WELFARE EFFECTS OF GAS INDUSTRY REFORMS IN THE EUROPEAN UNION: AN EMPIRICAL ANALYSIS

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Abstract

Since the mid-Nineties, the EU has decided to implement radical reform both the in the gas and the electricity sector. The paper offers an exploratory empirical analysis of the impact on consumers' welfare of the reforms of the gas industry in EU-15 area. After considering some features of the natural gas industry and of its reform in selected countries, we study the relationship between regulatory reform indicators and price dynamics by means of panel data techniques. We then present a simple exercise of welfare evaluation. We do not find any evidence about beneficial effects on prices from the regulatory reform process.

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1 Introduction

The advent of "regulatory reforms", including privatization, network unbundling, regulation and liberalization in many European and OECD countries is often seen as a key tool for fostering economic growth and welfare. It is pointed out that heavy regulated markets imply negative welfare effects since public ownership and some forms of heavy regulation distort the allocation of resources between sectors and between firms, ending up affecting the overall economic performance.

One prominent characteristic of the European Union policy is the attempt to implement regulatory reforms also into the energy industry, historically considered a natural monopoly sector. The provision of gas and electricity services at acceptable prices is fundamental to increase the competitiveness of business and the welfare of household. In order to achieve this objective the EU came to the decision that radical reform both the in the gas and the electricity sectors had to be made.

In the last 15 years, these reforms have yielded a "new paradigm" characterised by a general consensus over the necessity to carry out some common measures for achieving a well functioning market-oriented industry'.[1] Namely, three parallel reforms have been called for: the privatization of the incumbents (sale of existing publicly owned firms and licensing of private entrants); unbundling, i.e. the separation of network segments of the industry from the potentially competitive ones, associated both with incentive regulation of the networks and establishment of independent regulatory bodies regulatory empowered at guaranteeing a non discriminatory access to the network infrastructures; liberalisation and development of a competitive environment by removing barriers to entry and asymmetries.

Theoretical and political challenges are posed by the execution of this "paradigm", given that it is well known that large and integrated firms can often enjoy considerable economies of scope, scale or coordination depending on the degree of conglomerate, horizontal or vertical integration. This supposed pursuit of efficiency is often at the expense of competition, in that large firms are likely to acquire a strong if not dominant market position, and productive and dynamic inefficiencies are likely to occur as a consequence of that. Energy sectors display considerable problems of this type, especially since in most cases

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[1] On this issue, see ***Jamasb and Pollitt, 2005***

their current set-up has its origin in a long tradition of state monopolies, where vertical integration was the rule.[2]

An extended empirical literature looking at macro-economic outcomes provides some support to this negative view of vertically integrated monopolies. For example Alesina *et al.* (2005) find that regulatory reforms in sectors which were characterised by competition (transport, communication and energy) have had a significant positive impact on own-sector capital accumulation. By contrast, the evidence of more direct positive effects is poorer. For example Barone and Cingano (2007), do not find significant effects on the growth of the industry value added when looking at aggregate measures of services liberalization. Moreover, this predominant focus on macroeconomic aspects, which mixes the issue of privatization with that of liberalization, has partially covered what has been one of the primary goals of EU policy on public utilities and services, i.e. fostering competition in order to provide consumers with lower prices and more freedom to choose. Indeed, "the devil could be in the details", and even market liberalisation could not bring significant positive welfare effects (e.g. see van Witteloostuijna, Brakmanb and van Marrewijk, 2007, for an analysis of the Dutch natural gas industry). In any case, detecting which specific reform intervention, if any, is more likely to positively affect citizens' welfare becomes crucial. As a matter of fact, some worries about the real effectiveness of the current patterns of regulatory reforms can no longer be concealed, and more articulated views such as that by the World Bank (2007) have appeared which, in comparison with the "EU paradigm", leave more degrees of freedom to national policy-makers.

Differently from some of the existing literature, in this paper we focus on first round partial equilibrium impacts (as typically done by applied indirect tax reform literature). After all, if consumers at large do not benefit directly from reforms, it seems unlikely that indirect benefits to them through impacts on other industries, or benefits to other agents, can change dramatically the evaluation.[3]. In order to achieve a conclusive policy assessment, one should undertake a welfare analysis based on detailed micro-data on households expenditures, possibly with a decomposition of prices and quantities, and controlling for quality indicators of services such as access possibilities and contractual transparency. For the natural gas

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[2] For a detailed history of nationalisation and consolidation in Europe see Millward (2006)

[3] Quite surprisingly, significant indirect effects in spite of small direct effects are found in a series of studies, namely (Copenhagen economics,2006; Alesina et al; Barone and Cingano, 2007).

industry, the latter issues are usually a relatively minor concern, so that the key indicator for evaluating the success of public utilities reforms is consumers' price.

Unfortunately, in order to undertake a cross-country analysis one needs to rely on average prices, with considerable information loss for those cases where there is price discrimination across types of contracts. Though, even if based on average prices, a few simple policy questions can be made:

- are European consumers facing lower prices than they would do if no regulatory reform processes would had taken place?

- Given the plurality of tools which contribute to define service regulatory reforms, which are the specific policies that actually affect price dynamics and consumer's welfare?

- Given that liberalization is likely to be associated with higher transaction costs which should somewhat outweighed, are effects on prices substantial or negligible?

In order to assess how regulatory reform has affected price dynamics, we combine a few datasets. The starting point for trying to answer some of these questions in this paper is the well known set of regulatory reforms indicators (REGREF), an OECD regulatory database which collects some indicators of privatization, disintegration, liberalization of several services of general interest across some OECD countries (Conway and Nicoletti, 2006). Information on prices are, instead, recovered from two standard statistical databases, EUROSTAT and IEA. Both these institutes provide net-of-tax series which cover the period when the European reforms have been started.

The strategy we adopt here is similar to the one used by Copenhagen Economics (2005) to estimate and forecast impact of market opening policies on overall price and productivity changes and to use this forecasts as inputs into their simulation model of the European economy. Our implicit hypothesis is that panel data techniques are able to get rid off of the national idiosyncratic aspects and of common trends, so that the effects of changes in regulation regimes can be detected.

The structure of the paper is the following. The next section reviews some features of the natural gas industry and its reform in selected EU countries. The relationship between

regulatory reform indicators and price dynamics is studied in Section 3 by means of panel data techniques. Finally, Section 4 discusses main results and concludes.

