GAS INDUSTRY REFORMS AND CONSUMERS' PRICES IN THE EUROPEAN UNION

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Gas Industry Reforms and Consumers' Prices in the European Union

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Abstract

This paper offers an empirical analysis of the impact of reforms in the natural gas industry on consumer prices across the EU-15 area. After briefly reviewing the most recent reforms, we study the relationship between regulatory indicators and price dynamics by means of panel data econometrics. Our findings suggest that so far there is limited evidence of beneficial effects for European consumers from the standard package of gas industry reforms.

1. INTRODUCTION

The advent of regulatory reforms in the energy industry, including privatization, network unbundling, regulation and liberalization, is often seen as a key step for fostering economic growth and welfare (see Nicoletti and Scarpetta, 2003). It has been pointed out that heavily regulated markets may have negative welfare effects since public ownership, vertical integration and market entry regulation distort the allocation of resources among sectors and firms, thus affecting the overall economic performance.

In the last 15 years, these reforms have yielded a "new energy paradigm" in the European Union[1]. Three parallel reforms have been called for: a) privatization of the incumbents (sale of existing publicly owned firms and licensing of private entrants); b) unbundling, i.e. the separation of network segments of the industry from other potentially competitive ones, associated both with incentive regulation of the networks and establishment of independent regulatory bodies for guaranteeing non-discriminatory access; c) liberalisation and development of a competitive environment by removing barriers to entry.

The liberalization policies carried out in the EU, and globally promoted by international institutions, have aimed to foster competition, with the idea that competition would generate positive effects to firms and households in terms of lower prices. In this paper we assess the success of public utilities reforms in reducing households' prices until now, with a European perspective and solely focussing on the natural gas industry.

The literature looking at macroeconomic outcomes of reforms provides some evidence against vertically integrated monopolies. For example Alesina *et al.* (2005) find that regulatory reforms in transport, communication and energy have had a significant positive impact on own-sector capital accumulation. Barone and Cingano (2008) find also evidence of more direct positive effects of services liberalization on the growth of the industry added

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[1] On this issue, see Jamasb and Pollitt (2005) and Pollitt (2009).

value, productive efficiency and exports.[2] Nonetheless, some worries about the real effectiveness of the current patterns of regulatory reforms have also been voiced, and more articulated views have appeared, allowing national policy-makers more degrees of freedom in the design of their own reforms.[3]

The earlier focus on macroeconomic and fiscal issues seems to have overlooked the importance of sector specificities. In the EU regulatory policy no substantial difference between electricity and natural gas sectors is considered. For instance, the Third legislative package on the EU Electricity and Gas markets states that both sectors require "*Separation of production and supply from transmission networks: Network ownership and operation should be 'unbundled'. This refers to the separation between the network operation of electricity and gas from supply and generation activities*" (CEC, IP/2007/1361). Accordingly, ownership unbundling is explicitly invoked by the recent Directive 2009/73/EC concerning common rules for the internal market in natural gas and repealing Directive 2003/55/EC".

The lack of recognition of the very nature of the natural gas industry by the EU reform model has been recently pointed out by Jamasb *et al.* (2008). Natural gas transmission networks, unlike electricity and transport sectors, are oligopolies rather than natural monopolies, where the presence of companies with relevant market power could yield "double marginalization" processes in case of unbundling of vertical stages (see also Davies and Waddams, 2007, and, for an analysis on the Dutch natural gas industry, van Witteloostuijna *et al.*, 2007). According to this view, reducing the market power of the incumbent at the distribution stage would be harmful for consumer welfare due to the loss of bargaining power vis-à-vis the upstream stage.

The literature is not univocal on this point. As recently remarked by Zwart (2009), in a simulation model (NATGAS) of the European gas

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[2] A different stream of literature has looked at "firm-level" economic effects of privatization and liberalization, with mixed results about the relationship between privatization and efficiency outcomes. For a summary review, see Okten and Arin (2006), Section 2.

[3] E.g., see the World Bank publication by Lampietti *et al.* (2007).

market, in the presence of resource constraints the relationship between competition, output increase and price decrease is not immediate.[4] By contrast, simulations carried out with the GASMOD (Holtz, von Hirschhalsen and Kemfert, 2008) and GASTALE (Boots *et al*, 2004) models lead to more optimistic conclusions, indicating that a liberalized downstream market (in accordance with the EU liberalization policy) would determine lower equilibrium prices even in the presence of an oligopolistic upstream market. Downstream market liberalization could reduce the double marginalisation effects provided that a competitive market develops at this stage. Otherwise, consumers would benefit more from a vertically integrated industry.

In this paper we focus on first round partial equilibrium impacts, trying to answer the following simple question: to what extent has EU regulatory reform contributed to delivering lower prices to the average household? In order to answer this question, we combine price and regulatory datasets. Regulatory reform variables are taken from the OECD indicators of regulation in energy, transport and communication (ETCR). Data on households' gas prices come from EUROSTAT and International Energy Agency (IEA) sources. More information on the data used is provided in Section 2.

