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Electricity Prices as Signals for the Evaluation of Reforms: An Empirical Analysis of Four European Countries

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ABSTRACT *This paper looks at price trends as signals for the evaluation of utility reforms. A specific example is considered: electricity prices in four countries, namely France, Germany, Italy and UK. These countries offer a natural experiment in different patterns of public/private ownership and liberalisation of electricity industry. Electricity prices are mainly influenced by the mix of energy inputs, their costs, and by consumption per capita. Under different institutional settings, prices for business users are often more cost-reflective than prices for residential users. Beyond these common features, the evidence does not support the view that there is clear dominance of one industry pattern in terms of welfare change for the representative consumer. This conclusion tends to question the widely held idea that one specific 'orthodox' reform should be preferred: privatisation with liberalisation and vertical disintegration. Utility reforms should be flexible and country-specific.*

KEY WORDS: Electricity industry; tariffs; public services; utilities reforms.

JEL CLASSIFICATION: L33; L43; L94

Introduction

Since the mid 1980s one specific mainstream pattern in network utility reform has emerged: namely, privatisation with liberalisation and vertical disintegration (or separation of production, distribution and supply—see Newbery (1999) for a general discussion).

Empirical analyses of the effects of reforms typically focus on country or company studies and refer to comparisons of industry performances 'before' and 'after' the reform. One problem with this policy evaluation approach is that there is usually no counterfactual analysis, or a very limited one because of the intrinsic difficulty of building a 'no-reform' or a 'different reform' virtual scenario, against the observed one. This paper adopts an international perspective and uses evidence from different countries as a natural experiment in variations of patterns

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of public/private ownership and liberalisation. The empirical analysis is simple and straightforward, to preserve comparability and feasibility by regulators and other policy makers at national and EU level. The industry considered is electricity. The countries are France, Germany, Italy and the UK. The data considered are electricity prices, input costs, expenditures of households and some institutional/structural variables.

The findings suggest that there is no clear dominance of one institutional pattern in terms of welfare changes for the representative consumer. These findings are consistent with Glachant & Finon (2003), who use a more qualitative approach, while differing from the policy conclusions of some OECD studies (e.g. Steiner, 2000). The OECD studies in this area often consider a large number of countries, but a more limited time span. Moreover, these cross-country studies do not focus specifically on prices and welfare effects. In terms of policy evaluation, however, the latter are indeed the key variables.

The rest of the paper has the following sections: first, research motivations are presented; then the paper offers a brief outline of structural and institutional differences in the electricity industries of selected European countries; third, it presents detailed evidence on price performance and energy input costs; fourth, the paper considers other price explanatory variables; the last section offers a simple calculation of consumers' welfare changes for the four countries and comment on these findings.

The empirical findings suggest that the 'orthodox' wisdom that points to the privatisation–liberalisation–disintegration pattern is not warranted. Further research is needed to understand why major European countries offer strikingly different models of industrial organisation for the same public service, with no clear dominance of one model for consumers' welfare. A policy implication is that electricity industry reforms should be flexible and country specific.

Research Motivation

Processes of privatisation, liberalisation and regulation in the field of public utility services draw increasing attention to the subject of the performance of the companies. This term is a generic one and can have different meanings: the profit rate as a ratio between gross or net profit and total asset or equity, the ratio between profits and revenue, productivity of capital, of labour, or total factor productivity, cost per unit produced, etc.

The choice of each of these indicators leads to specific conceptual measurement problems widely discussed in the regulatory literature, particularly with regard to the alternative of a mechanism based on the price-cap criterion or on the rate of return (Baldwin & Cave, 1999).

However, the economic evaluation of the results of a reform in the field of services of general economic interest should not depend exclusively or mainly on business performance indicators. What should be the main concern of those who study or plan public policies is the change in the welfare of the various agents that has taken place, or could take place, as a result of the reform.

There are considerably fewer studies on the subject of the welfare impact of regulatory reform than is actually desirable, presumably because of the greater difficulty in theoretical welfare analysis and in conducting an empirical inquiry (see Megginson & Netter, 2001). For the case of electricity in the UK and, more generally, about the welfare impact of public services reform, see Newbery (1999),

Newbery & Pollitt (1997), Domah & Pollitt (2001), Liberati (2005) and Florio (2004). The latter offers a comprehensive review. The evidence of welfare effects for other countries is much more limited (see Galal *et al.*, 1994, and more recently Ugaz & Waddams-Price, 2003).

The study of such effects of specific public services reforms raises important problems of empirical welfare analysis. While usually the above-mentioned contributions focus on country studies and on the counterfactual analysis (what might have happened in absence of reform, or under a different reform), the present paper adopts an international perspective.

The advantage is that institutional variability among countries acts as a proxy for different policy counterfactuals in one country.

For the purpose of illustration, the paper shows that the study of the price trends for a public utility service such as electricity, if carried out using time series and comparisons between countries, challenges popular views about the impact of the reforms in Europe. The key issue the paper tests across countries is the hypothesis that a given mix of privatisation–disintegration–liberalisation generates sustained reductions in prices, against public ownership–vertical integration–market dominance or intermediate combinations.

For example, according to Jamasb & Pollitt (2005):

> Experience from liberalisation around the world has produced a measure of consensus over some generic measures for achieving a well functioning market-oriented industry. Liberalisation generally requires implementation of one or more of the following inter-related steps: sector restructuring, introduction of competition in wholesale generation and retail supply, incentive regulation of transmission and distribution networks, establishing an independent regulator. (p. 2)

How can we test this measure of consensus? This research question needs a rather subtle discussion, because it involves a difficult causality problem. In a given country, it may be true or not that, for example, privatisation was needed to achieve liberalisation and vertical disintegration was necessary to implement the latter. Economic historians may try to offer evidence of intentions of policy makers, by a combination of factual evidence (government papers, party manifestos, parliamentary debates, regulatory documents, interviews to managers, etc.) and of reasoning. There will be, however, a lot of conjectural thinking involved in this process. Moreover, even if for one government there is an historical connection between different actions, for example between industrial restructuring of state-owned enterprises and their subsequent divestiture, or between vertical disintegration and liberalisation, these links may not be necessary everywhere. For example, one key reform in the UK electricity industry in the late 1980s was the relaxation of the policy constraint of using national coal as an input. This decision was taken by the British Government before privatisation and perhaps in preparation for it. However, in principle, the same decision could have been taken under continued public ownership of electricity generation, simply through budgetary or environmental constraints. The fact that this disconnection was unlikely at that time does not establish that it was impossible under different circumstances. In Italy the electricity regulator after liberalisation and partial privatisation has not changed two pillars of the previous tariff structure: equal tariffs across regions, and a substantial discount for low users (under 3 kWh), but in principle public policy in tariffs could change this feature independently from the other reforms. In the Nordic countries

wide liberalisation was coupled with continued public ownership of generation companies. Thus, causality is difficult to be ascertained from just looking at what happened and the intentions of the actors, because in many cases a lot of policy options were available in one country in each period of time, and only some were actually picked by policy-makers. This point seems not well understood by those who are surprised to observe institutional variability across countries and tend to offer the same menu of reforms to everybody. A unique menu however is justified only if it can be shown that it delivers everywhere larger economic welfare changes than the alternatives.

What follows does not purport to be a comprehensive study of the impact of policy reforms for the sector considered. It simply suggests the need for regulators in different countries, for the European Commission and independent observers to start more exhaustive inquiries on the welfare effects of reforms across countries and in the long run. Instead of *assuming* that one reform pattern is good, the paper suggests the need to observe the impact of different patterns before drawing policy conclusions. To do so, the focus should be on prices and consumers' expenditure, because these variables have usually a dominant first-round impact on social welfare changes.