2 The structure of the natural gas industry and main sector reforms in the EU 15

The natural gas industry is composed by different segments, each of them with specific economic and technological features. The upstream phase include exploration, extraction and production. Once a potential natural gas deposit has been located and a well has been drilled the gas is worked for commercial purpose. The efficient and effective movement of natural gas from producing regions to consumption ones requires an extensive and elaborate transportation system. In many instances, natural gas produced from a particular well will have to travel a great distance to reach its point of use. The transportation system consists of a complex network of pipelines, designed to quickly and efficiently transport natural gas from its origin, to areas of high demand. Natural gas, like most other commodities, can be stored for an indefinite period of time. These storage facilities can be located near market centres that do not have a ready supply of locally produced natural gas. Distribution is the final step in delivering natural gas to end users. While some large industrial, commercial, and electric generation customers receive natural gas directly from high capacity interstate and intrastate pipelines most other users receive natural gas from local distribution companies: usually they are involved in the delivery of natural gas to consumers within a specific geographic area. Local distribution companies typically transport natural gas from delivery points along interstate and intrastate pipelines through thousands of miles of small-diameter distribution pipe. The retail segment is the last downstream phase of the industry. Prior to the deregulation of the natural gas commodity market and the introduction of open access to the transmission grid, there was no role for natural gas marketers. However, with the newly accessible markets introduced gradually over the past fifteen years, natural gas marketing has become an integral and competitive component of the natural gas industry.

The historical structure of the gas sector in Europe is that of a public owned vertical monopoly. This kind of organization is easily justified on the ground that the traditional benefits from vertical integration were generally strengthened by an additional factor which play a very important role. This factor is the burden of the long-term investment in the upstream phase (gas contract, infrastructure), which are supposed to require the need to minimise the uncertainty to sell the gas purchased in international markets. A direct

consequence of this circumstance has been the development of the so called *take-or-pay* contracts. These particular types of agreements, largely diffused in the gas international market, are signed between the owner of natural gas (often a large state owned firm from non EU countries) and a large buyer who imports the gas and then resells it wholesale. This contract is meant to leave the owner with some price risk,[4] while the importer entirely bears the quantity risk (the risk not to be able to resell the gas purchased). The argument put forth is that the extractors need to be covered from the market risk when they sink huge investment in extraction and transportation. Generally it is claimed that vertical integration is the natural remedy to ensure the upstream firms to be able to resell the contracted gas in the final market, covering their *take-or-pay* contracts.

The view of the European Commission is that, although these contracts pose serious problems to competition in retail supply, they do not necessarily require to maintain vertical integration. The existence of these contracts does not necessarily require the importer and the seller to be the same economic entity in the national market. By breaking up the import contract into several subcontracts, there are ways to guarantee the commitments that the importer has with the foreign producer firm without implying the creation of a dominant position in the national market.

Following this approach and based on the experience of United States and UK, the firsts two countries that have undertaken gas market deregulation in 1985 and 1992 respectively, the European Commission has promoted the liberalization of the gas industry by establishing a common set of rules and principles through two different Directives in 1998 and 2003. These directives represent the milestones in the gradual but radical restructuring of the gas sector. They had initially set a mandatory market opening calendar giving the EU 15 member countries eight years to open their markets to competition. Subsequently the second directive stepped up the pace of liberalization in the move to establish a single European gas market.

2.1 The European gas directives

The first European gas directive[5] was adopted by the European Parliament and Council in June 1998. Most of the member states forming the Europe of fifteen transposed this directive into national law on August 2000. The directive lays down a set of common rules and

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[4] International prices may vary during the period in which contract conditions are set, even if usually the contracted terms are indexed to other energy prices.
[5] First European gas Directive (98/30/EC)

procedures relating to the organization and functioning of the national gas sector. Its main objective was to establish a single natural gas market integrated, competitive, and regulated at EU level. This aim was crucial in order to boost the competitiveness of the European energy sector against international competitors and to improve the overall structural efficiency of the European gas market. The final purpose of the Commission was to give the right to freely choose the supplier to household and industrial customers and to create a real market price for gas, based on the interaction between supply and demand.

The central problem in that regard was the creation of a level playing field for new entrants in an industry that in most cases was previously dominated by a single incumbent. The industrial structure imagined in a liberalized energy market required therefore to combine competitive markets in sales linked through a monopolistic network segment. The general principle promoted by the directive is the third party access, by which the owner of the network is obliged to give access to all the delivery requests through the network by the production and sales operators, setting a cost reflecting and non discriminatory access price. The directive allowed the member countries to choose between an access price negotiated by the parties and a regulated price set by some public institutions. Third party access alone of course cannot avoid the distortion that the incumbent firm can create to foreclose the entry of new competitors. Some sort of separation of activities was therefore promoted, but leaving the member states the freedom to choose between different alternatives. From the most radical that prescribes proprietary separation of the monopoly activities from the competitive ones, to a milder legal separation, reached through the creation of different companies under a common holding, to the weakest version of accounting separation. The last indication of the directive is the opening of the demand side, through the notion of eligible customers, a client that has the right to seek the most convenient supplier. This type of client is identified by his yearly consumption and a timetable is set to widen the portion of liberalized demand by defining lower and lower consumption threshold.

Many other important elements of the structure of the gas industry were not treated, leaving their definition to discretions of the member countries: among them, the desirable degree of fragmentation of the competitive segments, the kind of market organization, the role of state ownership in the different segments.

On June 26, 2003, the European Parliament and the Council adopted a second directive,[6] which laid down a set of additional common rules for the creation of the internal natural gas market. Unfortunately, the OECD indicators of regulatory reforms in the members states that we discuss and use in the next section do not cover the implementation of this second directive, which abrogated that of 1998 and included new measures intended to advance legal deadlines for complete opening of national gas markets to July 1, 2004 for all industrial users and to July 1, 2007 for households.

The directive also reinforced the obligation to keep separate account. It requires that incumbent operators must ensure that transport operations have a separate legal account from other activities, effective July 1, 2004 for transport and no later than July 1, 2007 for distribution. Moreover, member states are enabled to impose transparent, non-discriminatory public-interest obligations on undertakings operating in the natural gas sector, which may relate to safety, security of supply, regularity, quality and price of supplies, and environmental protection. The powers of regulatory authorities were also reinforced, particularly as regard the control of the level of transparency and competition on the market. Despite the provisions of the two European directives that imposed a progressive opening of the market for industrial and household consumers, there is a great discrepancy between the legal market opening rate and the real one.