By applying panel data techniques, and controlling for a set of country-level characteristics, we find that recent reforms had limited effects on net-of-tax gas consumption prices. Sometimes, the effects seem to go in the opposite direction with respect to the "new paradigm" of regulatory reforms. These findings are confirmed using both the composite ETCR indices and their sub-components, as scores as well as categorical variables. The estimation of panel data models is presented and discussed in Section 3. Finally, section 4 concludes.

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[4] For a recent theoretical analysis of the contrasting economic effects in the case of vertical oligopolistic industries see for example Reisinger and Schnitzer (2008).

2. THE DATA: SUMMARY TRENDS OF PRICE AND REFORM INDICATORS

An EU-15 cross-country analysis of net-of-tax natural gas household prices can be performed using either the data provided by the Eurostat or those provided by the IEA. We use both data sets, also considering that the correlation of price variables coming from these two sources is high (about 0.75) but not perfect. Prices recorded by the two sources are slightly different because of different aggregations of primary data at the national level, different definitions of the average household or of the exchange rate used.[5] Using data from two independent data source allows us to assess the robustness of estimated results.

As the Eurostat time series starts in 1991, we set the starting date for both sources at that date, although the IEA provides data from 1978 for most of the EU-15 countries.[6] Both series are expressed in euro per Gigajoule and provide information on prices charged to domestic consumers net of tax. Figure 1 shows the price dynamics in the main European national markets,[7] depicting an increasing trend, especially in the most recent years. It also shows that despite some differences in levels, the trend of consumer price is similar regardless of the data source used.

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[5] The price data provided by the IEA refer to the price paid by a non-better specified average household in US dollars, those provided by Eurostat refer to the price paid by households with yearly consumption equal to 83.70GJ and is recorded in euro. The IEA net-of-tax price data have been converted into euros by using the Eurostat exchange rate.

[6] It should be noticed that no reform was started before the 1990s in the countries considered, hence earlier periods are uninteresting for analyzing the effects of reforms on prices.

[7] Greece, Portugal and Finland have been removed from the subsequent regression analysis either because the gas industry is of minor importance for household consumption or because the time series from both Eurostat and IEA presented many missing observations. Moreover, IEA does not provide household price information for Sweden.

As for reform variables, we use the OECD indicators of regulation in energy, transport and communication (ETCR) released in 2009, providing a series of summary reform indicators formerly known as REGREF (Conway and Nicoletti, 2006). All ETCR regulatory indicators range from a minimum of 0 (corresponding to full deregulation) to a maximum of 6 (corresponding to the most restrictive conditions for competition). The indicators provide a measure of the degree of public ownership, vertical integration, entry regulation and market structure of national gas industries in the EU-15. The ETCR indicators are mostly based on the existence of formal regulation (i.e. whether or not certain legislature is in place) rather than on the intrinsic quality of regulation, but unfortunately no better source of information is available for EU-wide comparative analysis. One can either use the ETCR scores which are based on a somewhat arbitrary "cardinalisation" of often categorical variables into the 0-6 scale,[8] or use the sub-indicators as categorical variables or create several aggregate regulation measures starting from intra-sector indicators (e.g., see Alesina *et al.*, 2005).

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[8] As for the natural gas market, the intra-sector ETCR indicators are made up of the variable "public ownership", coded from 0 (complete private ownership in the production/import, transmission and supply phases) to 6 (public ownership for all), the variable "vertical integration", coded from 0 (vertical separation in all phases) to 6 (vertical integration for all), the variable "entry regulation", which is a weighted average of legal conditions of entry in a market and is coded from 0 (free entry) to 6 (franchised to one firm), and the variable market structure, coded from 0 (no firm has a market share above 50% in either the production/import, transmission or supply phase) to 6 (the same firm has a share above 90% for each phase). For more details, see Conway and Nicoletti (2006).

Figure 1. Evolution of net-of-tax average household gas prices in EU-15
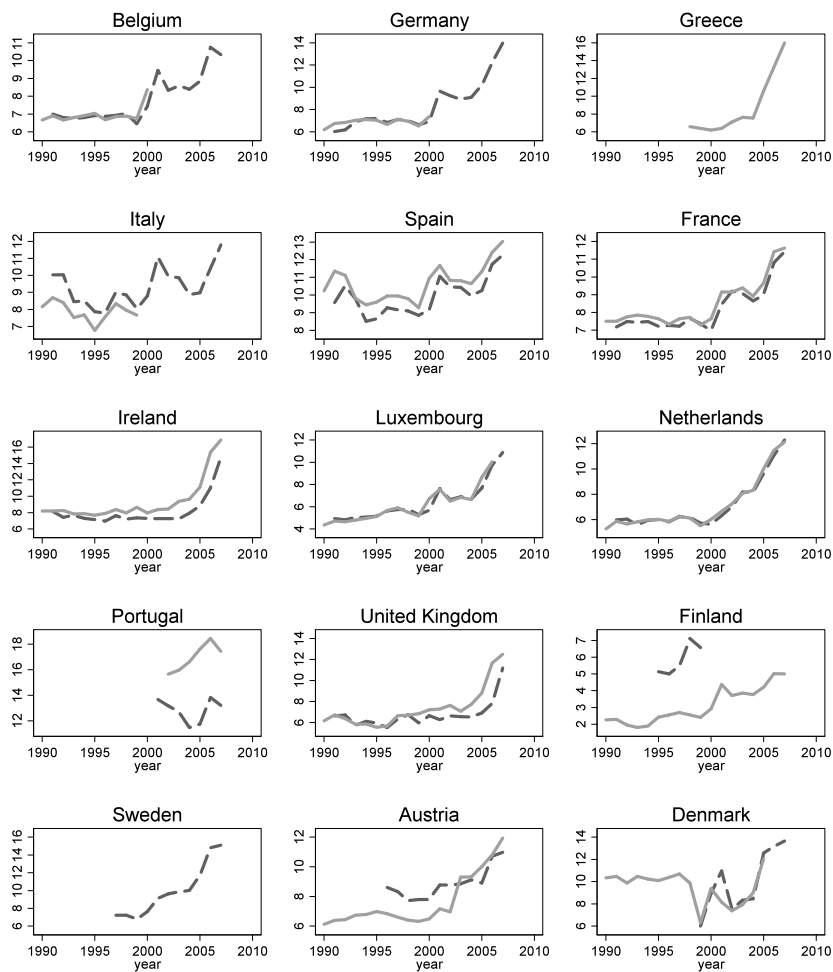
Source: Eurostat (dashed line) and IEA (solid line)
Note: price is in Euro/Gj

