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

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Welfare Effects of Gas Industry Reforms in the European Union: An Empirical Analysis

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Abstract

The paper offers an exploratory empirical analysis of the impact on consumers' welfare of the reforms of the gas industry in 15 member states of the European Union. After considering some features of the natural gas industry and of its reform in selected countries, we study the relationship between regulatory reform indicators (as summarized by the REGREF database by the OECD) and price dynamics by means of panel data techniques. We then present a simple exercise of welfare evaluation and to what extent price dynamics and the reforms have an impact on subjective consumers' satisfaction, as reported by three waves of the Eurobarometro survey. We also compare REGREF indicators with the Market Opening Milestones database, prepared by Copenhagen Economics on behalf of the European Commission. We do not find evidence that privatization per se has an impact on productivity, prices or satisfaction, while vertical disintegration seems to be beneficial.

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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.

Europe is currently seeking means to re-launch its economic performance to achieve a higher level of growth and competitiveness. A crucial policy in this regard, one of the fundamental element of the Lisbon strategy, is the introduction of competition into the energy sector. A stable and reliable gas and electricity supply at acceptable prices is fundamental to increase the competitiveness of business and the welfare of household and to achieve this objective the EU decided to implement radical reform both the in the gas and the electricity sector. Several key points has been addressed in the implementation of the liberalization process, that posed theoretical and political challenges. Among them we can mention the redesign of the horizontal and vertical structure of the industries, the privatization of the incumbents, the separation of the network segments from the potentially competitive ones, the role of regulation in guaranteeing a non discriminatory access to the network infrastructures, and the development of a competitive environment. It is well known that large and integrated firms can often enjoy considerable economies of scope, of scale or of coordination depending on the degree of conglomerate, horizontal or vertical integration. This supposed pursuit of efficiency may sometimes be at the expense of competition, in that large firms are likely to acquire a strong if not dominant market position. Energy sectors display considerable problems of this type, especially as most of the times their current set-up has its origin in a long tradition of state monopolies, where vertical integration was the rule.

An extended empirical literature looking at macro-economic outcomes provides some support to this interpretation.[1] On the other hand, it seems that looking at aggregate measures of services liberalization yield no significant effects on industry value added growth (Barone and Cingano, 2007).

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[1] 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.

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. The achievement of this objective has been looked for with a variety of policy reforms, some of them not necessarily correlated, and possibly implemented under different industry structures and government interventions.

Following a more "micro-oriented" viewpoint, the immediate policy questions can be quite specific. Namely:

- 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?

- Are effects on prices substantial or negligible?[2]

In order to assess how regulatory reform has affected price dynamics, we combine several 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). As for prices, we use standard statistical databases, such as Eurostat and IEA.

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.

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[2] This question stems from the fact that liberalization is likely to be associated with higher transaction costs (a reason for consumer dissatisfaction detected in some surveys?). Hence only substantial gains are therefore likely to ensure a "net" welfare gain.

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.

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. Section 4 presents a simple exercise of welfare evaluation and Section 5 analyzes whether price dynamics have an impact on subjective consumers' satisfaction. Finally, Section 6 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 type 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[3], 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 undertake 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

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[3] 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.

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[4] 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 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

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[4] First European gas Directive (98/30/EC)

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[5], which laid down a set of additional common rules for the creation of the internal natural gas market. This directive, which abrogated that of 1998, 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. Furthermore it reinforced the obligation to keep separate account. The directive 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

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

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.

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[6]. 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 case, 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 whereby the incumbent must divest a portion of his portfolio of long-term contracts[7]. 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.

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[6] *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.

[7] 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).

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	-
Netherland	100	30	2
Portugal	-	-	-
Spain	100	>50	5
Sweden	50	<5	-
UK	100	>50	47

Source: Commission of European Community (a), 2005

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, Netherland 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. Netherland probably has 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.

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[8].

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 Netherland. 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 Netherland 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. This situations raise the question of the security of gas supply which has been evaluated in a European directive of 2004[9]. 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

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[8] 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

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

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 Netherland. 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.

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
Netherland	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

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*)[10] 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 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[11], 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

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[10] 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.
[11] Transmission system operators

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 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.

Netherland is 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 Netherland is planned to be operational in 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 Netherland 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%), Netherland (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[12]. 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

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[12] 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.

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[13]. An *ENI* subsidiary, *SNAM Rete Gas* (50% owned by *ENI*), owns and operates the domestic natural gas transportation system. According to the recent 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%).

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

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[13] 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)

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*[14] and the German *E.ON* acquiring *NRE*[15]. *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.

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

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
Netherland	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)

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	Netherland	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

3. Data

The main sources of data for this paper are Eurostat and International Energy Agency (IEA) 2006. The main reason for using also this source instead of mainly referring to Eurostat is that this allows us to rely on a longer time series, and to make use of an additional price indicator of services supplied to household by the natural gas industry. Data on prices we use are household net-of-tax prices. IEA price information allows us to disentangle the tax component from the final price charged to domestic consumers. In particular, the time series of natural gas for residential use starts in 1978 for most of the EU15 countries and ends in

year 2005. Reference to net prices allows us to directly look for any direct effect of regulatory reform on production prices.

Figure 1: Net-of-tax price evolution in EU 15
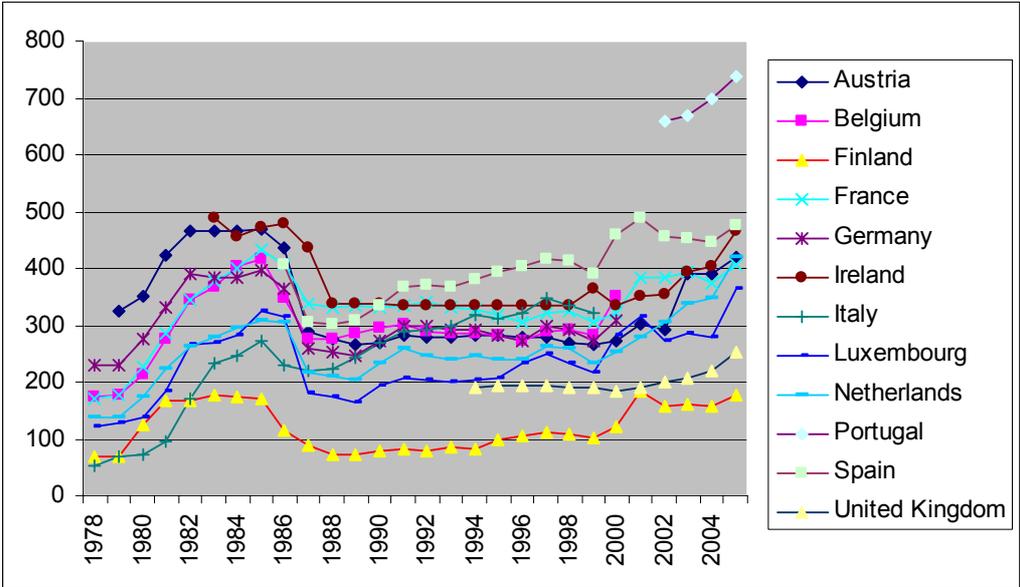
Source (IEA)

From Figure 1, 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 indices in service sectors come from the REGREF data set (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.[16]

As for the natural gas market, we use in particular 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

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[16] Several aggregate regulation measures can be created starting from intra-sector indicators. See for example Alesina *et al.* (2005).