Features of the Electricity Industry in Selected European Countries

The UK, France, Germany and Italy are the four major member states of the EU, thus their policy experience is highly relevant for a European wide debate on utility reform. These countries' electricity industries differ widely in their technology mix, market structures and institutional arrangements. We wish to exploit later this variability in the empirical analysis and what follows is just a brief outline of some national features. The industry is still in continuous evolution and what follows refers to the period covered by the data that we use for the empirical analysis (around 1980–2000—see Allen & Overy, 2001). Jamash & Pollitt (2005) offer a review of recent progress in the reform of the industry in several EU countries.

(a) The UK is the obvious reference case for the reform of the electricity industry and it has been studied extensively, see e.g. Domah & Pollitt (2001), Thomas (2000, 2004).

Imports around year 2000 satisfied about 4% of the domestic demand. There were big changes of fuel use for electricity generation over time. Coal used to be the main source until the early 1990s. At the end of the decade, 27% of electricity output used gas as fuel (and then the share further increased in subsequent years), nuclear power had a similar share, the remaining electricity production being based on conventional thermal power (coal, oil and a minor contribution by hydro, see DTI 1999).

The Electricity Government White Paper of February 1988 launched the restructuring of the British electricity sector, previously operated under public ownership (see Table 1). There were different structures in England and Wales, Scotland and Northern Ireland. In England and Wales there was a public monopoly of generation and transmission by the Central Electricity Generating Board (CEGB). There were then 12 regional distributors and suppliers to final users, each of them under a regime of local monopoly. In Scotland and Northern Ireland there were vertically integrated public monopolies.

The reform aimed at the liberalisation of generation and the simultaneous privatisation of the two state companies, National Power and Power Gen, of the

transmission company and of the network of RECs (regional electricity companies). Nuclear power was privatised in 1996. The price of the monopoly services (transmission and distribution) was regulated by price capping. This was under the control of a regulation agency (now called the Office of Gas and Electricity Markets, OFGEM), managed by a Director General (a board since 2000), the latter being appointed by the minister every five years. The antitrust authority, i.e. the Monopolies and Mergers Commission (MMC, now Competition Commission) could intervene in the event of disagreements between the regulator and the operators. An Electricity Exchange (Pool*)* was also set up for the trade of electricity and to determine the prices that the RECs should pay producers.[1]

The reform of 1990 (partially modified by the Utilities Act of 2000) required that electricity tariffs be divided into the different cost components: production, transmission, distribution, supply and subsidy for nuclear energy. The regulator controls the last four of the five components listed, while the production price is unrestrained. The tariffs were subdivided into tariffs applied to captive users (franchise market) and tariffs applied to free users (non-franchise market). The supply price was not capped for large users, while other supply prices were successively deregulated until being completely liberalised in 2000. Payment terms are established by each REC and must be approved by the regulating authority.

The tariffs for captive users, in turn, were divided according to the payment terms and the type of tariff.[2] As at May 1999 the domestic electricity market was made fully open to competition and there were no longer any captive users. Prices are currently fully liberalised with no price regulation to final users.

The results of liberalisation were not long in coming: the number of companies producing electricity increased to 47 after 1990, also thanks to the advent of turbogas technology. Nevertheless the largest production companies, including two Scottish operators, continue to maintain a substantial share of the market and it is believed that in the past they had considerable influence on the formation of prices and on the Pool.[3]

The new regulation framework (Utilities Act, 2000) emphasises the role of the authority in protecting the consumers and introduces the Gas and Electricity Consumer Council.

As mentioned above, the market is now fully liberalised. All consumers, domestic and business, can choose their own supplier. Vertical integration did not disappear, as it was probably forecast in the early phases of the reform. Distribution is still a regional monopoly, often integrated with electricity and gas supply and in one important case (Eastern) with generation.

Moreover, eight out of 12 RECs are now owned by foreign electricity companies, two by water companies and one by a generator, Scottish Power. Southern Electric merged with Scottish Hydro. Transmission is a national monopoly (the National Grid Company), privatised, operating under a price cap and with no built-in incentive to discriminate against access of third parties.

(b) France can be considered a symmetrical case study to Britain. It is a net exporter of electricity. Roughly 16% of the production of EDF, the public monopoly, is sold to Italy, Germany, the UK, Spain and Belgium. The French situation is also remarkable from the point of view of the productive mix: in 2000, 75% of the electricity produced was generated by nuclear plants, 15% came from hydroelectric and renewable sources and just 10% from fossil fuels. This situation leads to much lower direct production costs than in the other countries under consideration.[4]

Table 1. UK electricity milestones

February 1988	Government White Paper 'Privatising Electricity' published
March 1988	Government White Paper 'Privatisation of the Scottish Electricity Industry' published
November 1988	Electricity Bill presented to Parliament
July 1989	Electricity Pool of England and Wales commenced trading
March 1990	Offer assumed responsibility for electricity regulation
March 1991	60% of National Power and PowerGen floated on stock market
March 1991	Government White Paper 'Privatisation of Northern Ireland Electricity' published
June 1991	Hydro and ScottishPower floated on stock market
February 1992	Electricity (Northern Ireland) Order 1992 published
June 1993	Northern Ireland Electricity floated on stock market
March 1995	Remaining 40% of National Power and PowerGen floated on stock market
March 1995	Government 'golden share' in English RECs ended
December 1995	National Grid Group floated on stock market
July 1996	British Energy floated on stock market
December 1996	Government sold virtually all remaining shares in British Energy, ScottishPower, Hydro-Electric, Northern Ireland Electricity
March 1998	Government Green Paper 'A fair deal for consumers: modernising the framework for utility regulation' published
September 1998	Domestic electricity customers first able to switch suppliers
January 1999	The roles of the Office of Gas Supply and the Office of Electricity Regulation were merged to become OFGEM
May 1999	Domestic electricity market fully open to competition
June 1999	OFGEM formed
January 2000	Utilities Bill introduced in the House of Commons
July 2000	Utilities Act 2000 received Royal Assent
November 2000	Energywatch launched
March 2001	New electricity trading arrangements introduced for wholesale electricity
April 2002	National Grid and Lattice agree terms of merger to become National Grid Transco
2002	Domestic price controls lifted
October 2002	National Grid Transco formed following completion of merger

Source: Adapted from www.energylinx.co.uk

On 2 March 2000, France approved a law implementing EC Directive No. 96/92 regarding the liberalisation of the electricity sector, which modified the pre-existing structure created by the law of 8 April 1946. With the reform, an authority was set up to regulate the sector and to check that the efficiency objectives agreed in the programme contracts were achieved (direct public control by the Ministries of Industry and of Finance).

The tariffs on the French market are based on three fundamental principles: (a) uniformity of treatment (customers with the same characteristics must pay the same tariffs); (b) cost-reflective pricing (a price is applied to each category of consumer that should reflect the long-term marginal costs of the category itself, including a rate of return on capital); (c) the obligation to supply (EDF must at all times satisfy consumers' demands).[5]

As mentioned above, the reform in France has not yet led to a major change in the structure of the sector. Around 2000 there was still a public monopoly or near-monopoly (EDF—Electricité de France) operating at all stages (as a vertically integrated structure), from generation (85% of the market), to transmission (100%), distribution and sales (95%, but the share in the latter has fallen recently), to individual consumers, both domestic and business. As regards generation, in addition to EDF there are also other producers including self-producers (obliged to sell any excess to EDF), distribution cooperatives, state railways and so on. Distribution is managed almost entirely by EDF with 5% managed by distribution cooperatives (usually for private rural supply). An exchange is to be set up in the future to deal in electricity. In more recent years there was some further liberalisation, but market structure remains more concentrated than elsewhere in the EU.