The ETCR dataset provides a yearly time series from 1975 up to 2007, however we only used data from 1991 as the Eurostat price data start in 1991 and the liberalization process of the European gas industry did not start before (Table 1), apart from the UK. The trend across the EU-15 countries (towards reduction of public ownership, a less vertically integrated industry structure and a less regulated access to the market) was strongly affected by the two European Directives issued in June 1998 and June 2003, which represent the milestones in the gradual but radical restructuring of the gas sector. Although the EU has been neutral on privatization, in several countries there has been *de facto* an association between privatization, vertical disintegration and liberalization.[9] Looking at the ETCR industry score reported in Table 1, there is a clear downward trend since the early 1990s, but some heterogeneity across countries and across time remains.

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[9] For a more in-depth analysis, see for example (Thomas 2005).

Table 1. Evolution of the average ETCR 0-6 score in the natural gas industry

Country	1975	1991	1995	2000	2003	2007
Belgium	4.7	4.7	4.2	3.7	2.7	2.4
Denmark	5.0	5.0	4.5	4.4	2.6	1.7
Germany	3.3	3.3	3.3	2.0	2.0	1.7
Greece	6.0	6.0	6.0	5.8	5.2	3.5
Italy	5.2	5.2	4.7	4.7	2.4	2.1
Spain	4.0	4.0	4.0	3.1	1.6	1.1
France	6.0	6.0	6.0	6.0	3.7	2.1
Ireland	6.0	6.0	5.4	5.4	4.1	4.0
Luxembourg	4.5	4.5	4.5	4.5	3.5	3.3
Netherlands	5.0	5.0	5.0	4.0	3.9	3.2
Portugal	5.5	5.5	5.5	5.0	4.4	3.0
UK	5.8	3.5	3.0	1.9	1.7	0.7
Finland	4.5	4.5	4.5	4.8	4.8	4.3
Sweden	4.0	4.0	4.0	3.0	2.6	2.2
Austria	4.5	4.5	4.5	3.8	2.7	2.1

Source: ETCR (2009). Selected years only.

Table 2 presents a first explorative analysis of the relationship between the evolution of the gas industry regulatory framework and the (net-of-tax) average consumer price across the EU-15 for selected years between 1991 and 2007.

Table 2. The regulatory framework and gas prices. Selected years, in EU-15

PO	VI	ER	MS	1991	Pr1991	1995	Pr1995	2000	Pr2000	2003	Pr2003	2007	Pr2007
Public	Integrat.	Not free	>90%	IT FR IR PT GR	38% -1% 12%	FR GR PT	7%	FR GR	-6%				
		Partly	50-90%	BE	-4%	IR DK	6%	IR DK	-2% 21%	IR	-18%		
	L/A Sep.	Free entry	>90%									IR NE	18% -1%
	Own. Sep.	Partly	50-90%							FR	2%	GR	
		Free entry											
Mixed	Integrat.	Not free	>90%	NE	-18%	IT NE	17% -11%	IT PT	19%				
		Partly	50-90%	FI LU AU	-32%	BE FI AU LU	3% -23% -23%	AU BE FI LU	5% 0% -23%	FI			
		Free entry	>90%							LU	-22%	FI LU	-13%
	L/A Sep.	Partly	50-90%					NE	-24%	NE	-8%		
		Free entry	>90%							AU	0%		
		Not free								PT	43%		
	Own. Sep.	Partly	50-90%							DK	-6%		
		Free entry	>90%							BE IT	-3% 11%	PT AU BE DK FR IT	6% -12% -17% 10% -8% -5%
Private	Integrat.	Not free		SP	32%	SP	29%						
		Partly	50-90%	SW UK GE	-9% -17%	SW GE	7%						
		Free entry	>90%			UK	-11%	SW GE SP	3% -6% 24%	GE	1%		
	L/A Sep.	Not free											
		Partly	50-90%										
		Free entry	>90%					UK	-10%	SW UK SP	11% -26% 17%	SW GE	21% 12%
	Own. Sep.											SP UK	-1% -10%
Average current prices for EU-15:					7.28		6.72		7.41		8.88		12.45

Notes: 1991 means year 1991. Pr 91 means price in year 1991, when available. The other labels are interpreted similarly. Numbers show the percentage difference from the average EU-15 (using available data).
Source: Conway and Nicoletti (2006) for regulatory reform data and Eurostat (data downloadable from http://ec.europa.eu/eurostat/) for gas price data.