(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). Although in some cases these variables only take discrete variables, they are allowed to take any value in the 0-6 range.

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 1995 European directives. This can be easily verified in Table 5, where we report the average REGREF indicator for the gas sector.

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)

Unfortunately, the last year contained in REGREF indicators is 2003. Overall, we can therefore make use of an unbalanced panel composed of 26 years, whose main characteristics are summarised in the Table 6 below, when using IEA price information; and a panel of 13 years when using Eurostat data.

As Table 6 indirectly shows, we have an unbalanced panel. Most of missing observations concern price variables, which are not available for a few countries where the

market is nearly inexistent (e.g. Sweden), or collection of data is quite incomplete (Greece and Portugal).

Table 6: summary statistics of some relevant variables.

Variable	Obs	Mean	Std. Dev.	Min	Max
year	480	1990.5	9.242726	1975	2006
Net-price IEA	296	496.0971	757.8586	52.85	3766.5
Net-price EUR	184	8.08837	1.955284	4.82	14.8
entry_gas	435	4.66069	1.556537	0	6
public_gas	435	3.521839	2.206266	0	6
mktstru_gas	435	4.954023	1.026246	1	6
vertical_gas	435	4.944138	1.091455	0.9	6
Indigenous-production	422	4742.779	18418.4	6.5	115386
Imports	465	10983.79	17862.3	0.1	90700
exports	465	3542.135	11402.31	0.1	57723
Cpi	420	77.13976	25.67859	4.9	118.9
GDP	420	508.9278	538.4678	5.089	2528.675

Source: Our calculations on REGREF, IEA, Eurostat

4. Explaining gas price dynamics

In this section we estimate panel data models where natural gas prices are expressed as a function of sector regulatory variables, namely vertical integration, public ownership, entry regulation and market structure. Our aim is to look for any systematic ability by regulatory reform indicators 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.[17] We have firstly explored the datasets by means of within-group (or fixed-effect) 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.[18] 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 a strong exogeneity assumption, and consequently moved to only considering dynamic specifications, which on the contrary

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[17] The IEA database does not provide any information on gas prices for Sweden. Moreover, complete information for Portugal is limited to two years. Eurostat does not provide information on gas prices for Greece, and has a number of missing values for several countries.
[18] These preliminary estimates are qualitative in line with those obtained with the dynamic specifications presented later on. The related regression tables are available on request.

are able to account for more general assumptions on unobservable heterogeneity components.[19]

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 log of household electricity prices for country i at time t, R_{it} the vector of regulatory variables (in logs) for country i at time t,[20] Z_{it} a vector of additional controls, and α and β two vectors of country and time dummies:

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

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. 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, remember that one does not need to interpret it as a real structural parameter, given that in panel data estimation 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. However, unconsistency can be corrected via instrumental variable approaches such as the GMM first difference estimator by Arellano and Bond (1991), or by correcting the least square dummy variable estimates (LSDV) by approximating the small sample bias of the LSDV estimator (e.g. Kiviet, 1995; Bruno, 2005). As is well known, consistency of the Arellano-Bond requires a weak exogeneity assumption on instruments, and reposes on large N dimension. For samples with a moderate N dimension, Monte Carlo evidence generally supports the use

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[19] 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.
[20] The vector of regulatory variable could also contain the square of sector REGREF indicators, in order to try to detect any nonlinear effect (i.e. decreasing or increasing marginal effects) of these variables on prices. We plan to carry out this check in subsequent stages of our research.

of corrected LSDV estimator instead of more traditional GMM estimators (e.g. Judson and Owen, 1999).

Given the limited size of our panel data, we report results both from the Arellano-Bond 1 step estimator and the Bruno's (2005) LSDV method for unbalanced panels. Results from the estimates carried out with IEA and Eurostat prices are reported respectively in Tables 7 and 8. Each variable is expressed, whenever possible, in natural logarithms in order to be able to directly interpret the estimated coefficients as the parameters of a constant elasticity model.

The first two columns of Table 7 report the results carried out on the whole period covered by IEA. We have checked the robustness of the results by introducing a set of additional control variables potentially correlated with the regulatory reform indicators (the Z_{it} vector), composed of those variables which demonstrated significant at 10% level at least in one of the several specifications which we have tested: national production, imports and exports, GDP (all in per capita terms), and the national consumer price index. In most cases, adding these variables has not affected the quality of the results on the regulatory variables, i.e. their estimated coefficients and significance level, but only marginally increased the estimated standard errors.

Table 7: Estimates of the effects of REGREF indicators on natural gas price dynamics (IEA price data)

Dependent variable: log price (net of tax) of natural gas for households	Panel regression, dynamic models					
Control variables	1978-2003 sample		*1991-2003 sample*		*1991-2003 sample with quadratic regulatory effects*	
	(AB)	(Bruno)	(AB)	(Bruno)	(AB)	(Bruno)
	(A)	(B)	(C)	(D)	(E)	(F)
Vertical Integration	*0.2204****	*0.1758***	*0.1728****	*0.1435***	*0.2672****	*0.2273***
	[0.0523]	[0.0606]	[0.0499]	[0.0589]	[0.0737]	[0.0888]
Square of vertical integration					*-0.0776**	*-0.0662*
					[0.0376]	[0.0435]
Public Ownership	-0.0063	-0.0077	-0.0085	-0.0086	0.0550	-0.1051
	[0.0309]	[0.0333]	[0.0331]	[0.0361]	[0.0765]	[0.1481]
Square of *Public Ownership*					-0.0688	-0.0598
					[0.0765]	[0.0894]
Entry Regulation	-0.0195	-.0040	-0.0123	-0.0120	-0.0149	-0.0116
	[0.0182]	[0.0213]	[0.0173]	[0.0158]	[0.0178]	[0.0206]
Square of entry regulation					*0.0119*	*0.0112*
					[0.0083]	[0.0097]
Market Structure	*0. 0122*	*0.0288*	*0.0240*	*0.0345*	-0.0688	-0.0688
	[0.0765]	[0.0957]	[0.0696]	[0.0807]	[0.1174]	[0.1174]
Square of market structure					*0.0555*	*0.0555*
					[0.0642]	[0.0642]
Per capita indigenous production	*0.3057**	*0.4735***	*0.1847*			
	[0.1303]	[0.1584]	[0.2130]			
Per.capita GDP (log nat. currenc.)	*0.4070****	*0.3222****	*0.3143**			
	[0.0642]	[0.0545]	[0.1620]			
Per capita imports	*-0.0291****	*-0.0192*	*-0.0174*			
	[0.0059]	[0.0064]**	[0.0095]			
Per capita exports	*0.0018*	*0.0077*	*0.0016*			
	[0.0058]	[0.0074]	[0.0073]			
Consumer Price Index	*-0.2131*	*-0.6555****	*-0.7149*			
	[0.1901]	[0.1264]	[0.4516]			
Lagged dependent variable	*0.5771****	*0.7229****	*0.5560****	*0.6170****	*0.5780****	*0.7149****
	[0.0387]	[0.0531]	[0.0802]	[0.0761]	[0.0778]	[0.1053]
Constant	*-0.0150**		*0.0101*			
	[0.0063]		[0.0102]			
Observations	246	259	123	136	123	136

Notes: Standard error in brackets. * $p<0.05$, ** $p<0.01$, *** $p<0.001$

Moving to the analysis of price effects by the REGREF regulatory variables, the evident result is that the estimated coefficient for vertical integration is highly statistically significant and different from zero at least at the 0.1% level, whilst the other regulatory variables do not display any significant effect. The estimated coefficient (and elasticity) for vertical integration is between 0.22 (A.-B. estimator) and 0.18 (Bruno estimator)[21]. In other

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[21] In this case, standard errors have been computed by bootstrapping with 100 replications.

words, where the REGREF indicator is reduced by 10%, natural gas prices (net-of-tax) are expected to reduce by about 2%. In addition, natural gas price dynamics is also strongly affected by the dynamics of per capita GDP, overall inflation and imports.