(c) Germany is self-sufficient and actually a net exporter of electricity (around 8% of production). The productive mix includes 63% fossil fuels, 31% nuclear and the remaining 6% hydroelectric and other renewable sources (1999). A gradual move away from nuclear generation is foreseen.

Prior to the reform, the law of 1935 had led to the existence of a *de facto* regime of private regional monopoly with nine vertically integrated regional companies, then merged in four groups which, in 2000, still controlled 80% of production, 40% of distribution and all transmission. Below this oligopolistic regional level that has been static for decades, a sub-regional level operates that is formed from about 80 firms whose principal activity consists of acquiring energy from the large distributors and reselling it on to local operators. About 800 entities operate at a local level, most of them publicly owned. Twenty per cent of generation is controlled by sub-regional and local companies.

In 1998 (law of 29 April) the Community directives regarding the liberalisation of the sector were adopted. The reform anticipated total openness: each consumer could choose his own supplier without any limitations or volume threshold. The supplier could also be a producer, a regional distribution company or a municipal company.

An electricity exchange was also set up (Musgens, 2004). During the years covered by this paper there was no independent regulator and control on the industry, in fact, was the direct responsibility of the public administration: the Ministry for Economic and Industrial Affairs, regional governments and the anti-trust authority (Kartellamt). The first deals with energy policy in the broad sense, while the regional governments authorise the construction of new power stations, approve tariffs and grant licences for the production, transmission and distribution

of power. The antitrust authority verifies the tariffs as well. However, changes to regulatory arrangements are now required under EU Directive 2003/54, and an independent electricity regulator is going to be established (2004).

For business users the tariffs include a fixed quota according to the maximum quantity of contracted power and a variable amount based on the quantity of energy consumed and the period of use (peak or not). Up until 1996 the tariff also included a compensation tax (which accounted for an average of 8.5% of the final price). This guaranteed the use of German coal in the production of electricity and was collected by the Federal Office for Industrial Economy. Special tariffs and purchasing obligations are provided for the production of energy from renewable sources. About 60% of the electricity sold in Germany today is traded on the basis of 2–3-year contracts, while small consumers can enjoy standard contracts.

(d) Italy is a net importer of electricity: roughly 15% of demand is satisfied by imports from Switzerland, France, Slovenia and Austria. The current productive mix is the result of a political choice (following a referendum) to dismantle nuclear power stations: in 2000, 78% of electricity was derived from fossil fuels and 22% was of hydroelectric origin or from other renewable sources.[6]

With regard to the structure of the sector, after a long period of private oligopoly Italy changed to a vertically integrated public monopoly (1962). Enel, the public sector company, became a Plc in 1992. The adoption of EC Directive No. 96/92 in March 1999 brought about the liberalisation of the electricity sector in the production, imports, exports, sales and purchasing stages, the de-verticalisation of Enel and the constitution of a state-owned company to manage the national transmission system (GRTN, now partly privatised).[7] The reform does not provide for total openness as it does in Germany: since 2000 those with a consumption of over 20 GWh have been able to join the free market or, within a consortium that consumes at least 20 GWh, those who consume at least 1 GWh. Since 2002 the threshold has been 9 instead of 20 GWh (the limit remains 1 GWh for those belonging to a consortium). If the market were not effectively liberalised it would still be possible to lower the eligibility threshold.

Law 481/95 also provided for the establishment of an authority for the regulation of electricity and gas. Subjects who possess the eligibility requisites may apply to the said authority. The new chosen supplier will have to pay a toll (transit) to use the system and related services.

In January 2001 an electricity exchange was set up, a market place in which to make spot purchases of energy or stipulate futures contracts (no more than 10% of the value of transactions are expected to take place in this market).

A truly open market situation, however, still does not exist in Italy. New suppliers can choose the most remunerative customers and thus maintain fairly high price levels. Consequently the service can probably benefit only small business users with high consumption levels who decide to form a consortium. By the end of 2003 Enel sold off part of its power stations (equivalent of roughly 15 000 MWh of production), by means of competitive procedures.[8]

As one can see from these short country profiles, in Europe a number of electricity market models coexist that are very different from one another from the point of view of the regime of ownership, degree of openness, productive concentration, the technological mix and the degree of vertical integration. The Scandinavian

Table 2. Electricity market structures: France, Germany, Italy, UK around 1999–2000

	France	Germany	Italy	UK
Population 1998 (in millions)	58.7	82.1 (including Former GDR)	57.5	59.1
Total production 1997 (in GWh)	481 000	508 300	239 900	326 066
Consumption per-capita (MWh year)	6.05	5.08	4.04	5.01
Trade balance (in GWh)	net exporter (16% of production)	marginally net exporter (8% of production)	net importer (16% of consumption)	marginally net importer (5%)
Power generation mix	mostly nuclear (78%) some hydro	mostly thermal (63%) with subsidy to coal + nuclear	mostly thermal (79%) some hydro	more balanced (thermal 46%, nuclear 26%)
Share of state owned enterprises	very high (EDF)	mixed (mostly at municipial level)	high (but privatisation going on since 1999)	full privatisation since 1990
Franchise market	yes	No (1998 0 kW)	yes	No (1998 0 kW)
Independent regulator established (year)	2000	2004	1995	1990
Price regulation to final users	yes	yes	yes	no
Restrictions to number of competitors in some markets	yes	no	yes	yes
Vertical separation in the electricity industry: degree of unbundling of generation and transmission	integrated	accounting separation	integrated	separate companies
Vertical separation in the electricity industry: degree of unbundling generation through supply	integrated	unbundled	integrated	unbundled

Table 2. *(Continue)*

	France	Germany	Italy	UK
Institutions	Ministry of Finance, Ministry of Industry (tariffs, capital expenditures, macro effects), Post and Telecommunications and Foreign Trade (construction, energy policy)	Most regulation occurs at the level of Lander. Anticompetitive practice regulated by Cartel Authorities: Federal Cartel Agency (jurisdiction in cases with effects beyond one Lander), Federal Minister of Economics (tariffs), and Lander level	Ministry of Industry, commerce and Crafts (primary) and also Ministries of finance, public works and state holdings	Department of Trade and Industry, Office of Electricity Regulation (OFFER) lead by Director General of Electricity Supply (licensing), Monopolies and Mergers Commission, lead by Director General of Fair Trading (application of competition law)
Supply Liberalisation	2000	1998	1999	1990
Third Party Access	none (planned)	negotiated TPA	Limited (GRTN)	regulated TPA
Electricity market	to be implemented	2004	2001	English and Wales market (1990)
Transmission price regulation	Cost based	Cost based	Price Cap	Price Cap

Source: See text and Steiner (2000), UNIPEDE (1998) and Eurostat (2000).

countries offer another example of industry structure with a combination of liberalisation and public ownership.

This variability of structures and reform designs is probably evidence of lack of consensus on the best approach. Moreover several authors have observed the variety of outcomes in terms of a number of dimension, see e.g. Glachant & Finon (2003). The paper focuses on price trends and their determinants to see whether one reform design dominates the others in terms of conventional consumer welfare.

Prices

We consider first the average prices of electricity (including taxes) for business and domestic users. We shall also show the cost trends for some energy inputs.

Figures 2–5 show the trends in average electricity tariffs between 1985 and 1997 in the countries studied.[9] The index numbers are based on a constant 1990 euro.

As regards the price to business users in Italy, in a regime of public monopoly and with an unfavourable technological mix, between 1985 and 1997 there was a drop of roughly 25%, not that much different than in France (30%). The price reduction in the UK was not a lot higher at 34%. In Germany price reductions were smaller at the beginning of the period, perhaps also because of the role still played by coal, but in the last two years they fell by 30%, not that far from the 35% recorded in Sweden. The sharp drop in prices in Germany is linked to the abolition of the compensation tax in 1996 (see above).

