INTEGRATION OF EUROPEAN ELECTRICITY MARKETS

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All eventual errors and omissions are my own.

Declarations

I hereby declare, to the best of my knowledge and unless otherwise stated, all the work in this thesis is original. I can also confirm that this thesis has not been submitted for a degree at another university.

Abstract

This thesis contributes to the study of the role of some identified obstacles to delay the process of liberalisation and integration of European electricity markets and to impede the achievement of its full benefits, namely increase efficiency and, ultimately, to pass on this efficiency gains to final consumers by lowering prices of electricity.

Chapter 1 is a description and analysis of the progress made on European liberalisation and integration of electricity markets, identifying some of the main obstacles found on the path to achieve the Single European Market for electricity and solutions proposed to avoid them, either from the perspective of the EC and from the perspective of economic literature. The concerns considered for this review are related with the main focus of the thesis, market power and concentration. The solutions found on the literature to avoid these obstacles are related with the search for the best market design to be adopted in the Single Electricity Market. Since the Nordic countries constitute an integrated market considered as a success, this example is briefly explained in order to understand which are the main features of this success.

The second chapter presents a simulation for the integration of the Iberian wholesale electricity market (MIBEL) in order to study how the exercise of market power will evolve with regional full integration. Following Borenstein and Bushnell (1999), we compare simulated market outcomes on four days of 2004, with no integration and with full integration. The presence of market power is measured using the Lerner Index. The simulation results allow us to conclude that, as expected, market power is lower after full integration. However, even after full integration, market power is still a feature of the market. Therefore, the full benefits of liberalisation and integration are not seized by the consumers, since wholesale prices persist to be higher than the marginal costs. The market participants with more benefits are the Portuguese, both consumers and the incumbent firm.

The third chapter's purpose is to assess econometrically the impact on final consumer of mergers between electricity generators and natural gas suppliers. We find evidence that a merger of this type will increase final price of electricity in the market where it occurs. Moreover, as a consequence of the EOn-Rurhas merger German household consumers pay more 1.8% for the electricity and, in Finland, the Nest-Ivo merger caused an increase of around 2% on prices for household consumers. The answer to the question "should household consumers be concerned if a cross sectorial merger happens" seems to be yes, due to the detrimental effects on final prices.

Introduction

Since the late 1980s, a wave of reforms has transformed the market organisation of some infrastructure industries all over the world. Electricity was one of the first utilities to be chosen for reestructuring and European countries follow this trend.

The EU reform of the electricity market was implemented by the enforcement of several Directives and Regulations that started with Directive 96/92/EC. From this first Directive to the more recent Third Energy market package (Directive 2009/72/EC), the objectives are to establish a competitive, secure and transparent EU Single electricity market. As ultimate goal, efficiency should be achieved and it should be ensured that European consumers benefit from these efficiency gains, by paying less for their electricity.

In throughout the past years, competition implementation has been characterized by problems or obstacles associated with drawbacks and slow progress. The contribution of this thesis is to study whether or not the ultimate aims of liberalisation and integration process in Europe is fully achieved, despite the existence of obstacles. More precisely, with this purpose, this thesis can be divided into two parts.

In the first part, that consists in chapter 1, it is discussed the progress on Single European energy market, specifically on electricity markets. This evolution is analysed in the perspective

of economic literature. In the second part of the chapter, some obstacles and concerns, identified by the EC and also by the economic research, are reviewed. The concerns mentioned are related with the focus of the second part of the thesis, namely market power and concentration. The purpose of this review is not only to explain each obstacle but also to describe the solutions presented in economic research about these subjects. In the last years, with the recognition that the restructuring process in European electricity markets was in slow path, the EC proposed a bottom-up regional approach of liberalisation and integration. The idea of starting from regional integrations between countries with similar features and already converging to move on to the IEM is a solution to boost the introduction of competition and the integration in electricity markets. With this perspective, European regions and countries, as well as the EC are concerned about choosing the best market design in order to achieve their goal as soon as possible. In fact, the solutions searched for the obstacles and concerns mentioned are, in essence, the search for the best features to promote competition and efficiency. With this purpose, the Nordic integrated market, as the first common inter-country market with recognised success, may be the source of information about the best features of the market to achieve the best outcome. The first part of the thesis closes with the answer to this point.

In the second part of the thesis, the approach is eminently more empirical. In the last two chapters, the intention is to assess the consequences on prices of two identified problems: the presence of market power and the existence of mergers between natural gas suppliers and electricity generators.

In chapter 2, the focus is on the effect of regional integration of electricity markets on the exercise of market power. The exercise of market power is a feature of electricity markets and is pointed out as one of the main reasons for the persistence of high prices, even after liberalisation.

The achievement of a Single European market may help to, at least, diminish this problem. In the path to the creation of an Internal Market, the European Commission recognised the main role of regional integrated markets. Therefore, we use the integrated Iberian market (MIBEL) as a experimental field to infer the market power evolution as a result of integration.