A possible way to detect the level of competition in the gas market is to look at the percentage of eligible consumers that have effectively switched suppliers. Table 1 report this information for the EU 15 at the end of 2004. In general, it is possible to observe that market opening is much less advanced in reality than in theory. The situation varies considerably across countries. In UK the percentage of large users that have changed supplier is very high (50%). This country, the first one experiencing the liberalization in the gas sector, continues to lead Europe in this respect. Similar switching rate are also recorded in Ireland and Spain. The situation in Austria and Germany is opposite with a switching rate below 10%, while in France it is in line with the average of Europe at about 25%. In all the countries where small customers are already eligible, very few have changed suppliers, except in the UK and Italy.

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[6] Second European electricity and gas Directive (55/2003/EC)

Table 1 - The EU 15 gas sector: switching rate at the end of 2004

Country	Legal market opening rate %	Real market opening rate %	
		Large Users	**Households**
Austria	100	9	0.5
Belgium	90	60	4
Denmark	100	30	<5
Finland	-	-	-
France	70	25	-
Germany	100	7	<2
Greece	-	-	-
Ireland	86	>50	-
Italy	100	30	35
Luxembourg	72	<5	-
Netherlands	100	30	2
Portugal	-	-	-
Spain	100	>50	5
Sweden	50	<5	-
UK	100	>50	47

Source: Commission of European Community (a), 2005

It is quite evident that beyond the reach of EU legislation, real market opening is impeded by a number of obstacles that cannot be only overcome by enacting regulatory texts. The gas sector continues to depend on a number of technical and economic factors specific to Europe and its gas market situations. Imports are highly concentrated in a small number of producing countries, located outside Europe. There is a structural lack of competition on the supply side, dominated by state-owned companies from producing countries outside the European union, such as *Gazprom*, *Statoil* and *Sonatrach* which in 2005 together represented over 45% of the entire European supply.[7] This dependence is also expected to grow strongly in the years to come. The deregulation effort is therefore coming up against a major barrier: the European Union is striving to open up its downstream gas market despite the fact that its upstream sector, most of which is not subject to European regulation, is still controlled by a small number of market players. Moreover the presence of *take or pay* contracts and long term relationship established prior to deregulation between producing countries and purchasers are now curtailing possibilities for short term exchange and opportunities for new entrants. As a result, in many cases a single shipper dominates the market and sells nearly all the gas available. To facilitate the entry of new gas supplier into the market and weaken the dominance of incumbent operators, some countries have introduced gas release programs

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[7] *Gazprom* is a company mainly controlled by the Russian state that possesses the world's richest natural gas reserves. *Statoil* is an integrated oil and gas company based in Norway. *Sonatrach* is the Algerian company active in research, transformation and transport of hydrocarbons.

whereby the incumbent must divest a portion of his portfolio of long-term contracts.[8] The development of competition in the industry is also hindered by technical constraints. The cross country gas exchange is limited by network congestion due to insufficiently interconnections between member states: capital expenditures in new gas infrastructure currently represents a missing key to the emergence of a truly competitive market.

2.2 The gas market in EU 15: production, consumption and external trade

The evolution and the maturity of the gas market in the EU 15 differs considerably across countries. In some of them natural gas is steadily used as a primary source of energy while in others, due to the limited availability of internal resources and/or to the scarcity of interconnections, its use is very restrained. This frame clearly emerges if we look at table 2. The highest level of consumption is recorded in UK where natural gas has replaced oil as the main primary fuel and the rate of diffusion among the household consumers is very large (35% of total consumption). The second market in EU 15 is that of Germany where total consumption is slightly under UK but the share of household gas consumption is the same. Italy is the third largest natural gas consumer in Europe with a demand that has been steadily increasing in recent years. This growth has been driven mainly by the power sector as the government decided to decrease the share of oil in thermal power generation. The diffusion among the household consumers has been also quite strong with a share of 26% over total consumption.

France, Netherlands and Spain represent intermediate market in terms of consumption. The French gas market is mature in age but the share of natural gas in primary energy requirements is small if compared to other mature market and growth is not expected due to the dominance of nuclear power. Netherlands probably have the most mature gas market in the world. Natural gas accounted for about 50% of primary energy requirements, a share significantly greater than in any other European country. Spain has one of the fastest growing gas market in Europe with further possibility of growth considering the limited diffusion of natural gas among household consumers.

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[8] These procedures are not provided under the two directives, but the European Commission has already imposed a gas release program by way of compensatory measure in approving some mergers (for instance *E.ON-Ruhrgas* in Germany). In some case a gas release program has been imposed by the national legislation (England, Italy, Spain) and by certain regulatory bodies (France, Denmark, Austria).

As regard the small and Nordic European countries, the picture varies considerably depending on the geographic position and on the availability of internal resources. While Austria, Denmark, Belgium Ireland and Luxembourg show a discrete use of gas both in production stages and for household consumption, the same is not for Greece, Portugal, Finland and Sweden where the diffusion of this source of energy is very limited and lowered by the limited interconnections and in some case by specific choices.[9]

Table 2 - The EU 15 gas sector: main data at the end of 2004

Country	Internal Production (TJ_gcv)	Total Consumption (TJ_gcv)	Import dependency* (%)	Household consumption over total (%)	Imports from LNG over total (%)
Austria	77550	357055	-78	19.5	0
Belgium	0	677290	-100	25.8	17.2
Denmark	395033	223311	43.5	14.6	0
Finland	0	183779	-100	0.6	0
France	51530	1807998	-98	28.5	20.4
Germany	685342	3750763	-82	35.2	0
Greece	1337	102462	-98.7	1.6	18.4
Ireland	32025	169708	-81	16.2	0
Italy	493813	3066058	-84	26	8
Luxembourg	0	111588	-100	10.5	0
Netherlands	2864924	1708444	40.3	21.5	0
Portugal	0	153733	-100	5.5	36.8
Spain	14398	1159510	-98.7	12	37
Sweden	0	41142	-100	4.8	0
UK	4019594	4087717	-1.6	35	0

Source: Eurostat 2006
Note: * = positive numbers mean that the country is a net exporter

Of course the use of natural gas and the dimension of national markets are also driven by the endowments of each country. The largest gas-field are located in UK and Netherlands. Germany, Italy and Denmark have also some important gas-field but with more limited dimension. A natural consequence of this scarcity of endowments is a situation of strong import dependency. Among the 15 countries considered, only Denmark and Netherlands are net gas exporters. Both countries export about 40% of internal production to Sweden, Germany, France, Belgium and Italy. The situation of UK is different because the internal production, even if the largest across the EU15, is entirely destined to cover the internal demand. All the remaining countries satisfy nearly their entire demand with large gas imports.