In the end, the cumulated changes in price for business users appear to be fairly even for all the countries studied, with a reduction in prices in the region of 30% between 1985 and 1997, albeit with different time profiles.

It is also interesting to compare the costs of the inputs, which fell far more than the prices of electricity in all countries. For example, the price of natural gas fell by about 60% in France, roughly 55% in Germany, 70% in UK and 42% in Italy. The price of diesel oil fell by around 60% in all countries with a peak of 70% in Germany and a minimum of 53% in Italy.

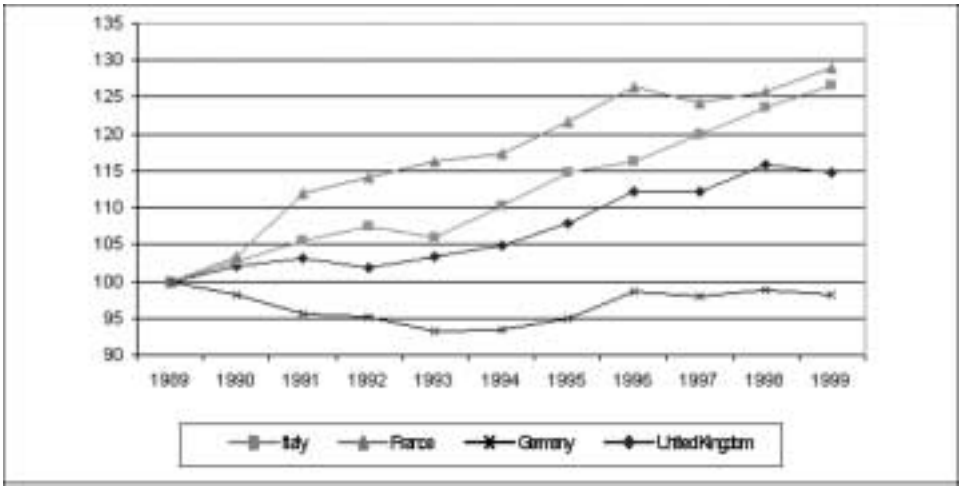

Figure 1. Volume of electricity produced (index figures, 1989=100).
Source: Our processing of data from *Statistics in Focus – Environment and Energy – 1989–1999* (Eurostat, 1989–2000).

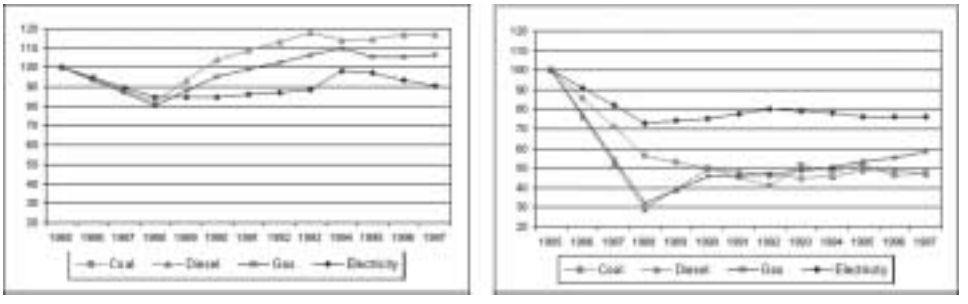

Figure 2. (a) Prices for domestic consumption in Italy (index numbers). (b) Prices for industrial consumption in Italy (index number).

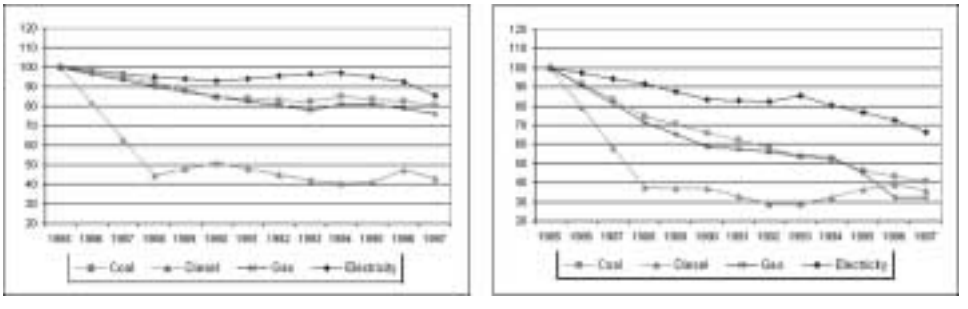

Figure 3. (a) Prices for domestic consumption in UK (index numbers). (b) Prices for industrial consumption in UK (index numbers).

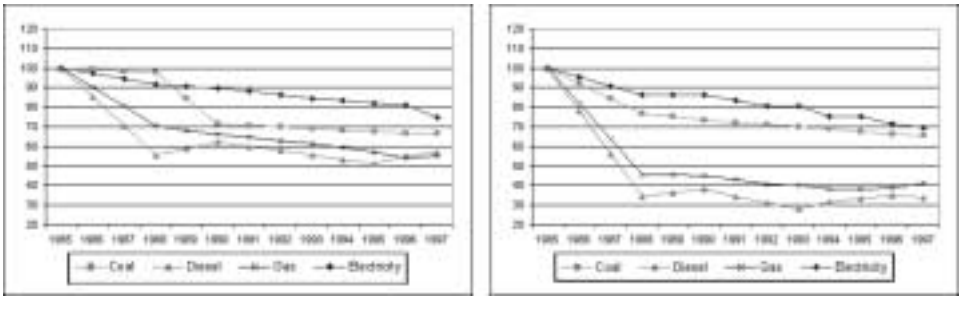

Figure 4. (a) Prices for domestic consumption in France (index numbers). (b) Prices for industrial consumption in France (index number).

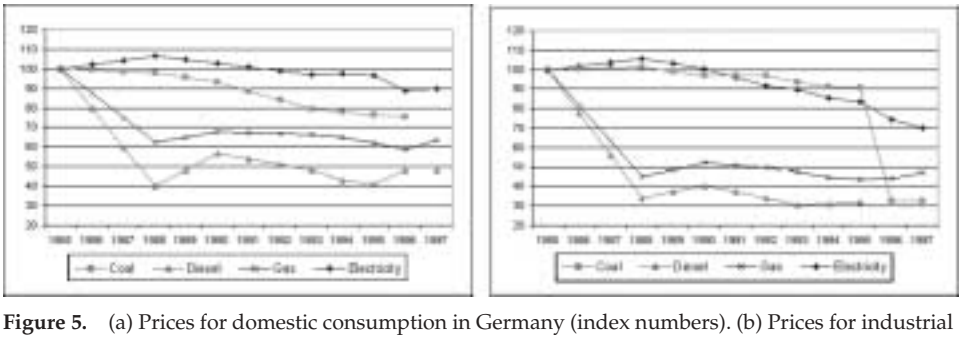

Figure 5. (a) Prices for domestic consumption in Germany (index numbers). (b) Prices for industrial consumption in Germany (index number).

Table 3. Average annual percentage growth of electricity prices, business and residential users (1985–1997)

	Business users[1]		Residential users[2]	
	1985–1990	1990–1997	1985–1990	1990–1997
France	–2.9	–3.1	–2.1	–2.6
Germany	0.0	–5.0	0.5	–1.9
Italy	–5.4	0.2	–1.4	–1.2
UK	–3.6	–3.2	–1.4	–1.2
EU average	–2.8	–3.2	–1.3	–1.2

[1]Excluding VAT. [2]Including VAT
Source: Our calculations based on data from European Commission (1999), pp. 53 and 68.

