption [%]	
Country	1992	2005	1992	2005	1992	2005	1992	2005	1992	2005
Australia	22,572	30,191	na	na	5.10	5.90	0.23	0.20	1.33	1.50
Austria	25,850	30,326	281.6	405.6	3.26	4.24	0.14	0.14	0.23	0.17
Belgium	24,677	29,096	211.6	404.3	4.93	5.58	0.23	0.20	0.00	na
Canada	24,560	30,031	na	509.7	7.56	8.30	0.34	0.27	1.79	2.08
Czech Republic	13,911	18,170	na	788.2	4.73	4.40	0.34	0.25	0.02	0.02
Denmark	24,322	30,101	206.9	374.3	3.48	3.60	0.15	0.12	1.68	2.10
Finland	20,965	27,298	224.3	364.6	5.85	6.65	0.28	0.23	na	na
France	23,667	26,687	239.4	411.2	3.91	4.42	0.18	0.16	0.10	0.02
Germany	24,794	27,138	199.3	384.5	4.49	4.21	0.19	0.16	0.27	0.20
Greece	19,001	26,081	343.0	575.8	2.15	2.80	0.16	0.14	1.00	0.01
Hungary	10,442	15,416	654.2	na	2.76	2.75	0.25	0.18	0.48	0.20
Ireland	17,689	34,256	347.8	438.2	2.97	3.89	0.18	0.11	1.00	0.14
Italy	23,779	24,772	274.0	473.3	2.61	3.22	0.12	0.13	0.36	0.14
Japan	25,278	27,195	324.4	413.7	3.61	4.17	0.15	0.15	0.03	0.04
Korea	12,097	19,485	na	659.9	2.16	4.59	0.23	0.23	na	0.02
Luxembourg	40,293	61,939	250.2	402.6	9.35	10.67	0.28	0.19	na	na
Mexico	8,384	9,370	na	na	1.53	1.65	0.19	0.18	0.92	0.87
Netherlands	24,028	30,967	259.9	460.1	4.47	5.03	0.20	0.17	1.83	1.59
New Zealand	17,952	22,882	na	na	4.04	4.21	0.24	0.18	1.01	1.00
Norway	24,763	41,625	236.8	476.4	5.07	6.50	0.19	0.17	7.95	15.55
Poland	7,550	12,251	na	784.5	2.62	2.34	0.37	0.20	0.40	0.37
Portugal	15,581	17,537	428.1	568.7	1.78	2.59	0.14	0.15	na	na
Slovak Republic	8,443	14,093	273.4	na	4.02	3.43	0.43	0.25	0.04	0.02
Spain	17,814	24,160	294.7	452.5	2.33	3.37	0.15	0.15	0.18	0.01
Sweden	23,825	28,314	179.1	386.0	5.56	5.66	0.24	0.19	na	na
Switzerland	30,536	31,435	180.7	326.4	3.68	3.62	0.13	0.12	na	na
Turkey	6,182	6,799	490.2	810.9	0.94	1.19	0.16	0.15	0.04	0.03
United Kingdom	21,011	28,975	215.1	324.1	3.71	3.84	0.19	0.14	0.90	0.93
United States	30,030	36,848	na	476.2	7.71	7.82	0.27	0.21	0.91	0.83

Own calculations based on OECD (2008b).