For brevity reasons, we do not report the estimation results when using the REGREF indicator for the gas sector as a whole, given that no significant effect is usually detected, or only a extremely small effect is obtained. Given that the aggregate sector indicator is simply the arithmetic mean of the 4 sector level indicators, we can conclude that it is the break of monopolistic vertical integration which is significantly associated with a reduction in price levels, and not the sector regulatory reform as a whole.[22]

In column (C-D) we have reported results for the subperiod 1991-2003. The reason for this choice is twofold. First, we want to make a more direct comparison with the regression carried out with Eurostat price statistics. Second, in the Nineties, there as been a clear acceleration of the European integration process following the signing of the Maastricht's Treaty. Even the European directives on network utilities can be seen as part of this process. By looking to the data reported in Table 7, separate consideration of this period seems a natural choice given that no indication of regulatory reform is detected by the REGREF indicators before 1994.

Overall, stronger integration among European economies should increase the reliability of cross-countries comparisons such the one carried out here. As for regulatory variables, we found that the coefficient of the vertical integration indicator is still highly statistically significant, with a slightly lower value. It is also confirmed the lack of significance of other natural gas regulatory indicators.[23]

In column E and F, we finally present results of a regression carried out on the 1991-2003 subperiod where also the squares of regulatory indicators have been included. Given that none of the control variables included in the "Z_{it}" display any significant effect, we have

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[22] As an additional robustness check, we have carried out regressions restricted to those countries with very limited price information or a negligible natural gas consumption by households (namely, Finland, Portugal and Sweden). Being the quality of the results unaffected, we present here the regressions carried out with all the available information.

[23] 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.

omitted them from the estimation. Quadratic effects are clearly significant at least in the A.-B. estimation, and detect "decreasing returns" of vertical disintegration process across EU-15. Remark that this in contrast with some comparable findings by Alesina *et al.* (2005), who at a more aggregate level found "increasing returns" in regulatory reform policies at the OECD level.

The figures reported in Table 8 are the outcome of a similar analysis carried out by using the Eurostat statistics on net-of-tax-prices of natural gas for households. Eurostat prices refer to Gigajoules instead of 10^7 KWs, but estimation in logs allow us to make a direct comparison between the two data sources, at least for the common period 1991-2003. The first two columns are analogous to columns C and D in the previous table. This allows for concluding that estimation results are quite similar, in spite of the differences between the two series. With the Bruno's (2005) method, the elasticities of price to the degree of vertical integration (0. 15) is pretty similar to that computed with the IEA price series.

The estimation of the model with quadratic effects confirms the nonlinear shape of the relationship between the degree of vertical integration and net prices, but also detects an interesting additional effect. At least in the A.-B. regression, the linear and quadratic indicator of public ownership display statistically significant coefficients which outline a negative relationship between degree of public ownership and price levels. Lack of significance of the linear specification is apparently the result of the high concavity of the relationship, and not of the absence of effects from privatization. When non linear effects are accounted for, loss of public control would seem to entail higher prices, with strongest effects the higher the degree of privatization.

Of course this result must be treated very cautionary, whether because it is not confirmed in the LSDV regression, and is in sharp contrast with studies such as those by Alesina *et al.* (2005), who found quite opposite results.

Table 8: Estimates of the effects of REGREF indicators on natural gas price dynamics (Eurostat price data)

Dependent variable: log price (net of tax) of natural gas for households	Panel regression, dynamic models			
	1991-2003 sample		*1991-2003 sample with quadratic regulatory effects*	
Control variables	Arel.-Bond	Bruno LSDV	Arel.-Bond	Bruno LSDV
Vertical Integration	*0.1207**	*0.1496***	*0.3216***	*0.3598****
	[0.0494]	[0.0496]	[0.1025]	[0.1083]
Square of vertical integration			*-0.1188**	*-0.1106**
			[0.0480]	[0.0472]
Public Ownership	*-0.0340*	*-0.0188*	*-0.3130**	*-0.1342*
	[0.0470]	[0.0331]	[0.1478]	[0.1171]
Square of *Public Ownership*			*0.1817**	*0.0672*
			[0.0913]	[0.0695]
Entry Regulation	*-0.0012*	*-0.0188*	*0.0114*	*-0.0140*
	[0.0137]	[0.0107]	[0.0177]	[0.0142]
Square of entry regulation			*0.0073*	*-0.0007*
			[0.0094]	0.0085
Market Structure	*0.0791*	*0.0816*	*-0.0095*	*-0.0558*
	[0.0706]	[0.0668]	[0.1316]	[0.1028]
Square of market structure			*0.0243*	*0.0958*
			[0.0667]	[0.0623]
Per capita indigenous production	*-0.2340*		*-0.1024*	
	[0.1711]		[0.1624]	
Per.capita GDP (log nat. currenc.)	*-0.3953***		*-0.3012*	
	[0.1353]		[0.1450]	
Per capita imports	*0.0008*		*0.0085*	
	[0.0098]		[0.0110]	
Per capita exports	*-0.0077*		*-0.0133*	
	[0.0076]		[0.0084]	
Consumer Price Index	*-0.2916*		*-0.4857*	
	[0.4377]		[0.5093]	
Lagged dependent variable	*0.2196**	*0.5155****	*0.2280**	*0.4862****
	[0.1016]	[0.0849]	[0.1111]	[0.0950]
Constant	*0.0409****		*0.0377***	
	[0.0103]		[0.0123]	
Observations	117	131	117	131

Notes: Standard error in brackets; * p<0.05, ** p<0.01, *** p<0.001

To summarize, though the imperfect correspondence among available data sources and the limited size of the available series makes imprudent to draw any definitive conclusion, it seems us that the main message arising from the 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". Also in the natural gas market, aggregate indexes of regulatory reform fail to detect any significant effect, whereas promising insights can be obtained by a separate consideration of different REGREF indicators. This has allowed us to

see that "beneficial regulatory reforms" can not be induced by simply divesting state companies (on the contrary, a few estimates detect an opposite effect) or invoking de-regulation *per sé*. More invasive policies which imply the break of nationally vertically integrated monopolies which traditionally have characterised the European market of network utilities seem to be the really relevant determinants of natural gas prices.

4. Estimating consumers' welfare effects of regulatory reform policies.

The previous analysis of the determinants of natural gas price dynamics provides a first indicator of *whether* privatization and/or liberalization policies were able to positively affect (or undermine) consumers' welfare across European countries.

However, in order to get some sort of evaluation of policies' opportunity costs", one also need to estimate *how much* European consumers may or may not have benefited so far from regulatory reform policies.