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[9] Greece, Finland and Portugal derogate from the provisions of the second European gas directive by virtue of their status as emerging or isolated markets. In Sweden nuclear power accounts for half of electricity supply. After the 1980 referendum to phase out all nuclear power plants by 2010, the government has given priority to renewable sources to fill the gap left by nuclear power and this choice has hampered the further development of the gas market

This situations raise the question of the security of gas supply which has been evaluated in a European directive of 2004.[10] At present, nearly all the gas imports into EU come from three countries – Russia, Norway and Algeria. With indigenous gas reserves declining and worldwide gas consumption expected to increase significantly, the current heavy dependency on a small number of supplying countries needs to be overcome. In this respect some European countries have undertaken the construction of new transport infrastructure, pipelines or liquefied natural gas facilities (LNG). In particular this last option seems to be very useful in order to enhance gas imports from new producing countries and to diversify the supply sources. Spain is the European country with the highest number of LNG terminal in Europe: 37% of total gas imports are transported by ship from very distant country such as Nigeria and middle-east countries. The same approach was followed by France and Portugal where respectively 36% and 20% of total imports are derived from LNG terminals. This share is more limited in Greece (18%), Belgium (17%) and Italy (8%), where only one LNG terminal is present, and is equal to zero in all the other European countries where there is an increasing debate about the opportunity to build these infrastructures.

To illustrate the diversity of the industry, in the following sections we briefly sum-up the main features of the gas industry and reform process performed to implement the two gas directives in some selected European countries. The country analyzed are UK, France, Germany, Italy, Spain and Netherlands. The choice to exclude the remaining nine countries from a deep analysis is due to the limited diffusion of natural gas as previously pointed out.

2.3 Reform trends

The opening of the gas market in UK was carried out well in advance of the requirements of the two European directives. The process began with the Act Gas in 1986 which disposed the privatization of the public monopolist vertical integrated *British Gas* and the creation of a regulatory authority (*OFGAS*)[11] and was concluded in 1998 when all domestic customers were given the right to choose the supplier. In 1997 *British Gas* separated its retail division. It became *BG plc* and included the distribution and transmission network activities (*Transco*) while the smaller retail division, which had a small production division, but no network interest became *Centrica*. In 2001 *BG plc* separate the *Transco* network division as a distinct

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[10] European Directive 2004/67/EC concerning measures to safeguard security of natural gas supply

[11] At present, the Regulatory body for the British energy industry (England, Wales and Scotland) is the Energy Markets Authority, which operates through the Office of Gas and Electricity Markets (*Ofgem*). This was produced in 2001 from the merger of the gas (*Ofgas*) and electricity (*Offer*) regulatory bodies.

company called *Lattice* but in 2002 it merged with the *National Grid Company* to become *National Grid Transco* (NGT). The regulator therefore required NGT to separate the distribution and transmission sector. The distribution network was split into eight different regional business and four of these were sold. As a result of this long reform process the gas wholesale market in great Britain is now highly competitive.

In contrast to UK, France was one of the latecomer in implementing the EU gas directives. The main texts governing activities related to gas are the 2003 and 2004 Law, which transposed the two gas Directives. These laws extended the powers of the French regulator (*CRE* established in 2000) in order to include also the electricity and gas sector. Furthermore they officially ensures the transposition of the legal unbundling obligation applicable to the TSOs,[12] since they provides for the creation of a separate legal entity in charge of the management of the transmission system. Despite the adoption of the two directives and the legal separation implemented, the European Commission think that the unbundling remains still insufficient in order to avoid discriminant behaviours. As a consequence the opening rate of the market is largely theoretical with a switching rate in the industrial segment not comparable with that of the UK, and with the retail market for small consumers not open until July 2007.

Germany transposed the second European gas directive by the Energy Act of July 2005. According to the provisions of the directives the Act established a regulatory authority (the *Federal Net Agency*) with competences in the gas and electricity sector. Despite the official start of liberalization in 1998 with a negotiated third party access to the transmission grid to new entrants and the right to choose the suppliers to any customers, the market is still suffering from a lack of liquidity in terms of both capacity and commodity. Only one gas retailer has a market share above 5% and the switching rate between industrial customers and household is very restrained (7% and about 2% respectively). This fact can be attributed to a number of reason such as long term supply contracts in the internal market; contractual congestion in the pipeline preventing new market entrants from acquiring capacity; a certain hesitation of the large gas producers to sell gas to new market entrants; the not yet completely implementation of a real unbundling. The overall feature of the German gas market, similar to a complex web made up of companies operating at several levels, and characterized by a high degree of vertical and horizontal contractual connections and economic interdependence

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[12] Transmission system operators

between the companies involved, may represent a further obstacle to the development of a truly competition.

The first step towards the liberalization of the gas sector in Italy was the approval of Law 481 of November 1995 establishing the Italian regulatory Authority for Electricity and Gas (*AEEG*). It gave the regulator wide competences, including ex-ante tariff fixations, complaints and appeals. Contextually the partial privatization of the vertical integrated public gas monopolist *ENI* was performed. Since the second half of the nineties about 80% of the shares were sold to private investors, with the Treasury still retaining a control position. The transposition of the two gas directives was made by several legislative measures, taken in different occasion. The most relevant was the Letta decree (decree N. 164/2000) that gave a strong impulse to the creation of effective and increasing competition, liberalizing the activities of importation, exportation, transportation and dispatching, distribution, and trade of natural gas. Among the most relevant provisions there were: the legal unbundling of transport, storage and distribution activities; the reduction of concentration in the market with the introduction of a 50% maximum market share ceiling on gas sold to final customers and 75% of gas imported by a single player; the creation of wholesale market competition; the eligibility for all customers by January 2003.