Legenda: PO=Ownership (public, mixed, private), VI=vertical integration (integration, legal/accounting separation, ownership separation), ER=entry regulation (Free, partly free and no free entry), MS=market structure (less than 50%, between 50% and 90%, over 90%).
BE=Belgium, DK=Denmark, GE=Germany, GR=Greece, IT=Italy, SP=Spain, FR=France IR=Ireland, LU=Luxembourg, NE=Netherlands, PT=Portugal, UK=United Kingdom, FI=Finland SW=Sweden, AU=Austria.

The table uses the ETCR classification of reform status. In the table we distinguish between three alternative types of industry ownership (mainly public, mixed, mainly private), which can be associated with one of three possibilities of vertical integration of the network (integration, legal/accounting separation, or ownership separation), one of three modes of market entry (free, partly free, no free entry) and one of three possible market structures (the market share of the incumbent can be above 90 percent, less than 50 per cent, or somewhat in between). Each cell contains the countries characterised by a particular combination of ownership, vertical integration, market structure and entry regulation in a given year and the (net of tax) consumer price as percentage deviation from the EU-15 average, which is reported in the last row of the table and is expressed in current euros (or ECU before the introduction of the euro).

Let us focus on the five countries (Ireland, France, Greece, Portugal, Italy) which were vertically integrated public monopolies in the early 1990s. Their prices deviate from the EU average in different ways, with Italy showing very high relative prices, France close to the EU average, and Ireland in between. In France, consumer prices have always been close to the EU average even though privatization and liberalization reforms had the smallest impact. At the other extreme, in the UK, where gas has been under private ownership since the early 1990s , gas prices have been lower than the EU average and prices seemed to fall even more following full liberalisation. During the same period, the Netherlands had a private vertically integrated industry and prices were well below the average. In Spain, however, private ownership with limited entry was associated with very high relative prices, at levels similar to those of Italy. In Germany, a mostly private gas industry seems to be associated with prices lower in the early 1990s than in more recent years, when prices tend to converge to the EU average or be marginally higher. Under mixed public-private ownership and vertical integration, Luxembourg shows significantly low gas prices over the years, even lower than those in the UK. Denmark, under public ownership until recent years, had consumer gas prices below the EU average in most years. Thus, it is not self evident that prices, in the presence of some combination of industry reforms are systematically lower or higher than the EU average.

In order to thoroughly explore this issue, we need to account for specific country features, and to test the hypothesis that reforms had an

impact on prices, after controlling for other country-specific factors. Among these, and complementing the information on prices and the ETCR indicators, we used a series of sector-specific variables (namely national gas production, and gas imports taken from the IEA) and macroeconomic indicators (per-capita GDP and consumer price trends obtained from the Eurostat). In addition, given the strict relationship between natural gas and crude oil prices, the "Brent" series provided by the IEA was also included.

3. ECONOMETRIC ANALYSIS

A comparative analysis of the effects of a common policy reform on the European residential natural gas sector is a difficult task. As recently documented and studied for example by Asche, Nilsen and Tveteras (2008), apart from the common feature of very small short-run demand elasticities to own price and a dramatic consumption increase at an aggregate level, large differences across European countries are easily detected in terms of shares on total energy consumption and natural gas grid coverage. Moreover, since in Europe long-term supply contracts from Russia, Algeria or Norway usually employ price formulae often based on the (time-lagged) prices of energy substitutes such as crude oil, fuel oil, coal etc., the supply of oil and natural gas are strongly linked, and changes in crude oil prices have historically had a prominent role in shaping natural gas prices.

In this section we estimate panel data models regressing the log of net-of-tax natural gas prices for domestic users against the ETCR reform indicators to test for the presence of any statistically significant impact of reforms on the prices paid by European consumers. The main advantage of panel data techniques is that they allow for more efficient estimates of the effects of changes in regulation by exploiting both the cross-sectional and time-series variation. Moreover, these methods enable us to control for country fixed effects, national idiosyncratic shocks and common trends.

This estimation strategy is similar to the one used by Alesina *et al.* (2005) and Copenhagen Economics (2005) who estimate the impact of market opening policies respectively on investment in non manufactory industries in OECD countries, and on electricity and gas prices for industrial users.

Following the Blundell and Bond (2000) strategy, we first estimated some simple autoregressive (AR) models of order 1 and 2 of log prices using OLS and fixed-effects, and always including year time dummies to account for common trends. We find that the (log of) natural gas price is highly correlated with its lagged value regardless of the data source used, calling for the estimation of panel models including the lagged dependent variable (dynamic panels) instead of static ones. In fact, the omission of the highly significant lagged dependent variable would introduce a serious bias in the estimation, given its significant correlation with other control variables.