Detailed welfare evaluation may become a very cumbersome task, if one wants to go along "textbook prescriptions" for an exact computation of standard measures such as compensating variations and equivalent variations. These money metric measures are based on expenditure functions and Hicksian demand. This usually entails the choice of "affordable" forms of utility and demand functions, and the estimate of micro-level demand functions or systems. For the scope of this paper, this would imply collecting detailed household-level consumption and price information for each country.

However, as is well-known from the tax reform literature (e.g. Creedy, 2000; Banks, Blundell and Lewbel (1996)), an alternative approach to the overall evaluation of welfare changes can be based whether on the specification of a social welfare function defined in terms of individuals' utilities, allowing for explicit distributional judgements. By means of this approach, approximations depend on Marshallian, rather than compensated, demand changes, which in principle may also account for distributional judgements. Hausman (1981) recalls that the Marshallian approximation is adequate in certain situations, but not for measurement of deadweight loss. Above all, this approach requires substantially less information, and may be based on the use of aggregate level data only (e.g. Brau and Florio, 2004; Ahmad and Stern, 1991). This allows for basing our welfare analysis on the previously described dataset only.

4.1. Standard approximate welfare measures

An example of the use of an approximation of the Marshallian consumer surplus not directly considering distributional judgments is given by Waddams Price and Hancock (1998) who adopt the following measure:

$$\Delta W = X_i^*(p^0 - p^1) = X_i^* \Delta p_i, \tag{2}$$

where "0" and "1" denote the periods "before" and "after" the policy change, X_i^* is the mean of the quantities consumed in periods 0 and 1, and Δp_i is the price variation induced by the policy reform. Equation (2) actually is an average between a Paache and a Laspeyres price index.

The basis for introducing a distributive analysis is represented by the following well-known "first order social welfare approximation", widely used in the tax reform analysis.

$$\Delta W = -\sum_h \beta^h x_i^h \Delta p_i \tag{3}$$

More precisely, the previous expression is obtained by first differencing a Bergson-Samuelson social welfare function with respect to the price i of interest, ruling out cross price effects, and using Roy's identity in order to express the welfare variation in terms of individual demand x^h and welfare weights β^h.

With the expression (3), the welfare variation is a weighted sum of ex ante individual consumption. However, an expression in terms of aggregate demand X_i is easily obtained by introducing the concept of distributional characteristics $d_i = \sum_h \beta^h x_i^h \Big/ X_i$, so that (3) becomes

$$\Delta W \equiv -d_i X_i \Delta p_i. \tag{4}$$

Formulae (3) and (4) are particularly useful for the case of policies which have marginal effects on prices. From a "practical" viewpoint, it is important to observe that the assessment of the welfare effects of a price change of a good or service does not need any behavioural parameter such as price or income elasticities, but essentially market data.

For both expressions (3) or (4) the use of data from consumption surveys is required, whether for associating individual consumption to some specification of the social weights or computing distributional characteristics. The most used parameterisation of the weights is derived from Atkinson's (1970) isoelastic additive social welfare function. For example, by setting equal to 1 the weight associated with the consumer with the lowest total expenditure E^h, we get weights of the form $\beta^h = \left(E^h / E^1\right)^{-e}$. The parameter e is usually interpreted as an index of inequality aversion. The larger e, the larger the implicit value given to redistribution by the society. For $e = 1$, the social weight halves as individual total expenditure (or income) doubles. For $e = 0$, all weights are equal to 1 consistently with a utilitaristic social welfare function.

If no different distributional judgements are given, equation (3) and (4) reduce to a Laspeyres price index. In case of price reduction, this clearly represents an underestimation of welfare effects vis à vis the use of a compensating variation measure.

Some policy reforms may entail large price variations. Banks *et al.* (1996) and Harberger (1964), propose a few second-order approximations to changes in social welfare, which usually require the estimation of individual-level demand elasticities. By excluding distributional concerns, an expression in terms only of aggregate Mashallian demand and price elasticity is obtained (e.g. Creedy, 2000):

$$\Delta W \approx -X_i \left[1 + \frac{\Delta p_i}{2 p_i} \eta_{X_i, p_i}\right] \Delta p_i, \qquad (5)$$

As an alternative, a measure in terms of log price variations can be used (Banks *et al*, 1996; Mckenzie and Mookherjee, 2005):

$$\Delta W \approx -\sum_h w_i^h \left[1 + \frac{1}{2} \Delta \ln p_i \frac{\partial \ln w_i^h}{\partial \ln p_i}\right] \Delta \ln p_i,$$

that is

$$\Delta W \approx -\sum_h w_i^h \left[H \overline{w}_i + \frac{1}{2} \Delta \ln p_i \eta_{\overline{w}_i, p_i}\right] \Delta \ln p_i \qquad (6)$$

where $\eta_{\overline{w}_i, p_i}$ is the elasticity of the aggregate budget share to price.

4.2. Applied welfare analysis.

The strategy we adopt here has been already used for analysing the impacts of regulatory reforms. For example, Copenhagen Economics (2005), by means of an applied general equilibrium model named CETM (Copenhagen Economics Trade Model), forecasts the overall price and productivity change caused by market opening and use these estimates in their simulations of the European economy. Mckenzie and Mookherjee (2005) use information from household surveys in four Latin America countries to estimate privatization effects on consumption prices and access to utilities.

The starting point for making the evaluation is the detection of the pre-policy period. In the case of the European natural gas market this is a very simple task given that the first change in the average index of vertical integration is recorded in 1994. For this reason, it makes sense to limit our analysis to those years where regulatory reforms took place. Note that results presented in Table 7 and 8 have as a starting year of the panel 1991 and 1992, but for any starting year between 1991 and 1994, the elasticity of the net natural gas price to the index of vertical integration in each of the models estimated is nearly invariant.

To keep our evaluations conservative, let us consider the elasticity of price to vertical integration obtained from the dynamic model with the Eurostat price series (Estimated elasticity: 0.15) with the Bruno's method. In principle, we can evaluate two kinds of reforms:

- those which have actually taken place in EU states for which we have price information and a non marginal market size between 1994 and 2003;

- some possible additional reductions of vertical integrations in those countries where the industry is still heavily integrated.

For the first exercise, we have that the REGREF index of vertical integration both in EU15 and in the 11 countries with a not marginal market of natural gas was equal to 5.1 in 1994 and to 3.5 in 2003. To compute the price variation implied by the estimated elasticity equal to 0.26 (0.15), let us exploit the elasticity formula in logs:

$$(7) \qquad \Delta \ln p = \eta_{p, R_i} \Delta \ln R_i ,$$

from which we obtain the following expression which can be used for any ex ante price p^0.

$$\Delta p = \exp\left[\ln p^0 + \eta_{p,R_i}\Delta \ln R_i\right] - p^0 \tag{8}$$

where R_i is the regulatory variable of interest (in our case "vertical integration"). Being the variation of R_i = -1.6, $\Delta \ln R_i = -0.3765$, which by using the previous expression yields $\Delta \ln p = -0.0565$ for an elasticity equal to 0.15.

In order to get the price variation induced by the decrease in vertical integration consider that in 1994 the average price in Gigajoules was equal to 6.83 Euros. Applying expression (8) we therefore get an estimated price variation of -0.37 Euros per Gj (equal to – 5.5%) for $\eta_{p,R_i} = 0.15$.