Accounting in 2005 for 20% of Spain's primary energy structure, Spain gas market is relatively recent and strongly growing. Overall consumption of gas has doubled from 2000 to 2005 with a 18% growth in 2005. The country had implemented important provisions of the two gas directives. Full market opening, including for domestic customers, and regulated third party access, also for gas storages are effective since January 2003. Ownership unbundling, at least partially, of gas transmission system operators was implemented, as well as legal and accounting unbundling of distribution system operators. An energy regulator exists since 1994 (*CNE*). However some important elements of the directives still have not been transposed and the adoption of the implementing legislation has constantly been delayed. Spain is therefore the only member state with Luxembourg subject to general infringement procedure for non communication of transposition measures for both the gas and electricity directives, that are now before the European Court.

Netherlands are the second EU 15 gas producer country. About half of its production is exported to French, Germany, Belgium and Italy. The two directives concerning the internal market for gas have been transposed and no infringement case were launched against the country in this respect. An authority gas regulator (*DTE*) was set up since 1998. The most important gas firm is *Gausnie*. This company was previously owned by the Dutch state (50%)

and by *Exxon-Mobile* and *Shell* (25% each). On July 1 2005, *Gausnie* was formally split into two companies, a network company that will continue to be known as *Gausnie* and a purchasing and sales company for natural gas, *Gausnie Trade and Supply*. The Dutch state bought out *Shell* and *Exxon-Mobile*'s holding in the network company, while the ownership of the purchasing and sales company remains unchanged. There are a lot of plans and rumours on new investments in the gas sector with many Dutch utilities who have planned to build new storage facilities close to the German border and three LNG terminals near Rotterdam. There are also numerous definite investments plans for new connection with other markets. The BBL gas pipeline between UK and Netherlands was planned to be operational by 2007.

2.4 Market structures

Despite the European Commission advocates a single cross-country policy reform pattern, there is still a large variability in the national natural gas market structure among the EU 15.

In UK the privatization of *British Gas* as a vertically integrated company prevents new entrants from came into the market for many years. However since the middle of the 90s the government required it to progressively reduce its market share in the industrial market where it was replaced largely by oil companies. There are now many off-shore producers active in the Nordic Sea production as well as importers using the interconnector between the UK and Belgium. The main features of the retail UK gas market is the progressive process of merge with the electricity market: all significant suppliers offer gas and electricity as a dual package. *Centrica* still holds about 60% of the residential gas market, with the rest of the market going to the five major electricity companies: *RWE/NPower*, *EON/Powergen*, *EDF*, *Scottish and Southern*, and *Scottish Power*. *Centrica* only holds a small percentage of the industrial market, in which a significant proportion is held by the oil and gas majors. Britain is now facing a transition: from self-sufficiency in natural gas production it is becoming a net importer due to the declining internal production. To overcome this new condition the country created the first trading connection with continental Europe via Belgium in 1998 and the links to Norway and Netherlands were successfully reinforced. The future projects include the creation of many LNG terminals in order to diversify the supply sources.

The gas industry structure in France parallels that in the electricity sector with one large company, *Gaz de France* (GDF) dominating the market. It was fully national owned until July 2005 when 22% of the shares were sold by initial public offer. There are two TSOs in the country: *Gaz de France Reseau Transport* (GDF-RT) and *Total Infrastructures Gaz de France* (TIGF). They have been unbundled in legal terms, which means that GDF-RT and

TIGF are separate entities, distinct from their groups. GDF-RT is a fully owned subsidiary of the group *Gaz de France* while TIGF is a subsidiary of the private group *Total*, the second gas operator in the French gas market. GDF and Total control almost 95% of gas imports by long terms contracts. The main providers of natural gas are Norway (27% of total imports), Russian (21%), Netherlands (20%) and Algeria (12%). A relevant portion of French total import (about 20%) enter via LNG terminal. The high concentration of gas imported in the hands of only two companies prevents the wholesale market to develop. In the retail segment there is a limited competition also: *Gaz de France* has not separated its retail activities and dominate the market for industrial and household consumers but two new foreign companies (*British Petroleum* and *E.ON*) are attempting to enter the market.

The structure of the German gas market is characterized by a multi-tier structure containing five big companies at the import and transmission level, another 24 regional companies at transmission level, and approximately 700 companies operating at the local distribution level. *Ruhrgas*, with about 50% of the available gas dominates the market. It was taken over by *E.ON*, one of the two largest electricity companies in 2003[13]. The main competitors of *Ruhrgas* are *Wingas*, a company jointly owned by *BASF* and *Gazprom*, *RWE* the other large electricity company, *VNG* and *BEB*. The German gas transmission system is operated by the five big companies plus a number of regional transmission companies. Like in the electricity sector, most of the incumbent companies have acquired minority stakes at the level of local municipal utilities, which are usually supplied by long term contracts. Germany disposes of a relatively diversified gas supply portfolio containing domestic production (18% of total gas supply), imports from EU member states (22%), from Norway (26%) and from Russia (37%). All gas imports are contracted by the five big companies.

The main participants in the Italy natural gas market are *ENI, ENEL Group, Edison Group, AEM group, Hera Group, E.ON.* and *Gaz de France*. The most relevant firm is still the former integrated monopolist *ENI*. The wholesale market is strongly dominated by *ENI* with 84% of domestic production and 65% of imports through five main infrastructures under his direct or indirect control[14]. An *ENI* subsidiary, *SNAM Rete Gas* (50% owned by *ENI*), owns and operates the domestic natural gas transportation system. According to the recent

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[13] The condition imposed by the German authority for allowing the take over included the sale of its stakes in a number of different gas companies and also it was required to auction a significant proportion of its gas import contracts to reduce its dominance on wholesale market.

[14] TAG pipeline (mainly Russian gas), TENP pipeline (mainly Norwegian gas), Panigaglia LNG Terminal (mainly Nigerian and Algerian gas), TTPC pipeline (Algerian gas), Green Stream pipeline (Libyan gas)

legislation *ENI* had to reduce its ownership to 20%. *Stogit* (100% owned by ENI) manages most of storage facilities. There are about 430 distributors in the country. The largest one *Italgas* (100% owned by ENI) has a 32% market share and is legally unbundled since 1999. In the retail market at the end of 2006, 380 companies owned a gas licence. Most of them represent unbundled sales division of formerly integrated distribution companies. However the market is strongly dominated by three largest group: *ENI* with a market share of 40.3%, *ENEL* (15.8%), and *Edison* (7.9%).