Looking at domestic consumers, the reduction in price in Germany was much lower for them than for business users, in the region of 12%. In the UK domestic users saw their prices fall by 15% (half as much as the reduction for business users). The lower fall in prices for residential consumers in the UK compared with business users was very likely related to the earlier introduction of competition in the business market. There were also changes in the VAT on the residential market in the UK: first introduced at an 8% rate in the mid 1990s, the VAT was reduced to 5% in 1997 by the new Labour government.

In Italy domestic prices for electricity dropped by 10% compared with 1985—again hardly a generous reduction compared with business users. The French consumers obtained the greatest advantages, with a reduction of 25%. Swedish consumers, however, experienced an increase of 35%.

Thus for all the consumers in the countries considered the reduction in the prices of electricity for domestic use was considerably less generous than that for the business market, except in France (25% vs. 30% respectively).

In the case of domestic users price trends appear to have been quite uneven in the individual countries—evidence perhaps that the markets are less liberalised and competitive than the business supply market.

Table 3 summarises price changes for the four countries for business and residential users, including and excluding VAT.

Table 4 offers a summary of electricity prices in levels. As can be seen from this table, if we exclude France where the prices are clearly lower than the

Table 4. Electricity prices for domestic and business users in year 2000, net of taxes, prices in kWh at current exchange rates

	Residential users (weighted average per class of users)	Residential users (simple average per class of users)
France	0.100	0.060
Germany	0.140	0.082
Italy	0.131	0.090
UK	0.129	0.084
EU average (weighted on consumption)	0.110	0.070

Source: Our calculations based on Eurostat data.

Table 5. 1997 index of average price in real terms (1990=100)

	Domestic users		Business users	
Country	IEA	AER	IEA	AER
Italy	106	107	109	101
Germany	83	87	81	70
France	89	83	96	80
UK	91	92	72	79
Average for 20 European countries	105	–	90	–

Source: Paniccia (1999) based on IEA data (1998, 2000) and our processing of *Annual Energy Review* data (European Commission, 1999).

European average, presumably because the nuclear technology used (and to hidden subsidies), the prices in Germany, Italy and the UK are not that different from one another, despite the enormous structural and regulatory differences.

Last, we turn now from current to real prices. The data for 1990–1997 from the International Energy Agency are expressed in terms of real average price and are given in Table 5. We have also listed the Annual Energy Review figures for the same time horizon.

As Table 5 shows, the figures from the two sources are far from being identical and show the greatest differences for business users. Eurostat uses an alternative method of sampling and refers to the price per typical consumer. Available data show that for the typical domestic users spending had increased since 1985 in all countries considered, although there was no obvious pattern (see Table 6).

Paniccia (1999) carried out a comparative analysis for Italy, France, Germany and the UK for the period 1990–1998 following the 'typical consumer' method. The conclusions she reached were the following:

- for smaller domestic users (1200 kWh), tariffs in Italy fell by 30%, compared with a reduction of 5–10% in the other three countries;
- for average domestic users (3500 kWh), tariffs in Italy rose by 30% (whereas they were stable in the other countries);[10]
- for small business users (160 MWh) and for medium–large users (24 GWh), prices dropped sharply all over (although less sharply in Italy);
- for the largest business users (50 GWh) in Germany prices dropped by 25%, in Italy and France they fell by 5%, and in the UK they rose by 4%.

Table 6. Indices (1985=100) of spending for electricity for a typical domestic user (annual consumption of 3500 kWh—July 1998)

Country	ECU	Local currency	PPP
UK	119	119	110
Germany	125	111	122
France	110	107	111

Source: Eurostat (1989–2000).

In Italy the price structure was progressive for domestic users (for a consumer of 600 kWh annually the price is the lowest in Europe), while it is regressive in the other countries. Volume discounts are granted to those who consume more, according to a scheme, which is also used in Italy for business users.

From the above discussion, one may notice how important it is to pay attention to the different methods of sampling and the various sources of statistics. In this paper, however, we are less interested in carrying out a comparison of price levels among the countries, and more interested in trying to understand to what extent the performance of prices and, more generally, the change in the welfare of the consumer, is linked to policy reform. The following paragraph takes a closer look at this problem.

Empirical Analysis

This section tests the evidence and is divided into three parts. First, we shall attempt to explain the trend in electricity prices on the basis of the trend in the prices of productive inputs. Then we shall try to verify the existence of a relationship between the trend in prices and other significant variables: consumption, the structure of the sector and the productive mix. Finally, the papers offer a simple calculation of the Marshallian surplus change in the different countries.

Electricity Prices and Energy Input Costs

It is not easy to define an unambiguous acceptable method to determine how much the structure of the sector (more or less marked privatisation and liberalisation), influences the performance of prices.

A first approach, albeit crude, could be that of studying how much the cost of productive factors influences the price of electricity. If one finds a strong correlation between the above-mentioned variables, one could hypothesise that the mark-up remains constant regardless of the ownership regime and market competition.

This type of analysis certainly does not allow one to directly verify the relationship between the degree of liberalisation of the market and prices, but it does constitute a first indirect check. It is worth pointing out that the raw materials taken into consideration (coal, gas and diesel oil) are those most commonly used for the generation of electricity and, consequently, this analysis could bring less satisfactory results for countries with a high percentage of nuclear generation in the productive mix (France).

Below we analyse what happens in the individual countries and then make a more general comparison. The data used are the same as those presented in Tables 3–5 and refer to the period from 1985 to 1997. We use 'average cost' to indicate a weighted average of the price of productive inputs. The weights used to achieve the average are equal to the percentage claimed by each of the inputs in the production of electricity in each of the countries studied (with 100 being the sum of the three inputs).[11]

Almost everywhere electricity prices are strongly correlated to those of energy inputs (more so for business users than for domestic ones). The price of coal shows the closest correlation to electricity prices in all countries,[12] for both domestic and business users. For the former the correlation coefficient never falls below 0.65 higher than for other factors in Germany, whereas in France the coefficient is higher for gas, and in the UK it is the same as for gas.

Table 7. Simple correlation (*r*) between tariffs and energy inputs costs, 1985–1997

	Residential users				Business Users			
	Italy	UK	France	Germany	Italy	UK	France	Germany
Coal	–	**0.652**	0.866	0.827	0.885	0.953	0.937	0.960
Diesel	0.290	0.556	0.787	0.140	0.962	0.695	0.802	0.433
Gas	0.534	0.645	0.920	0.253	0.936	0.975	0.847	0.403
Average cost	–	0.630	0.871	0.767	0.967	0.953	0.782	0.833

Source: Our on calculations on data from European Commission (1999).

For industrial users the coefficient varies from 0.88 (Italy) to 0.96 (Germany), but in the UK it is overtaken by gas and in Italy by diesel oil and gas. In five out of seven cases the average price is between first and second position, but, above all, it never falls below 0.63 for domestic users and below 0.78 for business users (Table 7). Prices are much more cost-reflective for business users than for residential users, except in France (because of the nuclear input, not considered here). The results obtained thus confirm that there is a strong relationship between the prices of the inputs and those of electricity, suggesting a mark-up over input costs as the pricing rule across countries.

Table 8 shows correlation of electricity prices across countries. Again we observe higher correlation among prices by countries for business users than for residential users.[13] Moreover, striking similarities in price trends appear between UK and France for business users, and to a lesser degree between other countries, despite different industrial structures. Italy is rather an outlier in the group.

Electricity Prices and Other Structural Variables

Paniccia (1999) tests the relationship between the price of electricity and the following variables:

- the type of equipment used to produce electricity (productive mix);
- total electricity consumption;
- average electricity consumption per inhabitant;
- index of sector concentration.