The basis for our computations of the welfare effects is residential consumption in each country (reported in TJ in the Table 9). We can easily see that in 1994, the average consumption in Gj was equal to 3,650,963,000, and in 2003 equal to 5,193,757,000. If we adopt the Waddams Price-Hancock measure we must consider an average consumption of 4,422,360,000 Gj. The estimated welfare gain from the reduction in the degree of vertical integration expressed in 1994 Euros therefore is:

$$\Delta W = -(-0.37 * 4,422,360,000) \approx 1,658 \text{ million Euros for } \eta_{p,R_i} = 0.15$$

In per capita terms, this equals to nearly 4.7 Euros.

Table 9. Residential consumption of Natural Gas in Terajoules.

	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Austria	46147	43964	47497	53477	54902	59346	63062	64631	67596	66951	71527	69557
Belgium	141197	136311	145456	170515	148670	157086	152293	153172	168496	160795	167411	175153
Denmark	26322	26310	28823	32741	30631	31653	31527	30011	31856	30634	32774	32599
Finland	1697	1875	791	838	867	900	1024	971	1044	1211	1166	1219
France	375203	384868	365036	422798	411422	406970	441558	837061	925420	840113	928373	814528
Germany	862265	865825	974638	1151644	1060556	1072232	1056000	1090000	1150000	1150000	1251209	1320000
Greece	0	0	0	0	0	0	181	226	243	398	870	1612
Ireland	10062	11074	11682	14054	13270	15718	17959	20365	22367	22077	25021	27529
Italy	615271	568412	627300	657589	644282	694100	725309	696429	732522	711797	803531	796678
Luxembourg	7919	7799	8517	10000	9343	10059	9909	9784	10760	10602	10964	11768
Netherlands	395663	376319	400938	469520	393904	374560	371044	370692	385112	364010	372802	367527
Portugal	0	0	0	0	39	358	1681	3404	5448	6816	7351	8432
Spain	38218	41131	44355	51909	56666	66670	81519	91748	104155	116871	136792	140062
Sweden	2564	2941	2909	2798	2607	3627	4031	3526	4215	2194	1814	1985
United King	1224584	1186956	1173636	1353028	1243915	1281222	1289038	1331672	1364987	1354939	1391350	1427080

Source: IEA

Overall, the benefit for consumers may seem limited in absolute terms, though one must consider that there is still large room for additional liberalization of the market. Let also

remember that in case of price reduction the first order welfare approximation represents an underestimate of the real welfare change. The overall welfare gain is likely to be higher once one considers measures such as those reported in the equation (5). In future research we will apply also this kind of formulae, as soon as an estimate of the natural gas demand elasticity to price is estimated

5 Consumers' satisfaction with gas prices

In the previous section we analyzed whether an objective measure of an important element of consumers' welfare, such as the market price that consumers pay for gas, is influenced by the industry structure, the market entry regulation, the market structure and the public ownership share in the industry. In this section we push forward the analysis undertaken in Fiorio and Florio (2007), where subjective satisfaction with prices and quality of three public utilities, including gas supply, was analyzed. Consumers' subjective satisfaction is measured in the Eurobarometer data set, which collects information about approximately 1,000 people in each EU-15 countries in 2000, 2002 and 2004 (for a thorough analysis of the Eurobarometer datasets concerning satisfaction with some services of general interests, see Fiorio *et al.*, 2007).

As satisfaction to gas is coded with ordinal variables, analogously to Eurobarometer (2004) we dichotomize consumers' satisfaction, i.e. answers to questions about prices and quality of gas supply are classified into "satisfied" and "not satisfied". In particular, the consumer price satisfaction variable is recorded equal to 1 if the respondent states that the price he pays for gas services is fair, and is recorded equal to 0 otherwise. The consumer quality satisfaction variable is recorded equal to 1 if the respondent states that the quality of the service used is very good, and is equal to 0 if the answer is fairly good, fairly bad or very bad.[24] Table 10 shows that average satisfaction with gas supply is rather large across the countries considered and the trend has been roughly increasing since 2000, although the variability of individual satisfaction is large.

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[24] Some readers might be puzzled by the fact that we include among the non-satisfied those who declared that quality of SGI is fairly good, however this is due simply to increase variability. In fact, only about 5% of consumers across services rate quality of SGI as fairly or very bad.

As we do not know the exact level of individual satisfaction, S^*, for each service, we assume that satisfaction is generated by a latent variable model:

$$(9) \qquad\qquad S^* = \mathbf{x}\boldsymbol{\beta} + e$$

where $\mathbf{x}\boldsymbol{\beta} = \beta_2 x_{2c} + ... + \beta_k x_{kc}$ includes individual characteristics (i.e. sex, occupation) accounting for individual observed heterogeneity, time-varying country macroeconomic variables (i.e. GDP level and rate of growth) accounting for time-varying heterogeneity and a time fixed-effects variable to capture any time trend. The subscript c refers to the cluster, as it is assumed that the unobserved characteristics is $e_{ic} = \alpha_c + \varepsilon_{ic}$, where α is the cluster-specific term and ε is the idiosyncratic error term. In other words, we allow for an unobservable effect common to all households in the same country and we treat it as a fixed-effect. This is a quite general model which assumes that $Cov[e_{ic}, e_{jc}] \neq 0$, though $Cov[e_{ic}, e_{jd}] = 0$ for $c \neq d$, where i, j indicate the observation, and c, d indicate the cluster, and it is reasonable in situations where the number of cluster is small relatively to the sample size. This model can be estimated directly by introducing a dummy variable for each cluster. In the present case we have a number of clusters equal to the countries considered, with about 17,000 observations, and the model is estimated by cluster dummy variables model (Cameron and Trivedi, 2005), omitting the constant to avoid the dummy variable trap.

Table 10: Descriptive statistics for gas price and quality satisfaction by year

Satisfied with price of gas supply					
Year	Obs	Mean	Std. Dev.	Min	Max
2000	15	0.665	0.153	0.396	0.880
2002	15	0.657	0.134	0.401	0.842
2004	15	0.748	0.130	0.498	1.000
All	45	0.690	0.142	0.396	1.000
Satisfied with quality of gas supply					
year	Obs	Mean	Std. Dev.	Min	Max
2000	15	0.461	0.204	0.128	0.731
2002	15	0.399	0.196	0.077	0.661
2004	15	0.466	0.213	0.078	0.750
All	45	0.442	0.202	0.077	0.750

Source: our calculations on Eurobarometer data.
Note: Price satisfaction include very and fairly satisfied. Quality satisfaction includes only very satisfied.

As S^* is latent, one can only observe

$$S = 1[S^* > 0]$$

where $1[\ ]$ is equal to 1 if the argument is true and equal to zero otherwise. Assuming that ε is distributed as a standard normal, independently from $\mathbf{x}$, we obtain the probit model:

$$(10) \quad \Pr(S = 1 \mid \mathbf{x}) = \Pr(S^* > 0 \mid \mathbf{x}) = \Pr(e > -\mathbf{x}\boldsymbol{\beta} \mid \mathbf{x}) = 1 - \Phi(-\mathbf{x}\boldsymbol{\beta}) = \Phi(\mathbf{x}\boldsymbol{\beta}) \equiv p(\mathbf{x})$$

where Φ is the standard normal cumulative density function.