Table 3 - *The EU 15 gas sector: production, imports and retailing at the end of 2004*

Country	Production and Imports		Retailing	
	Number of entities bringing gas into the country (production or imports)	Number of entities dealing with at least 5% of natural gas (imported and produced)	Total number of suppliers	Suppliers having a share of at least 5% of the total
Austria	4	4	27	5
Belgium	4	2	32	2
Denmark	1	1	7	5
Finland	1	1	30	1
France	13	1	34	2
Germany	27	5	700	1
Greece	1	1	15	1
Ireland	7	5	2	2
Italy	26	3	389	5
Luxembourg	2	1	6	4
Netherlands	n.k	n.k.	25	4
Portugal	1	1	10	4
Spain	14	4	41	4
Sweden	1	1	7	5
UK	24	6	15	7

Source: Goerten and Clement (2006)

In Spain the gas industry before liberalization was dominated by one integrated private company, *Gas Natural*. Until 2000 it controlled the transmission network and the retail segment. In 2002 the regulator authority forced the company to spin off 65% of the shares of *Enagas*, the private firm that controls Spain's natural gas transport system. *Gas Natural* still owns 18% of *Enagas* shares but this quote must be reduced to 5% within the end of 2007. The country imports all its gas mainly via pipeline from Norway and Algeria but with a significant proportion coming via LNG terminals from countries such as Qatar, Oman and Nigeria. Spain developed in recent years a quite competitive wholesale gas market. The government introduced a gas release programme which operated from 2001 to 2004 and resulted in six new entrants acquiring gas from the largest company *Gas Natural*. *Gas Natural* was forced to sell 25% of its contracted gas to new entrants to promote competition. After this process, the market share of the incumbent has reduced from 100% in 2000 to 48% in 2005. The new

entrants include some electricity companies (*Endesa, Iberdola*, and *Union Fenosa*) which facilitate dual gas and electricity offer, and major foreign companies such as *British Petrolium*, *Shell* and *Gaz de France*. Despite the gas retail market has been fully open since January 2003 the overall setting is far to be considered as highly competitive. If tough competition seems to prevail on the market for big and industrial customers, the situation is less satisfactory for household. The switching rate since market opening is only about 5% and *Gas Natural* still strongly dominates the market for household with a share over 70%.

In the Netherlands the gas sector is still largely controlled by the incumbent *Gausnie*. Despite the transmission system operator is now ownership unbundled and state owned, the dominant position of the company is still largely unchallenged due to its strong position in terms of production. This is reflected by the modest share of small consumer that have switched the supplier since market opening in 2004 (2%). The frame in the industrial segment is slightly different with a cumulative switching rate of 30%. Retail and distribution is carried out primarily by the same locally owned companies as retail and distribute electricity. There have been several take-over and merger in this area with the UK gas retailer *Centrica* acquiring *Oxxio*[15] and the German *E.ON* acquiring *NRE*.[16] *DONG*, a Danish gas company bought the retail business of *Intergas* which sells gas to about 150.000 consumers and electricity to about 300.000 and was previously owned by a pool of municipal companies.

Table 4 – The EU 15 gas sector: type of unbundling for the Transmission System Operator

Country	Type of unbundling	Country	Type of unbundling
Austria	Legal	Italy	Legal
Belgium	Legal	Luxembourg	Not implemented
Denmark	Ownership	Netherlands	Ownership
Finland*	--	Portugal*	--
France	Legal	Spain	Legal
Germany	Partly legal	Sweden	Ownership
Greece*	--	UK	Ownership
Ireland	Not implemented		

Source: Commission of the European Community (b), 2006
Note: * = countries that derogate from the provisions of the second European gas directive by virtue of their status as emerging or isolated markets

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[15] Oxxio is an electricity company that entered the gas market in 2000. It serves 400.000 electricity and 140.000 gas customers
[16] NRE is a gas and electricity company with about 275.000 customers previously owned by the city of Eindhoven an other 11 local municipalities.

3. Empirical assessment of European reforms on prices: a) data

As far as the natural gas prices are concerned, movements in crude oil prices have a prominent role in shaping natural gas prices. Even recent findings imply a continuum of prices at which natural gas and petroleum products are substitutes (Brown and Yücel, 2007). Given this external constraint to the effectiveness of policy reforms, it is however interesting to look for the effects of European attempts to reform this network utility in the last 10 years. The main sources of data for this paper are Eurostat and International Energy Agency (IEA). The main reason for using also this source instead of mainly referring to Eurostat is that correlation between the two series is not very high (under 0.75).

Data on prices we use are household net-of-tax prices, disentangling the tax component from the final price charged to domestic consumers. In particular, the IEA time series of natural gas for residential use starts in 1978 for most of the EU15 countries and ends in year 2005. The EUROSTAT series has started in 1991. In principle, the reference to net prices should allow for directly looking at any direct effect of regulatory reform on production prices. Eurostat prices refer to Gigajoules, whereas the unity measure for IEA is 10^7 KWs. We can get a first picture of price dynamics in the main European national markets from Figure 1.[17] It is evident that common shocks determine most of price variation in current terms. No particularly converging process seems to be in place in the period considered.

The regulation indicators in service sectors which we use in this paper come from the REGREF data set (for details, see Conway and Nicoletti, 2006). Sector-level data are available for the following service industries: electricity, natural gas, road freight, air passenger transport, rail transport, post and telecommunications. All the regulatory indicators range on a common (0-6) scale from least (0 corresponding to full deregulation) to the most restrictive conditions for competition. In principle, several aggregate regulation measures can be created starting from intra-sector indicators (e.g., see Alesina *et al.*, 2005), but in most cases one has to rely on the forced "cardinalisation" into the 1-6 scale of some ordinal characteristics.[18] This operation could be somewhat controversial in several cases. For

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[17] Though the European Directives regarded the EU-15 countries, henceforth we are always excluding from the analysis Greece, Portugal and Finland, due to their nature of limited or isolated markets and the absence of complete time series in the two abovementioned data sources. Moreover, IEA data lack information on Sweden, whilst EUROSTAT does not provide complete series for Denmark.