Hence we estimate a dynamic panel model, i.e. we include the lagged dependent variable among the regressors. Let p_{it} be the log yearly household natural gas prices for country i at time t, $\boxed{\times}$ the vector of regulatory variables for country i at time t, Z_{it} a vector of additional controls, and β a vector of time dummies:

$$p_{it} = \rho p_{i,t-1} + R_{it}'\gamma + Z_{it}'\delta + \alpha_i + \beta_t + \varepsilon_{it}, \tag{1}$$

where $\alpha, \beta, \gamma, \delta, \rho$ are parameter vectors to be estimated and ε_{it} is an *iid* (over i and t) stochastic term.

In this model, time dummies account for common shocks on consumer prices and oil prices, and following Arellano and Bond (1991) they are considered strictly exogenous. The additional controls in the Z_{it} vector, are included to control for (time-variant) country effects which are not eliminated by the first differencing procedure adopted in the estimation methods for dynamic panels. We considered both sector-specific variables (namely national gas production and gas imports) and macroeconomic indicators (per-capita GDP and consumer price trends). In addition, given the relationship between natural gas and crude oil prices, the "Brent" oil series provided was also included.

The ρ parameter captures the correlation between current and lagged price variations. However, we should recall that it cannot be interpreted as a real structural parameter, given that in dynamic panel data analyses its estimated value subsumes the combined effect of true state dependence effects and correlation over time due to time varying unobserved heterogeneity (Woolbridge, 2002). In the case of feedstock prices, it is likely that true state dependence (e.g. habits and adjustment costs) is relatively

small, but the dynamic specification is able to capture the effect of country-specific unobservable factors such as access to different pipelines with different import prices and the presence of *take-or-pay* contracts.

Given the correlation of the lagged dependent variable with the error term, which yields inconsistent estimates of traditional random effects, fixed effects and first differences estimators (see, among others, Cameron Trivedi, 2005) we used generalized method of moments (GMM) methodologies, which allow for more general assumptions on unobservable heterogeneity components and for treating the endogeneity problem with a wide set of instruments obtained within the immediate data set. Consistent estimates can be obtained using the Arellano and Bond (1991) first difference estimator. A higher efficiency is gained by using the "system-GMM" by Arellano-Bover (1995) and Blundell and Bond (1998), under the assumption that the individual effect is uncorrelated with the first difference of the first observation of the dependent variable.

As discussed previously, information on natural gas prices is missing for some years and countries. Hence, although the European Directives regarded all the EU-15 countries, we always exclude from the analysis Finland, Greece and Portugal, due to their nature of limited or isolated markets and the absence of complete time series in both the IEA and Eurostat data sets.[10] Given that the last year contained in ETCR indicators is 2007, we can make use of an unbalanced panel composed of 17 years.

The results from applying the system-GMM approach for the estimation of equation (1) are reported in Table 3, where both price sources have been considered. In order to contain the risk of too many instruments, biasing downwards the estimated standard errors (e.g. Ziliak, 1997), we contain the order of admitted lags to *t-2*. Standard autocorrelation and over identification test are also reported.[11]

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[10] Moreover, as the IEA data lack information on Sweden for all years considered when the IEA data set is used the number of countries included drops to eleven.
[11] GMM estimators are valid only if there is no serial correlation in the errors. Since the first difference of a white noise process is necessarily autocorrelated, only second order autocorrelation test are reported (see Arellano and Bond, 1991).

Columns (a) and (c) in Table 3 report the results from the regressions where only the ETCR indicators and the time dummies have been considered. In this case the implicit assumption is that first differencing and the time trends can account for all the unobservable components. In these models the only common result is the statistically significant effect from the lagged dependent variable, while no significant effects from the regulatory reform variables can be detected, apart from the entry regulation indicator for the IEA price series.

The models reported in the columns (b) and (d) improve the specification of the model with a series of country-specific controls, most of which are statistically significant. As expected, crude oil price is positively correlated with natural gas prices. Given this pricing structure for wholesale gas, and the huge swings in oil prices in the period 1991-2003, it is hardly surprising that oil is an important determinant of domestic gas prices in Europe.[12] However, we focus here on the effects, if any, of reforms on prices. Columns (b) and (d) in Table 3, show that after controlling for time dummies, Brent oil, and other macroeconomic variables, there is some evidence that public ownership is associated with lower prices. This is true with both data sets, although the p-value is statistically significant at 10% only using the Eurostat data (14% using the IEA data). By contrast, with more market regulation, prices increase regardless of the data set used, and the effect is always statistically significant. In this case, the result is in line with the positive effects of liberalization recalled before (Alesina *et al*, 2005).

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[12] We thank an anonymous referee for stressing this point.