Table 8. Simple correlation of electricity prices across countries, 1985–1997

	Residential users				Business Users			
	Italy	UK	France	Germany	Italy	UK	France	Germany
Italy	1.000	–	–	–	1.000	–	–	–
UK	0.399	–	–	–	0.641	1.000	–	–
France	0.031	0.745	1.000	–	0.700	0.961	1.000	–
Germany	–0.394	0.501	0.772	1.000	0.269	0.882	0.863	1.000

Source: Our on calculations on data from European Commission (1999).

She calculates the simple correlation coefficient between average electricity prices (source IEA) and above-mentioned variables for 1996 (the concentration index is the only one that refers to 1997). The study is carried out taking into account the 15 countries of the European Union plus Norway and Switzerland. We repeat this analysis for 1997 taking the prices from two different sources (IEA and the Annual Energy Review).

Table 9 shows the updated data for 1997 for some of the countries and in Table 10 there is a summary of the results achieved when considering all 17 countries.

The correlation between the level of prices and market concentration is very low. In general for business users where the market is probably more competitive, technological variables, which in turn determine costs, are much more important than market concentration. The consumption per inhabitant variable, however, is an indication of the persistence of economies of scale and of agglomeration. Besides, a comparison between the price trends for domestic and business users shows that the latter benefit considerably more from the dynamics of falling costs and the increasing doses of liberalisation, even if the lower costs are not always transferred integrally to users as mentioned in the previous section.

At this point we shall again restrict the analysis to Italy, the UK, France and Germany. The objective is to verify whether the preliminary results reached with the method used by Paniccia are also confirmed by simple econometric testing.

Again, the aim is to verify which factors are more important than others in determining price levels in the electricity sector. The variables considered are: type of generating plants, total consumption, average consumption and a variable of market structure, with the addition, however, of the prices of productive inputs.

As regards the types of generating plants, we use the following definitions:

- *Output.* The total amount of electricity produced (indices);
- *Q. Hydro.* The amount of electricity produced by hydroelectric plants (indices);
- *Q. Nuc.* The amount of electricity produced nuclear plants (indices);
- *Q. Foss.* The amount of electricity produced by fossil fuel plants (indices).

Consumer variables include:

- *Tot. Cons.* Total electricity consumption (indices);
- *Av. Cons.* Average electricity consumption per inhabitant (indices).

The variables related to the prices of productive inputs are:

- *Coal P.* The price of coal (indices);
- *Gas P.* The price of gas (indices);
- *Diesel P.* The price of diesel for domestic users (indices).

As regards the structure of the market, in each case the one of the following that gave the most significant results was used:[14]

- Liberalisation;
- Expected time before liberalisation;
- Privatisation;
- Expected time before privatisation;
- Degree of private ownership;
- Possibility of access to the network by third parties (TPA);
- Degree of vertical integration between generation and transmission;
- Degree of vertical integration between generation and supply;

Table 9. Production per type of plant and degree of concentration of the market, total consumption and consumption per inhabitant in some EU countries (1997)

	Type of generating plant									
	Nuclear	Fossil	Hydro	Other	Total		Degree of concentration of the market*	Total consumption		Consumpt. per inhabitant
	(%)	(%)	(%)	(%)	(GWh)	(%)	(%)	(GWh)	(%)	(kWh)
France	78.2	7.9	13.9	0	481 000	100	0.85	380 700	16.7	6508.6
Germany	31.7	63.4	4.1	0.8	508 300	100	0.17	480 000	21.0	5852.8
Italy	0	79.2	19.3	1.5	239 900	100	0.63	254 100	11.1	4422.1
UK	26.6	46.0	0.7	26.7	326 066	100	0.22	301 004	13.2	5110.0
Average EU (15) + Norway and Switzerland	33.7	44.7	17.5	4.1	2 405 079	100	–	2 280 964	100	5921.7

*Measured with a Hirschman–Herfindal Index: HH = $\sum_{i=1}^{n}(q_i)^2$ where q_i is the market share of ith firm.

Sources: Paniccia (1999) (concentration); Unipede (1998) (type of plants and total consumption); Eurostat (2000) (inhabitants).

Table 10. Simple correlation coefficients (*R*) between the level of prices in 17 countries and some explanatory variables (1996–1997)

	Residential users			Business users		
Variable	Paniccia (1999)	IEA (1997)	AER (1999)	Paniccia (1997)	IEA (1997)	AER (1999)
Nuclear	0.01	–0.009	–0.01	–0.51	–0.42	–0.47
Fossil	0.09	0.35	0.13	0.35	0.07	0.31
Hydroelectric	–0.14	–0.38	–0.11	0.21	0.39	0.11
Degree of concentration*	–0.10	0.19	–0.13	–0.03	–0.01	–0.14
Total consumption	0.13	0.08	0.10	0.08	–0.09	0.06
Consumption per inhabitant	–0.44	–0.66	–0.28	–0.64	–0.55	–0.42

*Measured with a Hirschman–Herfindahl index: see Table 8.
Sources: Paniccia (1999) (concentration); Unipede (1998) (type of plants and total consumption); Eurostat (2000) (inhabitants); IEA (2000) and the European Commission (1999) (prices).

- Presence of an electricity market;
- Ways of regulating prices.

The method used for testing the determinant of electricity prices is a OLS regression analysis with pooled data, a mixture of cross-section and time series. The period considered is from 1989 to 1997.

The econometric analysis confirms that the relationship between the prices of electricity and those of productive inputs—gas and coal—is stronger for business users than for domestic consumers (for the former two productive inputs enter the regression compared with only one—gas—for the latter).[15] This result is in line with those obtained when analysing the simple correlations (see Tables 7 and 8).

Furthermore, the results obtained are very close to the conclusions reached by Paniccia (1999) regarding the inverse relationship between electricity prices and average consumption per inhabitant. This may be a spurious correlation. Consumption per inhabitant may be a proxy for a number of other variables, including the presence of deregulated markets. Number of years to liberalisation, however, in one specification partly controls for this and confirms the result.

However, there are differences in the conclusions regarding the relationship between electricity prices and the variables in the productive mix. In the correlation study strong evidence of an inverse relationship between the quantity of nuclear energy produced and the price of electricity was found, especially for business users. In the econometric analysis after having controlled for other variables, the share of hydroelectric energy produced has an inverse relationship with the price of electricity in some models even though the evidence is not very strong.

The most important result of our study, however, is that different empirical tests reach the same conclusion regarding the absence (during the period covered by the data considered) of any clear relationship between industry structure and the price of electricity. Particularly, privatisation and vertical integration variables are not significant, while expected years to liberalisation are more significant in some models (without Italy in the pool and particularly for business users). Tables 11 and 12 summarises the results obtained, Table 13 ranks some factors according to their importance in interpreting the price of electricity. The factors considered are the price of productive inputs (Input P.), the average

Table 11. Residential users tariffs. Linear regression 1989–1997. Four countries

	1. Without Italy		2. Without Italy		1. With Italy	
	Coeff.	T-stat	Coeff.	T-stat	Coeff.	T-stat
Constant	51.931	1.490	87.898**	2.593	128.633**	8.555
Output	0.421**	2.992	0.454**	2.972	0.273*	2.043
Gas price	0.857**	4.156	0.582**	3.197	0.229**	3.503
Q-Nuclear	0.106	1.556	0.004	0.075		
Q-Hydro	–0.034	–0.493	–0.132*	–2.246	–0.105	–1.316
Average consumption	–0.805**	–6.652	–0.742**	–5.761	–0.716**	–5.417
Liberalisation (years expected to)	–0.705*	–2.260				
No. Obs.	24		24		32	
R^2	0.855		0.818		0.515	
R^2 adj.	0.812		0.775		0.452	

* >95% significant.
** >99% significant.
Sources: Our estimation on data from European Commission (1999) (prices and input costs); Unipede (1998) (technology and total consumption); Eurostat (2000) (population); OECD (2000) (other structural variables).

consumption per inhabitant (Av. Cons.), total consumption (Tot. Cons.), the quantity of hydroelectric energy produced (Q. Hydro), the quantity of nuclear energy produced (Q. Nuc.) and the industrial structure (Ind. Struc.). The overall result is that the latter is a weak explanation variable for prices, while years to liberalisation are more important than privatisation and vertical disintegration variables, that are never significant.