The partial effect of x_j on $p(\mathbf{x})$ depends on $\mathbf{x}$ through the standard normal density function, $\phi(\mathbf{x}\boldsymbol{\beta})$, as $\partial p(\mathbf{x}) / \partial x_j = \phi(\mathbf{x}\boldsymbol{\beta})\beta_j$. The average partial effect (APE) for a continuous variable x_j is:

$$(11) \quad APE_j = \beta_j \frac{1}{n} \sum_{i=1}^{n} \phi(\mathbf{x}^i \boldsymbol{\beta}),$$

where n denotes the number of observations, and $\mathbf{x}^i \boldsymbol{\beta}$ the value of the linear combination of parameters and variables for the i-th observation. The APE for a dummy variable is:

$$APE_j = \frac{1}{n} \sum_{i=1}^{n} [\Phi(\mathbf{x}^i \boldsymbol{\beta} \mid \mathbf{x}_j^i = 1) - \Phi(\mathbf{x}^i \boldsymbol{\beta} \mid \mathbf{x}_j^i = 0)],$$

which avoids the problem of setting the dummy variables to their means.

All estimates to follow present results in terms of APE. As controls, $\mathbf{x}$, we used a set of individual characteristics (including sex, age, marital status, age when finished education, occupation, political views, respondent's cooperation as assessed by the interviewer), of country fixed-effects, year dummies, some country-level macroeconomic variables (population density, GDP per capita, GDP growth rate, employment growth rate, Gini index)

and some regulatory indicators of entry regulation, public ownership, market structure and vertical integration.[25]

Differently from Fiorio and Florio (2007), we include also gas market price for households among the independent variables of model (3), both in levels and in first difference, and the consumer price index (CPI) to test whether subjective satisfaction depends on actual prices and whether the relationship between subjective satisfaction and regulatory variables is at all driven by the relationship between regulatory variables and market prices of gas. In Table 8 APE coefficients for price satisfaction are reported.

Focussing on price and regulatory variables, in column (A) only the gas market price and CPI are included to test whether consumers' satisfaction is somehow related to prices. In model (B) we also include the gas market price first difference and in column (C) a set of macroeconomic controls (population density, Gini index, employment growth rate in previous year and GDP growth rate and per capita levels) is included. These first three models show that the gas price has no role to determine the probability of consumers' satisfaction in the EU countries considered: the coefficient is zero both for the price in levels and in first difference. Only CPI has a statistically significant positive APE coefficient, equal to about 1% if no macroeconomic controls are introduced and to about 2% otherwise. If the regulation variables obtained from the REGREF data set are introduced nothing changes as far as the gas price variables are concerned, while also the CPI coefficient becomes not statistically different from zero. This latter result is a sign of the relationship between regulatory variables and CPI index, possibly due to common trends across the 4-year-period considered.

If regulatory variables are included without prices, the only significant coefficient is that of public ownership, with a negative sign, showing that the larger is public share in the gas industry the lower tends to be consumers' satisfaction (column (D)). However, the sign is reversed if also price variables are introduced in the model together with macroeconomic variables (as in column (E)). The regulatory variables APE coefficients show that controlling for all available individual and macroeconomic characteristics of the population, for gas prices and CPI, for time trends and country-level clusters, 1 additional point in public ownership and market structure indicators in the gas industry increase the probability of

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[25] It would be meaningful to include a variable of household income but it is not available for the whole period considered. However, some of the variables included, such as education, occupation and age of the respondent are likely to be highly correlated with income.

having a satisfied gas user across the EU by 16% and 7%, respectively. However, as the probit model is non-linear, it should be recalled that the interpretation of the marginal effects is different from the case of linear regression models and in particular they closely represent the marginal change on the dependent variable (probability of satisfaction) due to a marginal change of an independent variable only for an infinitesimal change in the dependent variable.

The insignificant role of gas prices as determinants of consumers' satisfaction might be puzzling to some readers, however it should be recalled that gas price in recent years has been characterized by large variability within each EU countries as, differently from other services such as electricity or landline phone calls, gas services are provided by several different providers and each has its own tariff structure, within a regulated framework. Hence, the insignificance of the gas price level might be mostly due to the likely imprecise aggregation of highly different prices into a single one.

The price variable is also of marginal importance or insignificant to explain the quality of gas services (see Table 12). The time trend shows an improvement in both price and quality satisfaction from 2000 to 2004. Individual characteristics are relatively more important to explain price than quality satisfaction. Finally it should be noted that about 30% of observations are dropped when prices are included in the analysis, as for some countries (Italy and Sweden) price variables for considered years are missing, and for others (Belgium) there are collinearity problems.

Tables 11 and 12 also shows that country fixed-effects are the most relevant factors determining the consumers' satisfaction, as they also include other country-specific omitted variables.

Table 11: *Average partial effect of consumers' satisfaction with gas prices*

	Gas: Price (A)	Gas: Price (B)	Gas: Price (C)	Gas: Price (D)	Gas: Price (E)
Regulatory variables					
Public Ownership: Gas				-0.039***	0.162***
Market Structure: Gas				0.032	0.069**
Vertical Integration: Gas				0.000	0.015
Entry Regulation: Gas				-0.003	-0.003
Price variables					
Total price for households (Nat.Cur./unit)	0.000	0.000	0.000		0.000
First difference of total price		0.000	0.000		0.000
CPI	0.009*	0.009*	0.017**		-0.007

Individual characteristics					
Belgium	-0.671***	-0.679***		-0.630***	
Denmark	0.077	0.120	-0.698***	-0.635***	-0.698***
Germany	-0.636***	-0.646***	-0.685***	-0.598***	-0.685***
Greece	-0.610***	-0.627***	-0.703***	-0.638***	-0.703***
Italy				-0.662***	
Spain	-0.619***	-0.628***	-0.665**	-0.614***	-0.665**
France	-0.572**	-0.582**	-0.629**	-0.590***	-0.629**
Ireland	-0.587**	-0.606***	-0.698***	-0.635***	-0.698***
Luxembourg	-0.569**	-0.591**	-0.702***	-0.638***	-0.702***
Netherlands	-0.572**	-0.586***	-0.658***	-0.610***	-0.658***
Portugal	-0.653***	-0.667***	-0.700***	-0.638***	-0.700***
Great Britain	-0.427	-0.439*	-0.497**	-0.505***	-0.497
Finland	-0.651***	-0.663***	-0.702***	-0.638***	-0.702***
Sweden				-0.638***	
Austria	-0.632***	-0.644***	-0.696***	-0.634***	-0.696***
Macroeconomic controls					
Population Density			0.005	0.007**	0.024***
Gini			0.018	0.021***	0.016
GDP growth rate			0.066***	0.036***	0.036**
GDP, per capita			0.010***	0.008**	0.001
employment growth rate (-1)			-0.006	0.011**	0.019**
Year dummies					
year 2002	-0.038	-0.039	0.065**	0.059*	0.058*
year 2004	-0.012	-0.012	-0.050	0.114***	0.188***
Individual characteristics					
female	-0.008	-0.007	-0.008	-0.018**	-0.008
age	-0.007***	-0.007***	-0.007***	-0.005***	-0.007***
age squared	0.000***	0.000***	0.000***	0.000***	0.000***
single	-0.005	-0.004	-0.004	0.004	-0.004
separated/divorced/widowed	-0.022	-0.021	-0.018	-0.002	-0.018
age when finished education	0.011***	0.011***	0.011***	0.010***	0.011***
(age when finished education) squared	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***
manager	0.054***	0.053***	0.055***	0.043**	0.056***
other white collar	0.033*	0.033	0.032	0.026	0.032
manual worker	0.007	0.006	0.007	0.004	0.007
house person	0.039**	0.039**	0.039*	0.047***	0.038*
unemployed	-0.029	-0.029	-0.026	-0.037*	-0.027
retired	0.025	0.024	0.027	0.022	0.028
student	0.158***	0.163***	0.156***	0.168***	0.156***
political views: center	0.008	0.008	0.010	0.009	0.010
political views: right	0.014	0.017	0.018	-0.003	0.018
political views: d.k/n.a.	-0.013	-0.014	-0.017	-0.007	-0.017
respondent's cooperation: average/bad	-0.042***	-0.041**	-0.036**	-0.037***	-0.037**
Observations	17947	17117	16304	23563	16304
log-likelihood	-10328.518	-9815.401	-9288.124	-14224.996	-9284.508