Table 3. Dynamic regressions with official ETCR indicators

Dep. var.: net-of-tax price of nat. gas for households	System GMM estimates *Eurostat prices* sample 1991-2007		System GMM estimates *IEA prices* sample 1991-2007	
Control variables	(a)	(b)	(c)	(d)
Lagged dependent variable	1.1055***	0.7480***	0.6803***	0.6820***
	(0.0595)	(0.0349)	(0.1429)	(0.1289)
Vertical integration	0.0037	0.0017	-0.0077	0.0002
	(0.0096)	(0.0070)	(0.0110)	(0.0084)
Public ownership	-0.0006	-0.0056*	-0.0039	-0.0028
	(0.0045)	(0.0029)	(0.0076)	(0.0057)
Entry regulation	-0.0052	0.0129**	0.0209**	0.0186***
	(0.0050)	(0.0051)	(0.0096)	(0.0059)
Market structure	0.0035	0.0043	0.0029	0.0048
	(0.0085)	(0.0082)	(0.0093)	(0.0101)
Per capita home production		-0.0093**		-0.0136*
		(0.0037)		(0.0071)
Per capita imports		-0.0342**		-0.0522*
		(0.0167)		(0.0286)
Per capita GDP		0.0005		0.0004
		(0.0006)		(0.0008)
Consumer Price Index		0.0024		0.0005
		(0.0015)		(0.0014)
Brent oil price		0.0052***		0.0080**
		(0.0008)		(0.0035)
Time mummie	yes	yes	yes	Yes
Constant	-0.1880	0.1672	0.6058**	0.4137**
	(0.1292)	(0.1357)	(0.2667)	(0.1997)
Observations	173	173	162	162
Number of countries	12	12	11	11
N. of instruments	50	54	54	59
AB ar(2) test statistic	0.228	0.622	1.429	1.510
AB ar(2) p-value	0.819	0.534	0.153	0.131
Sargan test statistic	25.917	14.359	37.404	35.092
Sargan p-value	0.679	0.993	0.235	0.369

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

The cardinalization of the ETCR reform indicators into a 0-6 scale (see the details in Conway and Nicoletti, 2006) could be somewhat controversial in several cases. For instance, while there is a clear sequence going from private, mostly private, to mixed, mostly public and public ownership, one may wonder whether coding these different options with equally spaced values between 0 and 6 may affect the results. Moreover, as the reform scores used in the regression presented in Table 3 are an average of composite sub-indicators, using the latter allows a more focussed view on the relevant forces at play.

Hence, we go into further detail by replacing the average scores with the sub-indicators used in the ECTR data for creating the average 0-6 score indicators, with some modifications. In particular:

- The public ownership ETCR 0-6 score is replaced by the sub-indicators measuring the percentage of shares owned by the state in the production and in the distribution stage.[13]
- The entry regulation and market structure ETCR 0-6 scores, providing an indication of the liberalisation process, are replaced with the continuous variable indicating the percentage of the retail market open to consumers' choice. Moreover, a dummy variable that is equal one if the market share of the incumbent is below 90% and zero otherwise is also used.
- The vertical integration ETCR 0-6 score is replaced by dummy variables as the sub-indicators are provided as categorical variables (integrated monopoly, legal/accounting separation or ownership separation) and their cardinalization is debatable. In particular, the dummies created are equal to one if there is ownership, legal or accounting separation in the

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[13] There is also a third variable related to the percentage of share owned by the state in the transmission industry, but it is highly collinear with the variable related to production and has to be dropped in the model estimation.

industry and zero otherwise in the production, supply and distribution stages.

The results obtained by considering these sub-indicators are reported in the Table 4. They show that, in those cases where statistically significant coefficients are found, they point to an opposite direction than that expected under the standard reform paradigm. For example, focussing only on columns (b) and (d) where controls for country-specific macroeconomic variables are introduced (i) the higher the public share in import/production, but not in distribution, the lower the price paid by households and (ii) in those markets where the incumbent share is lower than 90% the price paid by households is higher. No statistically significant effect is found for the market share open to consumers and for the vertical integration of different stages of the gas industry.

Table 4. Effects of disaggregated regulatory reform indicators on natural gas price dynamics

Dep. Var.: net-of-tax price of nat. gas for households	System GMM estimates *Eurostat prices* *Sample 1991-2007*		System GMM estimates *IEA prices* *Sample 1991-2007*	
Control variables	(a)	(b)	(c)	(d)
Lagged dependent variable	1.0352***	0.7120***	0.6530***	0.7059***
	(0.0575)	(0.0545)	(0.1549)	(0.1400)
Public share in production	-0.0007*	-0.0008***	-0.0013**	-0.0010**
	(0.0004)	(0.0002)	(0.0006)	(0.0004)
Public share in distribution	0.0007***	0.0005	0.0001	0.0004
	(0.0002)	(0.0004)	(0.0003)	(0.0004)
Dummy for share incumbent <90%	0.0083	0.0257*	0.1279**	0.0697
	(0.0241)	(0.0140)	(0.0602)	(0.0456)
Market share open to consumers	0.0004***	0.0002	0.0004	0.0005
	(0.0001)	(0.0002)	(0.0005)	(0.0004)
Dummy for vert. separation in production	0.0016	0.0235	-0.0136	0.0110
	(0.0221)	(0.0195)	(0.0307)	(0.0362)
Dummy for vert. separation in supply	0.0105	0.0357	0.0767	0.0697
	(0.0312)	(0.0247)	(0.0518)	(0.0497)
Dummy for vert. separation in distribution	0.0107	-0.0151	-0.0164	-0.0196
	(0.0169)	(0.0200)	(0.0174)	(0.0232)
Per capita indigenous production		-0.0141**		-0.0112*
		(0.0064)		(0.0061)
Per capita imports		-0.0361**		-0.0353
		(0.0157)		(0.0268)
Per capita GDP		0.0003		0.0004
		(0.0007)		(0.0014)
Consumer Price Index		0.0013		-0.0012
		(0.0017)		(0.0022)
Brent oil price		0.0053***		0.0071**
		(0.0005)		(0.0036)
Time mummie	yes	yes	yes	Yes
Constant	-0.0573	0.3752***	0.6872**	0.5568**
	(0.1306)	(0.1391)	(0.2830)	(0.2574)
Observations	173	173	162	162
Number of c15	12	12	11	11
N. of instruments	53	57	57	62
AB ar(2) stat.	0.466	0.498	1.580	1.625
AB ar(2) p-value	0.642	0.618	0.114	0.104
Sargan stat.	26.012	13.449	35.998	34.983
Sargan p-value	0.675	0.996	0.287	0.374