Changes in Welfare

Finally, in this section, we attempt—for purely illustrative purposes—a simple calculation of the Marshallian surplus as an average of the Laysperes and Paasche indices (see Waddams Price & Hancock, 1998; Florio, 2004).

Building on Waddams Price & Hancock (1998) we propose some simple partial equilibrium formulas on consumers' welfare change. For a linear Marshallian demand and its compensated and equivalent counterparts, at privatisation, time 1, we observe quantity x_1 and price p_1. At an arbitrary horizon, time 2, we observe quantity x_2 and price p_2. These observations lie within the Marshallian demand function.[16]

The compensated demand intersects the Marshallian demand at point x_1,p_1. It takes value x_3 at p_2, where $x_2>x_3>x_1$ because the slope of the compensated demand is greater than the Marshallian demand. We assume that privatised companies produce normal goods. The equivalent demand intersects the Marshallian demand at point p_2,x_2 and takes the value x_4 at p_1, and $x_2>x_4>x_3>x_1$. The Marshallian welfare change caused by price change is

$$M = x_1(p_1 - p_2) + (p_1 - p_2)\,(x_2 - x_1)\,/\,2$$

or

Table 12. Business users tariffs. Linear regression 1989–1997. Four countries

	1. Without Italy		2. Without Italy		1. With Italy		2. With Italy	
	Coeff	T-stat	Coeff	T-stat	Coeff	T-stat	Coeff	T-stat
Constant	86.089**	3.963	89.939**	3.665	79.288**	5.548	74.903**	5.258
Output	0.024	0.182	0.177	1.312	0.074	0.578	0.046	0.358
Coal price	0.221**	4.059	0.262**	4.421	0.231**	4.258	0.270**	5.566
Gas price	0.550**	3.652	0.369**	2.446	0.429**	3.649	0.348**	3.289
Q-Hydro	−0.112	−1.519	−0.181*	−2.338	−0.100	−1.444	−0.096	−1.370
Q-Nuclear	0.177	1.910	0.017*	0.214				
Q-Thermal					0.023	0.528	0.050	1.250
Average consumption	−0.605**	−4.367	−0.451**	−3.187	−0.336**	−2.607	−0.270*	−2.192
Liberalisation (expected year to)	−0.823	−2.576			−0.298	−1.464		
No. Obs.	24		24		32		32	
R^2	0.899		0.864		0.845		0.833	
R^2 adj	0.862		0.823		0.807		0.799	

* >95% significant.
** >99% significant.
Sources: Our estimation based on data from the European Commission (1997, 1999) (prices and input costs); Unipede (1998) (technology and total consumption); Eurostat (2000) (population); OECD (2000) (other structural variables).

$$M = (p_1 - p_2)(x_1 + x_2) / 2$$

The Laysperes, Paasche compensated, equivalent variations are respectively:

$$L = x_1(p_1 - p_2)$$
$$P = x_2(p_1 - p_2)$$
$$CV = (p_1 - p_2)(x_1 + x_3) / 2$$
$$EV = (p_1 - p_2)(x_2 + x_4) / 2$$

Since $x_1<x_3<x_4<x_2$, it follows that $L<CV<M<EV<P$ (see Waddams Price & Hancock, 1998, for a simple graphical presentation).

We define now

$$E_1 = x_1 p_1$$

and

$$E_2 = x_2 p_2$$

Then

$$M = (E_1 - E_2 + p_1 x_2 - p_2 x_1) / 2$$

or

$$M = \{E_1(1 - p_2 / p_1) + E_2(p_1 / p_2 - 1)\} / 2$$

Note that

$$P = E_2(p_1 / p_2 - 1)$$
$$L = E_1(1 - p_2 / p_1).$$

Thus we can also write that the Marshallian measure as an average of Paasche and Laysperes welfare measures

$$M = (L + P) / 2$$

We do not need to know actual prices and quantities; we just need expenditures at privatisation (or liberalisation) and at the final year, and the price index p_2/p_1. Alternatively, if we select a middle year when

$$x^* = (x_1 + x_2) / 2$$

we can directly infer the Marshallian welfare change as

$$M = E^* (p_1 - p_2) / p^*,$$

where we need one midway expenditure data and two price indexes p_1/p^* and p_2/p^*.

We can be confident that this measure is between *EV* and *CV*, when the assumption of linear demand holds and substitution effects are negligible (as they might be for low elasticity of demand). We can then calculate the ratio between *M* and the income of the consumer for different percentiles, and give a welfare weight to each consumer type. Similar reasoning applies to producer surplus, and its changes determined by changes of costs. For a more general approach, with easy-to-implement measures, see Brau & Florio (2004).

The countries considered are again Italy, the UK, France and Germany. Data refer to the years 1980–1998, the source IEA—*Electricity Information* (2000), and are unfortunately not directly comparable with the other sources mentioned above. The calculation was made just for the domestic consumers using the figure for total consumption. Prices are expressed in 1990 US dollars to isolate the effects of fluctuations on the currency markets. The values were then converted into their equivalent purchasing power in order to be able to make comparisons. Real prices will often appear to increase because of this double conversion, while it may have decreased in local current currencies, but our main interest here is not the absolute value of the welfare change. What we are interested in is the relative position of country performances. Tables 13 and 14 give the results obtained at prices gross and net of tax. The distinction is potentially important because of different tax policies and Table 15 offers this information.

With this set of data we observe that after privatisation in the UK (1990) the increase in consumer welfare was lower than in France, and not very far from that in Italy, despite the fact that the electricity sector had not yet been liberalised in France and Italy.

Hence it is not possible to infer a precise relationship between the privatisation–disintegration–liberalisation of the sector and the change in social welfare, or a clear superiority of one model of industrial organisation over another. When we compare the change of Marshallian surpluses in the 1980s before the new waves of reforms, Germany with a mostly private and fragmented industry was a bad performer as compared with the mostly public and more vertically integrated industry in Italy, France and UK. In the 1990s, Germany was still a bad performer. The reformed British industry performs marginally better in welfare terms than the mostly unreformed Italian industry, but is largely outperformed by France, the country more resilient to privatisation, liberalisation and vertical disintegration. Perhaps this a consequence of some hidden costs of the nuclear power that dominates generation in France, that is not recouped by tariffs. This is however a controversial issue, and hidden costs and externalities of different types of electricity generation may be a concern for other countries as well. If we simply look at prices, it seems apparent that technology and scale economies largely dominate market structure as cross-country explanatory variables of prices and welfare changes. Further research is needed in this area before confirming or rejecting one reform paradigm.

Table 13. Importance of some factors in explaining the price of electricity

Variable	Input prices	Average consumption	Total consumption	Hydro	Nuclear	Industry structure
Residential	medium	high	low	medium	low	low
Business	high	high	low	medium	low	low

Table 14. Marshallian surplus (prices gross of taxes). Residential users—1990 US dollars (millions) in PPP

	France	Germany	Italy	UK
1980–85	2881	458	1031	2055
1985–90	–4771	–9085	–2223	–3650
1990–95	–1702	–4704	128	234
1995–96	481	2498	–269	–171
1996–97	2876	1963	890	179
1997–98	466	0	126	541

Source: Our processing of Electricity Information data (IEA, 2000).