Source: Our calculations on Eurobarometer, IEA (2006) and REGREF data.

* significant at 10%; ** significant at 5%; *** significant at 1%

Table 12: *Average partial effects of consumers' satisfaction with gas quality*

	Gas: Quality (A)	Gas: Quality (B)	Gas: Quality (C)
Regulatory variables			
Public Ownership: Gas		0.014	-0.227***
Market Structure: Gas		0.076***	-0.006
Vertical Intergration: Gas		-0.005	0.031
Entry Regulation: Gas		0.006	-0.028**
Price variables			
Total price for households (Nat.Cur./unit)	-0.000**		0.000
First difference of total price	0.000		0.000
CPI	-0.049***		-0.053***
Individual characteristics			
Belgium		0.617**	
Denmark	0.602***	0.479	0.602***
Germany	0.562***	0.551*	0.562***
Greece	0.599***	-0.082	0.599***
Italy		0.181	
Spain	0.475**	-0.053	0.475***
France	0.554*	0.077	0.554*
Ireland	0.602***	0.246	0.602***
Luxembourg	0.599***	0.641***	0.599***
Netherlands	-0.392***	0.661***	0.608**
Portugal	0.585***	-0.236	0.585***
Great Britain	0.605	0.612	0.605
Finland	0.598***	-0.187	0.598***
Sweden		0.238	
Austria	0.602***	0.423	0.602***
Macroeconomic controls			
Population Density	0.020***	-0.002	-0.005
Gini	-0.045***	-0.004	-0.010
GDP growth rate	-0.058***	0.039***	-0.062***
GDP, per capita	-0.011***	-0.005*	-0.001
employment growth rate (-1)	0.056***	0.004	0.052***
Year dummies			
year 2002	-0.037	0.083***	0.017
year 2004	0.338***	0.090***	0.347***
Individual characteristics			
female	-0.002	0.000	-0.001
age	-0.001	0.001	-0.001
age squared	0.000	0.000	0.000
single	-0.032**	-0.015	-0.030**
separated/divorced/widowed	-0.012	-0.018	-0.012
age when finished education	0.003	0.003	0.003
(age when finished education) squared	0.000	-0.000*	0.000
manager	0.024	0.016	0.024
other white collar	-0.025	-0.012	-0.027
manual worker	-0.016	-0.010	-0.017

house person	0.009	0.012	0.006
unemployed	-0.016	-0.027	-0.017
retired	0.016	0.019	0.014
student	0.047	0.039	0.044
political views: center	0.015	0.004	0.014
political views: right	0.034**	0.029**	0.035**
political views: d.k/n.a.	0.013	0.005	0.011
respondent's cooperation: average/bad	-0.036**	-0.023*	-0.038**
Observations	15838	22886	15838
log-likelihood	-9966.879	-13470.536	-9955.165

Source: Our calculations on Eurobarometer, IEA (2006) and REGREF data.
Note: Robust p values in brackets (using the Huber/White/sandwich estimator of variance)
* significant at 10%; ** significant at 5%; *** significant at 1%

6. Conclusions

The analysis carried out in this paper has shown that the assessment of the effects of regulatory reforms in network industries at the EU level may benefit from "micro-oriented" approach where the single sector indicators are considered.

The empirical analysis of price dynamics does not offer support to the view that privatization per se decreases prices. In fact public ownership would rather have the opposite effect, even if not statistically significant in most models. Vertical disintegration seems to play a more robust role in pushing down prices, but there are no increasing returns, as shown by the negative coefficient of the quadratic component in the estimation. This result should not be taken at face value, however, because in some cases, the REGREF database reports as unbundled industries in countries, as Italy, where the network is under the control of the incumbent. No other regulatory indicator has a statistically significant effect.

If we interpret unbundling as the key reform, then our first-order welfare measure would suggest a quite small positive change for the average consumer surplus, around 19 Euro. This is probably a conservative estimate, but given the reservations one may have about the measurement of unbundling in the REGREF database, that probably exaggerates the actual degree of vertical disintegration, the benefit to the average consumer up to now seems actually small. See Appendix B for a comparison between REGREF and the MOM databases, that shows low correlation on several regulatory dimensions.

Eventually, the subjective evaluation by the consumers, in terms of priace and quality satisfaction, as reported in Eurobarometer surveys, does not suggest a robust relationship with regulatory variables, and – surprisingly – with prices. We interpret this result as an indication of wide dispersion of prices, that is badly covered by an aggregate price index. After all, after

considering individual characteristics and macroeconomic controls, consumers' satistaction is best explained by country-fixed effects, a further indication of a fragmented market.

Further research is needed to understand why the effects we observe are so small and their determinants quite elusive. At present, a first problem with modelling price dynamics is related to the presence of common stochastic trends which could make the observed statistical relationship a spurious one. A simple check is given by the test for stationarity of "within country" residuals by means of a ADF test, though we must emphasize that the lack of long time series affects the overall affordability this kind of test.

A second 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 26 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,[26] and this is not certainly the case with at most 14 countries included in the sample. 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.

A third research avenue to be explored is a more complete welfare analysis, based on more evidence on demand elasticity for gas. Finally, more disaggregated information on price paid by consumers at regional/municipal level is needed to understand the subjective evaluation of consumers.

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 mixed. Public ownership of part of the industry, perhaps the networks, cannot be ruled out. Vertical disintegration seems to be more beneficial, but its meaning and extent should be carefully evaluated, because other regulatory indicators on market structure and entry regulation do not display a significant role. The welfare impact of the reforms that we have been able to measure is very small indeed, and the overall picture falls short of a dramatic change in welfare terms for the average consumer.

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[26] Moreover, it must be also assumed that lagged regulation is uncorrelated with the unobservable heterogeneity component at time t .