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

4. CONCLUSIONS

We have explored the impact of gas policy reforms on household prices in the core countries of the European Union over the 15 years to 2007. After controlling for macroeconomic factors, Brent oil price changes, own-price inertia, country and year- specific effects, our findings show that the impact of the reforms is -until now- negligible. Privatization *per se* does not lead to lower prices for consumers, and in fact there is some evidence pointing to a residual role of public ownership of the utilities as a mechanism that caps prices. This effect is quite small, but robust across different sources of price data. There is some limited evidence that softening entry legislation is beneficial to the consumer, as expected, but actual market shares of the entrants have no lowering effect or even tend to increase price. Our interpretation of these -perhaps counter-intuitive- findings is simple. The threat of entry following legislation changes motivates the incumbent to some price restraint, but there is no actual further effect from competition. The market is in fact still intrinsically oligopolistic and privatization, unbundling, and formal legislation allowing entry do little to alter this feature. The OECD vertical separation indicators are never significant in the empirical estimates. The prices consumers pay for natural gas in Western Europe are still determined by what they have being paying in the past (own price inertia), with the well known linkage to crude oil price, and GDP per capita as the usual proxy for demand shifts, plus country specific factors.

The limited number of countries we consider, and the unavoidable data limitations of a cross-country analysis cause us to be prudent in drawing strong policy implications from our empirical analysis. Our results are however quite robust and point towards a careful reconsideration of the European legislation in the gas industry. The core of the EU 2009 directive is to promote unbundling as a way to achieve market opening. While all the European Member States may formally comply with this legislation, past evidence shows that the process is perhaps longer and more cumbersome than expected. Further research is needed to understand whether privatization and mandatory unbundling of networks in the gas industry is a necessary and/or sufficient condition for actual competition. Moreover, it is not clear whether the empirical evidence necessary to support a unique reform design across the EU 27 Member States, as the one recently required

by the 2009 Directive, can be found. It seems fair to conclude that until now the European consumers have not yet cashed a dividend from the reforms.

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APPENDIX A (NOT TO BE INCLUDED IN THE PRINTED VERSION): THE ETCR DATASET

The ETCR regulatory dataset has been created by the OECD.[14] It collects information about indicators of privatization, liberalization and disintegration of services of general interest across the OECD countries for 22 years from 1975 to 2007. As regard the gas sector the database provide information about four dimensions: public ownership, vertical integration, entry regulation and market structure.

-Entry regulation: this series is an indicator of legal conditions of entry in the market and it is coded between 0 (free entry) to 6 (one firm). It is a weighted sum of four different sub index each with equal weight, namely: terms and conditions of third party access (TPA) to the gas transmission grid; existence of national, state or provincial laws or other regulations restricting the number of competitors allowed to operate in the gas production/import segment; percentage of the retail market open to consumer choice.

-Public ownership: this series indicate the ownership structure of the largest companies in the production/import, transmission and distribution segments of the gas industry. The variable is coded between 0 (private ownership) to 6 (public ownership).

-Vertical integration: this series is a weighted average of three indicators of vertical separation between different segments of the industry. It is coded between 0 (vertical separation in all phases) to 6 (integration for all). The components of the index, each with equal weight, are: degree of vertical separation between gas production/import and the other segments of the industry; degree of vertical separation between gas supply and the other segments of the industry; existence of vertical separation between distribution and gas supply.

-Market Structure: this variable is coded from 0 (no firm has a market share above 50% in each segment of the gas industry) to 6 (the same firm

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[14] See Conway and Nicoletti (2006) for further details.

has a market share above 90% in each phase). It is composed by three different sub-indexes: market share of the largest company in the gas production/import stage; market share of the largest company in the gas transmission stage; market share of the largest company in the gas supply stage.

The ETCR database provides also a summing index that is a weighted mean of the four different time series. This series, called *Aggregate Gas Regulatory Indicator (AGRI)*, has not been used in our regression because we were interested in understanding the impact of each component on consumers' satisfaction with prices and quality. Table A1 highlight the exact computation mechanism of this aggregate index.