Conclusion

The case of electricity is a significant and enlightening one from the point of view of the more general problems of utilities reform.

This paper has considered output, consumption, prices and consumers' welfare changes over more than a decade in four countries, with very different industry structures.

The available data do not yet allow us to establish which regulatory model and allocation of property rights best protect the consumer from the market power of the producers and the distributors. This is the story told so far by a simple study of prices (and quantities). One has to be aware that in some cases industry reform may raise prices because they were 'too low' in allocative efficiency terms. This however raises distributive concerns. It is important *per se* to know if some consumers suffer welfare losses following the proposed reform, either to redesign the reform itself, or to compensate losers, or possibly to make explicit that other benefits should overwhelm losses. Our results question the view that a unique model, namely privatisation plus vertical disintegration plus liberalisation is always superior in consumer welfare terms to other options. These findings will not end the dispute on the best policy reform for the electricity industry, but may suggest to regulators to focus more on the welfare dimensions of reforms. One can always claim, as Newbery & Pollitt (1997) do, that privatisation was responsible for the changes of the input mix in the UK, i.e. moving away from protection of domestic coal as an energy source. Other countries, however, changed their energy policy and achieved similar or better performance, following a different approach, as we have shown. Hence, one ingredient of a future critical reading of public

Table 15. Marshallian surplus (prices net of taxes). Residential users—1990 US dollars (millions) in PPP

	France	Germany	Italy	UK
1980–1985	2398	452	1119	2055
1985–1990	–4012	–7123	–987	–3650
1990–1995	–968	–3643	–173	987
1995–1996	629	708	–80	–145
1996–1997	2205	1679	744	75
1997–1998	374	211	266	347

Source: Our processing of Electricity Information data (IEA, 2000).

policies in this field is a careful monitoring of the trends in prices and in users' spending, combined with observation over time and international comparisons. This monitoring should not be seen as an end in itself, but as a basis for systematic calculations (*ex-ante* and *ex-post*) of the changes in welfare brought about by the reforms.

In such a perspective it would be desirable—in the absence of a European regulator—that an agreement be reached by the national regulators and the European Commission regarding the measurement of prices and expenditures for typical users in the EU member states, which would allow simple welfare change calculations and comparisons of the type suggested here to be made, in a more comprehensive and systematic form, and for more countries.

Notes

1. In 2001 the 'Pool' was replaced by the New Electricity Trading Arrangements (NETA). This ended the system of uniform pricing and introduced pay-as-bid pricing.
2. The various types were: standard tariff, day/night tariff, day/night controlled circuit tariff and tariffs with only a variable quota. The tariffs for free users varied according to whether the annual consumption was higher or lower than 60 MWh. If the consumption was lower than the stated threshold there were four tariffs (standard, day/night, evening and week-end). If it was higher then there were seasonal maximum demand tariffs. In fact, these tariff arrangements varied by companies, and in some cases survived the exit from the market of the supplier. Subsequently flat rate tariffs have been introduced, which are independent of consumption, but based on the number of components of the household and the size of the home.
3. Following liberalisation there have been some consolidation of the industry: for example in 1998 PowerGen (a generating company) acquired EME (East Midlands Electricity), the third largest regional electricity company in England and Wales. In March 1999 National Power (a generating company) acquired the British Gas company Calortex, etc. By 2004 there was further consolidation in the residential retail market, with just six major suppliers. Many new entrants did not survive more than a few years. As we have already mentioned, the panorama is in continuous evolution and an update on the structural and regulatory scenario can be found on the website of the new sector authority, the Gas and Electricity Markets Authority (www.ofgem.gov.uk).
4. However there is some public concern about the hidden cost of disposal of nuclear waste.
5. Tariffs are divided according to the power supplied: blue tariffs (from 3 to 36 kW); yellow tariffs (from 36 to 250 kW); green tariffs (over 250 kW). All tariffs also comprise a fixed quota (which depends on the power installed) and a variable amount (consumption and period of use during the day and during the year).
6. In Italy the quota of conventional fossil fuels remained stable at around 80% and, with the absence of nuclear plants, thus so also did the share of hydroelectric and renewable energy sources (20%). There was a sizeable readjustment in Italy when the nuclear plants were abandoned: between 1986 and 1989, in addition to an increase of 10% in total production of electricity, there was an increase in the quota of fossil fuels (from 69 to 80%) and a reduction in the hydroelectric (from 25 to 20%).
7. It was also decided to unify distribution in the urban areas, in cases where the presence of a municipalised company that had survived nationalisation had created dualistic solutions (as in the case of AEM in Milan).
8. In addition to Enel, the major suppliers who already, or soon will, operate in Italy include: AEM Milano, AEM Torino, Dalmine Energy, Edison, Enipower, Energy, Merloni Progetto Energy, Sondel, Verbund, ENBW and EDF. Documents updating the situation in Italy can be found on the authority's website (www.autorita.energy.it). These four natural examples are far from being representative of the electricity industry across Europe. Particularly, the Scandinavian electricity market has distinctive features (see Amundsen *et al*. 1998).
9. The data source is the Annual Energy Review by the European Commission. The data refer to the years 1985, 1988, 1990 and from 1992 to 1997. In order to obtain the missing data we carried out a simple linear interpolation between the observations available immediately before and after.
10. This was probably due to special protection offered by law to some independent generators, using non-conventional energy sources, including gas for the co-generation.

11. The data referring to the weight of the inputs were taken from the Annual Energy Review (1999). Values are available for the years 1985, 1988, 1990 and from 1995 to 1997. The missing data were obtained by a linear interpolation of the closest available data.
12. Data were not available in a comparable way for coal prices in Italy.
13. The analysis carried out so far can be subjected to two criticisms. The first refers to the sample, which, from the point of view of a correlation analysis, could be scarcely representative. The second, to the possibility that the use of linear interpolation for the unavailable data artificially increases the value of the correlation indices or, in any case, invalidates the results by altering the relative position of the productive inputs in terms of capacity to explain the performance of electricity prices. To answer the first question, one would need a larger data set. Steiner (2000) has similar data limitations. We hope in future to be able to build a more comprehensive data set by a new international project recently approved by the European Commission under the 6th Framework Program (http://www.feem.it/Feem/Pub/Programmes/Privatisation+Regulation+Antitrust/2006 02-UPP.html) (last accessed 8 November 2006). With regard to the second question posed above, we have repeated the previous calculations with the unavailable data calculated as missing values (thus eliminating the linear interpolation) with some minor differences in results. We find that, for domestic users, there was no change in the relative positions of the different productive factors in any country. It should be noted, however, that there was a net relative improvement in both the UK and Germany in the correlation between the weighted average price of input and the price of electricity. In fact, in these countries this value jumps from third and second positions, respectively, to first in the comparison of single productive factors. We may conclude that the interpolation of the missing data did not invalidate the previous conclusions. Details are available with the author.
14. The data are those from the *OECD International Regulation Database* also used in Steiner (2000) and which can be found on the Internet at http://www.oecd.org/document/1/0,2340,en_2649_34323_2367297_1_1_1_1,00.html (last accessed 8 November 2006). For a more detailed description of them see Steiner (2000, section 3.3).
15. We note that in one country (Italy) the quantity of electricity produced by nuclear plants over the period studied is zero and that it is therefore opportune to divide the study into two parts: with and without Italy, according to whether or not we include the quantity of electricity generated by nuclear plants.
16. A complication arises in the long run when we have demand shifts, e.g. because of exogenous income change or because changes of consumers' preferences. We ignore this point here.

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