[18] See the appendix for details. As for the natural gas market, the intra-sector REGREF indicators present 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),

instance, while there is a clear ordering between private, mostly private, mixed, mostly public and public ownership, one may wonder whether coding these different options by means equally spaced values between zero and six is significantly affecting the results. [19]
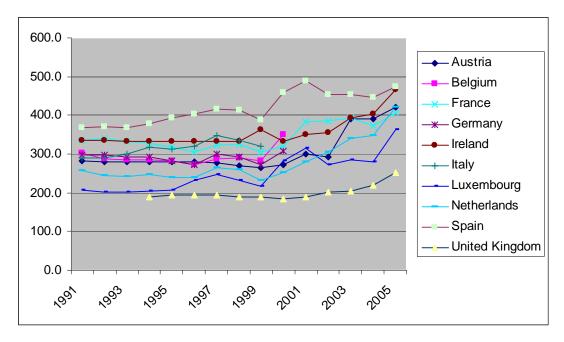
Figure 1: *Net-of-tax price evolution in EU 15*

Source (IEA)

Although REGREF indicators provide a long yearly time series starting in 1975, we only consider years after 1991 due to the reduced availability of price information and the lack of institutional changes before the Nineties. This choice is also motivated by the clear acceleration of the European integration process following the signing of the Maastricht's Treaty in the Nineties. Even the European directives on network utilities can be seen as part of this process. Overall, stronger integration among European economies should increase the reliability of cross-countries comparisons such the one carried out here. By looking to the data reported in Table 5, the consideration of this period onlyseems a natural choice given that no indication of regulatory reform is detected by the REGREF indicators before 1994.

Unfortunately, the last year contained in REGREF indicators is 2003. Overall, we can therefore make use of an unbalanced panel composed of 13 years. Most of missing

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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).
[19] For details on the aggregation methodology followed by Conway and Nicoletti (2006), see Table ZZ.

observations concern price variables, which are not available for a few countries where the market is limited. By excluding the countries cited above the minimum length of time series used in the econometric analysis is 7 years. The trend across the EU15 countries (towards reduction of public ownership, a less vertically integrated industry structure and a less regulated access to the market) is strongly affected by the 1998 European directives, as can be easily verified in Table 5, where the average REGREF indicator for the gas sector are reported. Clearly, there is a downward trend, but some heterogeneity across countries and across time remains.

Table 5: Evolution of the average REGREF indicator in the natural gas industry

Country	1975	1994	1999	2003
Austria	4.5	4.5	4.5	2.7
Belgium	4.7	4.7	3.7	2.6
Denmark	5	4.5	4.5	3.2
Finland	4.5	4.5	4.5	4.5
France	6	6	6	4
Germany	2.5	2.5	1.5	1.5
Greece	6	6	6	5.2
Ireland	6	6	5.4	4.1
Italy	5.2	5.2	4.7	2.4
Luxembourg	4.5	4.5	4.5	3.4
Netherlands	4.5	4.5	4.2	2.9
Portugal	5.5	5.5	5.5	4.1
Spain	4	4	3.2	2.5
Sweden	3.7	3.7	3.2	2.7
UK	5.8	3.3	1.9	1.7

Source: REGREF (Conway and Nicoletti, 2006)

For the reasons clarified above, the use of the usual REGREF indicators into econometric analyses is somewhat questionable. Thus, here we go into further detail by directly considering the "elemental series" used by the OECD for creating their indicators ranging between 0 and 6:

- As far as the public/private ownership dimension, the continuous variables available are the percentage of shares owned by the state in the import, export or production stage (henceforth PUBLIC-PROD) and the distribution stage (PUBLIC-DIST).[20]

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[20] There exist also a third variable related to the percentage of share owned by the state in the transmission industry, but for most countries it is nearly collinear with the variable related to production.

- As for liberalisation, a continuous variable which can be used is the percentage of the retail market open to consumers' choice (OPEN-CHOICE). Moreover, a dummy variable can be created for those cases where the market share of the incumbent is below 90%.

- Regarding unbundling, we do not consider a proper procedure transforming into a cardinal or ordinal scale the presence of an integrated monopoly, legal/accounting separation or ownership separation. We therefore created dummy variables for those cases where distribution is separated from supply, there is ownership separation and   or legal/accounting separation in the import/production and in the supply segment.[21]

4. Empirical assessment of European reforms on prices: b) results

In this section we estimate panel data models where natural gas prices are expressed as a function of the regulatory variables described above. Our aim is to look for any systematic ability by these indicators of regulatory reform to explain net-of-tax levels of natural gas prices faced by European households.

For our empirical investigation we have used both the price data provided by IEA, and those provided by Eurostat. We have firstly explored the datasets by means of within-group and first differences estimators with time dummies. As it is well known, these simple fixed-effect methods provide consistent estimates where a strong exogeneity hypothesis is satisfied. When the latter holds, a within group estimator should provide results very similar to the first difference model. Having found strong differences between the two models, we heuristically deduce the inappropriateness of the strong exogeneity assumption, and consequently moved to only considering dynamic specifications, which on the contrary are able to account for more general assumptions on unobservable heterogeneity components.[22]

The estimated model is the following dynamic specification, where the lagged dependent variable has been used as an additional regressor. Let p_{it} be the level of household natural gas prices for country i at time t, R_{it} the vector of regulatory variables for country i at time t, Z_{it} a vector of additional controls, and α and β two vectors of country and time dummies:

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

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[21] Up to 2003, in too few cases ownership separation was detected.
[22] An additional problem of a simple FE specification is that it is more exposed to spurious regression problems related to the presence of unit roots in the time series which compose the panel.

where $\alpha, \beta, \gamma, \delta, \rho$ are parameter vectors to be estimated and ε_{it} is a iid (over i and t) disturbance term. Country effects make sense in order to get rid of specific unobservable factors such as access to different pipelines with different import prices, the presence of different *take-or-pay* contracts, etc. Time dummies can account for common shocks on consumer prices and oil prices. As for the ρ parameter, which captures the correlation between current and lagged price levels, we must recall that one does not need to interpret it as a real structural parameter, given that in panel data regression its estimated value subsumes the combined effect of true state dependence effects and correlation over time due to unobserved heterogeneity (Cameron and Trivedi, 2005).