Table A1. Components of the Aggregate Gas Regulatory Index

Index	Weight	Sub-Index	Weight
Entry Regulation	1/4	1. terms and conditions of third party access (TPA) to the gas transmission grid	1/3
		2. percentage of the retail market open to consumer	1/3
		3. existence of national, state or provincial laws or other regulations restricting the number of competitors allowed to operate in the gas production/import segment	1/3
Public Ownership	1/4	1. ownership structure of the largest companies in the production/import sector	1/3
		2. ownership structure of the largest companies in the gas transmission sector	1/3
		3. ownership structure of the largest companies in the gas distribution sector	1/3
Vertical Integration	1/4	1. degree of vertical separation between gas production/import and the other segments of the	1/2
		2. degree of vertical separation between gas supply and the other segments of the industry	3/10
		3. existence of vertical separation between distribution and gas supply.	1/5
Market Structure	1/4	1. market share of the largest company in the gas production/import stage	1/3
		2. market share of the largest company in the gas transmission stage	1/3
		3. market share of the largest company in the gas supply stage.	1/3

Source: ETCR database

APPENDIX B (NOT TO BE INCLUDED IN THE PRINTED VERSION): THE MODEL SPECIFICATION

The choice of the dynamic panel specification of log net-of-tax natural gas price for households strictly follows Blundell and Bond (2000). As a first step, we estimate some simple autoregressive processes of log prices of order 1 and 2. Table B1 shows that the first lag is always highly significant while the second lag is not (except for the IEA source data, using OLS estimation methods only). This provides a strong motivation for including the lagged dependent variable among regressors, hence avoiding a very likely omitted variable bias.

Once the dynamic panel specification is chosen, it is well known (among others, see Cameron and Trivedi, 2005, chapter 22) that the lagged dependent variable is endogenous by construction and estimates are inconsistent using OLS, Within (FE) or First Difference (FD) estimation methods. Hence one has to revert methods using instrumental variables to treat the endogeneity of the lagged dependent variable. As often, and also in our case, no instruments are available outside the immediate data set, endogeneity is treated using generalized method of moments (GMM) techniques, involving the use of the lagged values of the dependent variables as instruments. GMM methods allow for more general assumptions on unobservable heterogeneity components and for treating the endogeneity problem with a large set of instruments obtained within the same data set. In particular, we use the the "system-GMM" by Arellano-Bover (1995) and Blundell and Bond (1998), which improve on efficiency compared to the earlier Arellano and Bond (1991) estimator.

However, as GMM efficiency is low if instruments are weak, again following Blundell and Bond (2000) we estimate a reduced form regression of the endogenous variable log prices at time t-1 $(p_{i,t-1})$ on the lagged difference at $t-2$ and time dummies, which are the main instruments used in the system-GMM method. Standard goodness of fit and significance tests are then used to assess the relevance of instruments. Table B2 shows that the instruments used in the system-GMM estimated in Section 4 are indeed strong, as they are jointly highly significant and explain around 50% of the variance of the lagged log price.

Table B1. AR (1) model estimates

Dependent variable: net-of-tax price of natural gas for households	Eurostat	Eurostat	Eurostat	Eurostat	IEA	IEA	IEA	IEA
	OLS	FE	OLS	FE	OLS	FE	OLS	FE
Dep. var. lagged 1 period	0.8506***	0.5932***	0.7761***	0.6054***	0.8841***	0.7076***	0.7339***	0.6655***
	(0.037)	(0.068)	(0.082)	(0.088)	(0.030)	(0.063)	(0.084)	(0.088)
Dep. var. lagged 2 periods		-	0.0736	-0.0343			0.1509*	0.0604
			(0.080)	(0.089)			(0.079)	(0.088)
Year dummies	yes	yes	yes	yes	yes	yes	yes	yes
Country dummies	no	yes	no	yes	no	yes	no	yes
Constant	0.2839***	0.7855***	0.2848***	0.8263***	0.2812***	0.6038***	0.2902***	0.5736***
	(0.075)	(0.141)	(0.077)	(0.169)	(0.062)	(0.121)	(0.062)	(0.129)
Observations	173	173	161	161	162	162	162	162
R-squared	0.900	0.916	0.909	0.922	0.919	0.926	0.922	0.926
Adjusted R-squared	0.8902	0.9000	0.8990	0.9059	0.9100	0.9106	0.9116	0.9103
Wald statistic	88.19	58.35	89.99	58.06	96.74	61.77	93.26	59.35
Wald p-value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Standard errors in parentheses

*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table B2. Reduced form regressions of the lagged log net-of-tax natural gas price for households over instruments used in the System-GMM

Dependent variable: net-of-tax price of natural gas for households	Eurostat	IEA
	OLS	OLS
R-squared	0.492	0.503
Adjusted R-squared	0.4271	0.3812
Wald statistic	7.603	4.126
Wald p-value	0.0000	0.0000

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Reduced form regression of *pit* over D*pi,t*-2,D*pi,t*-3,... and a full set of time dummies. Wald test testing H0: slope coefficients jointly zero.

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