Appendix A: data sources and definitions

Regulatory variables	REGREF, OECD dataset. Conway and Nicoletti (2006)
Eurobaromter data	Eurobarometer (2006)
U.S. dollar exchange rate	Source: Exchange rates to the U.S. dollar (USEXRMEI) were taken from the OECD Main Economic Indicators, with the following exceptions. IEA(2006)
Consumer Price Index	Base period: 2000=100 Source: The consumer price index (CPI) data were taken from the OECD Main Economic Indicators. IEA(2006)
Household Electricity Price (US$/unit)	Taxes, in national currency per physical unit, submitted to the IEA Secretariat by Administrations have been expressed in US$/unit using the Exchange rates to the U.S. dollar from the OECD Main Economic Indicators. IEA(2006)
Household Electricity Tax (US$/unit)	Taxes, in national currency per physical unit, submitted to the IEA Secretariat by Administrations have been expressed in US$/unit using the Exchange rates to the U.S. dollar from the OECD Main Economic Indicators. IEA(2006)
Distribution Losses	All losses due to transport and distribution of electrical energy and heat. For electricity, losses in transformers which are not considered as integral parts of the power plants are also included. IEA(2006)
Electricity imports	Amounts of electricity are considered imported or exported when they have crossed the national territorial boundaries of the country. If electricity is "wheeled" or transited through a country, the amount is shown as both an import and an export. The countries of origin for imports and destination for exports are neighbouring countries from which the electricity has been received (imports) and to which it has been sent (exports). Physical quantities are usually given. IEA(2006)
Residential consumption	Consumption by all households. Households with employed persons, a small part of the total Residential Sector, are included. This sector covers ISIC Division 95. (NACE Division 95). IEA(2006)
Source Hydroelectric (GWh/Tj)	Potential and kinetic energy of water converted into electricity in hydroelectric plants. Pumped storage is included. IEA(2006)
Source Combustible fuel (GWh/Tj)	Refers to fuels that are capable of igniting or burning, i.e. reacting with oxygen to produce a significant rise in temperature. They are combusted directly for the production of electricity and/or heat. IEA(2006)
Cost Gas (US$/TOE)	Gross calorific value basis for data in US dollars/10^7 kcal. Net calorific value basis for data in US dollars/toe. IEA(2006)
Cost Coal and cost combustible oil(US$/TOE)	Heavy (high sulphur) fuel oil and steam coal prices for electricity generation in US dollars/t, natural gas prices for electricity generation in US dollars/10^7 kcal. IEA(2006)

Cost Coal and cost combustible oil(US$/TOE)	Heavy (high sulphur) fuel oil and steam coal prices for electricity generation in US dollars/t, natural gas prices for electricity generation in US dollars/10^7 kcal. IEA(2006)

Appendix B: Comparison between MOM database and REGREF

In this section we provide a comparison analysis between the regulatory dataset employed in our estimates, the REGREF database, and a different one compiled by the consultancy firm Copenhagen Economics for the European Commission, the MOM database. Both databases provide informations about the extent of the reform process in the network industries but they are built in a slightly different way.

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 informations 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

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

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 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. The MOM database provide an indicator measuring the extent of market opening in a network industry[28]. This indicator is called Market Opening Index (*MOI*). It is an aggregate indicator that for a given year, member state, and network industry summarizes the progress of market opening on a scale between 0 and 1. The MOI is based on a sector specific Market Opening Milestones (*MOM*). A Market Opening Milestones is a concrete and specific policy initiative under realistic control of policy makers. A *MOM* has a zero score if the milestone has not yet been implemented, and a positive score between zero and unity when it is implemented. The weight of a milestone is based on expert estimates of its importance for market opening. In the gas sector the *MOI* includes 9 Market Opening Milestones. These are highlighted in table B2 with the corresponding weights.

The value of the Market opening Index in a given year is therefore calculated as the weighted sum of the scores for all MOMs. The index is constructed such that full market opening corresponds to unit value.

It is quite evident that the MOM database provide information very similar to that of REGREFF. The *MOI* is the equivalent of the *AGRI* index but with some important differences due to the lower and in part different number of components included. Furthermore the MOM

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[28] See Copenhagen Economics (2005) for further details

database doesn't provide directly a measures of Entry Regulation and Vertical Integration. To get these measures some computations are needed.

An equivalent, even if not identical, measure to the Entry Regulation index of REGREFF can be obtained by summing the Market Opening Milestones number 4, 5, 6 and 9[29]. As regard the Vertical Integration series, the corresponding in the MOM database can be derived by summing the Market Opening Milestones 1 and 2[30]. The Public ownership series of REGREFF corresponds to the MOM number 3, even if the latter considers only public ownership in the supply segment, completely ignoring the ownership structure in transmission, distribution and production/import stages of the gas industry. The comparison between the two dataset is provided in Table B3 and B4. The time dimension of REGREF has been shortened (data from 1975 to 1989 dropped out) to exactly match it with the MOM database. As regard the range of the series this is the interval (0, 6) in REGREF and (0,1) in the MOM database but the scale is reversed. In the MOM database higher values indicate more liberalization, privatization and unbundling, while in REGREF is the opposite. As a result the correlations between the different index is negative as reported in table 4. The table also shows a noteworthy variability. The highest correlations are those between the Entry Regulation index and the Aggregate index (-0.67 and -0.50 respectively). The correlations between the Vertical integration and Public ownership index are instead particularly low (-0.18 and -0.25). This is a direct consequence of the different computation methodology underlying. All the correlations are statistically significant at 1%.

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,	1/3

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[29] With weights 0.22, 0.22, 0.11, 0.45 respectively. These new weights reflect the same proportion between the four milestones in the computation of the MOI. The resulting Entry Regulation index doesn't match exactly that of Regreff because it consider the regime of third party access to the storage and distribution capacity but ignore the existence of law restricting the number of competitors.

[30] With weights 0.66 and 0.34. Also in this case the new weights reflect the same proportion between the three milestones in the computation of the MOI.

		state or provincial laws or other regulations restricting the number of competitors allowed to operate in the gas production/import segment	
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

Table B2*: Components of Market Opening Index for the gas sector*

Market Opening Milestones	Weight
1. Unbundling of Transmission system operators	0.2
2. Unbundling of Distribution system operators	0.1
3. Ownership of supply companies	0.1
4. Network access regime for third party access to transmission grid	0.1
5. Network access regime for third party access to distribution grid	0.1
6. Network access regime for third party access to storage capacity	0.05
7. Tariff structure in transmission pricing	0.1
8. Regulation of end user price	0.05
9. Degree of free choice of supplier	0.2

Source: MOM database

Table B3: *Summary statistics of Regreff and MOM database*

Data source	Variable	Obs	Mean	St. Dev.	Min	Max
REGREF	Entry regulation	210	4.11	1.83	0	6
REGREF	Public Ownership	210	3.19	2.21	0	6
REGREF	Vertical Integration	210	4.90	1.08	1	6
REGREF	Market structure	210	4.75	1.15	0.9	6
REGREF	Aggregate (AGRI)	210	4.25	1.18	1.5	6
MOM	Entry regulation	210	.173	0.28	0	1
MOM	Public Ownership	210	0.1	0.27	0	1
MOM	Vertical Integration	210	0.12	0.22	0	0.999
MOM	Aggregate (MOI)	210	0.14	0.23	0	0.9997

Source: Our calculations on Regref and MOM database

Table B4: *Correlations between Regreff and MOM database*

		REGREFF			
		Entry regulation	Public Ownership	Vertical Integration	Aggregate (AGRI)
MOM DATABASE	Entry regulation	-0.6758*			
	Public Ownership		-0.2576*		
	Vertical Integration			-0.1819*	
	Aggregate (MOI)				-0.5006*

Source: Our calculations on Regreff and MOM database
Note: * = significant at 1%

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