As it is well-known, with panel data estimation the inclusion of a lagged dependent variable entails an endogeneity problem which yields unconsistent estimates of traditional random effects, fixed effects and first differences estimators. Consistent estimates can be obtained via instrumental variable approaches such as the GMM first difference estimator by Arellano and Bond (1991). As is well known, consistency of the Arellano-Bond requires a weak exogeneity assumption on instruments, and reposes on large N dimension. When the N dimension of the panel is not large, improvements in the performance of the estimator can be obtained by the Kiviet (1995) and Bruno (2005) approach, based on the correction of the least square dummy variable estimates (LSDV) by approximations of the small sample bias of the LSDV regression containing the lagged dependent variable as an additional regressor. For samples with a moderate *N* dimension, Monte Carlo evidence generally supports the use of this corrected LSDV estimator instead of more traditional GMM estimators (e.g. Judson and Owen, 1999).

Given the limited size of our panel data, we therefore report results both from the Arellano-Bond 1 step estimator and the Bruno's (2005) LSDV method for unbalanced panels.[23] Both methods have detected a statistically significant effect from the lagged dependent variable.

The first two columns of Table 7 report the results carried out with IEA price series. As can be seen, we have not been able to find any significant positive or negative effect related to our regulatory variables.[24] No significant effects are detected if we allow for non

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[23] For the Bruno estimator, standard errors have been computed by bootstrapping with 100 replications
[24] A few significant effects (namely the higher the degree of vertical integration, the higher price levels; and the higher public ownership, the lower the prices) could be detected by using the usual REGREF indicators expressed along the 0-6 scale. We do not report these result for the reason explained above about the arbitrariety of such indexes.

linear relationships by means of quadratic terms, as for example it is done in Alesina *et al* (2005) by using the REGREF indicators "cardinalized" within the 0-6 scale. Finally, we have also checked the robustness of the results by introducing a set of additional control variables potentially affecting the natural gas market (the Z_{it} vector), such as the dimension of the national production, imports and exports, GDP (all in per capita terms), and the national consumer price index. In most cases, these variables did not show any additional explanatory power, and never their inclusion affected the quality of the results on the regulatory variables, i.e. their estimated coefficients and significance level. [25]

The results with the EUROSTAT price series are qualitatively similar, though the absolute values are different given that this prices are per Gigajoule. Most indicators for regulatory reform are not significant, with the exception of the dummy for markets where the share of the incumbent is below 90%.

Table 7: *Estimates of the effects of regulatory reform indicators on natural gas price dynamics*

Response variable:				
Net-of-tax price of natural gas for households	Panel regression, dynamic models			
	1991-2003 sample IEA-OECD price series		1991-2003 sample EUROSTAT price series	
Control variables	(AB)	(Bruno)	(AB)	(Bruno)
	(A)	(B)	(C)	(D)
Public share in production	-0.52	-0.49	*0.004*	-0.005
Public share in distribution	-2.68	-1.74	*0.012*	-0.007
Share open to consumers	0.83	0.85	*0.002*	0.002
Dummy for vertical separation in production	-18.95	-22.44	*0.132*	0.094
Dummy for vertical separation in supply	-10.79	-16.97	*-0.210*	0.038
Dummy for vertical separation in distribution	-110.89	-99.37	*0.069*	0.013
Dummy for share incumbent <90%	81.74	75.84	*-0.643***	-0.609**
Lagged dependent variable	0.45***	0.56***	*0.343****	*0.43****
Constant	*-1.21*		-0.13	
Observations	108	108	*110*	110

Notes: * p-value<0.10, ** p-value<0.05, *** p-value<0.01

[25] Fixing 1991 as a starting period of this additional analysis is of course an ad hoc choice, mainly driven by the correspondence with the Eurostat time series. We have however verified that as far as the regulatory variables are concerned, results are quite robust for any starting year of the panel between 1990 and 1995. In contrast, there appears a decrease in the importance of the additional control variables, as the process of European integration proceeds.

Though the imperfect correspondence among available data sources and the limited size of the available series makes imprudent to draw any definitive conclusion, the main message arising from these estimations is that the ongoing debate on potential consumer's benefits arising from privatization and regulatory reform policies should avoid any kind of "simplistic approach". In the natural gas market, disaggregate indexes of regulatory reform fail to detect any significant effect. Current available data do not support the view that "beneficial regulatory reforms" can be induced by simply divesting state companies or invoking unbundling and liberalization.

6. Conclusions

The analysis carried out in this paper has not found any statistically significant effect on prices from regulatory indicators characterized by a real quantitative scale. It turns out that our empirical analysis of price dynamics does not provide support to the view that privatization *per se* entails price reduction. Further research is needed to understand why the effects we observe are so small and their determinants quite elusive.

A critical aspect is to be related to the short T and N dimension of the panels we used. On the one hand, a large T is required for consistency when introducing the lagged dependent variable (e.g. Nickell 1981). In our case T is at most equal to 12 for a few countries, but we already pointed out that variations in regulatory reform indicators started in 1994. However it is well known that GMM methods in differenced form, as Arellano and Bond (1991) rely on a large *N* for consistency, and this is not certainly the case with at most 12 countries included in the sample. [26]

We regard our findings as preliminary evidence that -up to now- the empirical evidence that should support the welfare dominance of a standard reform-package in the EU is lacking. Whether these inconclusive results are a consequence of the reduced availability and /or bad quality of data or the indication of the ineffectiveness of European policy is a topic for future research.

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[26] Application of methods such as those by Ahn and Schmidt (1995) and Blundell and Bond (1998) is likely to be a promising way for facing both the abovementioned problems.

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Appendix A: REGREF

The REGREF regulatory dataset has been created by the OECD.[27] It collects information about indicators of privatization, liberalization and disintegration of services of general interest across the OECD countries for 18 years from 1975 to 2003. 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 a 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 has a market share above 90% in each phase). It is composed by three different sub-index: 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 REGREF database provide also a summing index that is a weighted mean of the four different time series. This series, called *Aggregate Gas Regulatory Indicator (AGRI)*, has

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

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 B1 highlight the exact computation mechanism of this aggregate index.

Table B1*: 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 choice	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 industry	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: Regreff database