With this framework, following Borenstein and Bushnell (1999), we present a simulation of the MIBEL. The main idea is the comparison of Portugal and Spain in four chosen days in a particular year (2004), considering two realities: no integration and full integration. The new market is assumed to be an oligopolistic (Cournot) market with a competitive fringe. To infer market power we use the Lerner Index and we compare the Cournot solution with the perfectly competitive outcome, before and after integration. From the simulation results, there is evidence that despite the lower Lerner Index after integration, compared with before, there is still exercise of market power by the firms, either on peak and off peak periods. Based on estimated market outcomes, it is possible to conclude also that the country that takes more benefits from the MIBEL is Portugal, either by the decrease of prices, that can be passed on to consumers, and the increase of the market share of the biggest incumbent firm. Even if at lower extent, Spain also takes advantages from the integration.

Finally, in the main last chapter, the target is to assess the effect of mergers between electricity generators and natural gas suppliers on electricity prices for household consumers. Liberalisation of energy markets created the opportunity for these cross-sectional mergers in Europe. Since natural gas is one of the main sources for electricity generator, these mergers attracted special attention from regulators and general public. In order to achieve the purpose, it was studied if household prices in European countries are determined by the existence of these mergers and if consumers should be concerned with this evolution of prices. The signal

for concern is if the vertical integration raises the final prices of electricity.

Our study refers to all gas-electricity mergers that occurred in European markets between 1997 and 2007. We use a reduced form model for the determinants of prices and we assume, in our empirical approach that our problem can be seen as a case of the evaluation literature.

We start from considering that all mergers of these type are similar, thus, have similar effects in all countries. However, recognising that all merger processes are different and that the market where it occurs is also different, we also consider each merger as a different happening. These two ways of classifying the merger determine different approaches in this chapter.

The results from this chapter are threefold. First, we found that the existence of a vertical merger between an electricity generator and a natural gas supplier seems to increase in average the final price of electricity for household consumers on markets where it occurs. The comparison of prices before and after the merger for each country where it occurs allows to conclude for the negative impact of these events on market outcome. Second, we found evidence that any household consumer in Germany pays a price for their electricity 1.8% higher because there was the merger between EOn and Ruhrgas. Third, even in Finland, where the merger was not controversial, because it involved public firms, the effect on prices was equally detrimental to consumers. Household prices after the merger are around 2% higher than they would be without the merger between IVO and NESTE.

Liberalisation and integration of the European market is a continuing process and remains a work in progress, therefore many of the questions mentioned in our research will continue to pose other different challenges in the future for further research on the topic.

Chapter 1

Single European Energy Market:

progress and some concerns

As the center of our research we need to characterize first the electricity, and then the European Electricity market and the restructuring process. If the first task is simple due to the well known special features of the good and its consequences, the second task is more complex. It is not simple to describe the Single European energy market, starting from the assumption that there is one.

This first chapter offers a detailed description and analysis of the competitive and regulatory framework of the European energy market, with particular concern about the economic view of all process of liberalisation, which involves deregulation on the one hand, and market integration, on the other hand. Since the beginning, electricity markets had an essential role, because it was the starting point for the restructuring of energy industries and it has been the market who determined the path for all the remaining energy markets, such as gas or carbon

storage. Therefore, we will focus our study on this market and its progress after restructuring.

Despite the trend being forward increased liberalisation and integration, there are several obstacles that made and are still making the European process a complex and difficult task. These obstacles were identified by the EC in several reports on the progress of implementation of the Internal electricity market and by the economic literature.

This chapter is structured as follows. The first section will describe the special characteristics of electricity as a good and as a market. These features help to understand why the focus of our research should be studied differently from other markets. Section 2 focuses on the implementation process and explains briefly the main provisions of the European electricity directives. The approach is to give an economic view of all the process, mentioning how economic researchers evaluated the last 20 years of reforms.

In the following section we discuss some barriers and problems mentioned as responsible for slowing down the liberalisation and integration of electricity markets in the EU. This chapter does not intend, by any means, to cover all issues on the introduction of competition in European electricity markets or to be exhaustive about all the empirical economic literature (when is available) on the topics, but instead, to give an economic approach of these issues. The topics chosen are related with the subject of the following chapters. The main finding of this review is that the solutions to avoid the obstacles are a search for a "perfect" market design in order to boost competition and liberalisation.

Finally, in the last section we describe the main features that justify the achievement of the first integrated international market in Europe, the Nordic market, in order to access if this example may be applied to other regional integrated areas in Europe in order to improve the restructuring process. The introduction of a new intermediate stage - the regional approach

- in the path to the SEM (Single European market) raises the importance of success for all the regional initiatives of integration in Europe, namely the Iberian Integrated market. Therefore, finding if the Nordic experience can be replicated is very important for all the European integration process.

1.1   Special features of electricity

Electricity has an unusual set of physical and economic characteristics that affect the way it is traded and used and make different and complex any intervention or study. Liberalisation and integration was implemented in Europe based on the belief that electricity could become a commodity to be bought and sold in a market, just like any other. However, the attributes that make electricity unique and relevant to study should be considered into the successful design of a competitive market (Green, 2001). In consequence, to analyse electricity market deregulation and integration, as any other aspect of this market, is very important to understand its particularities.

Firstly, from the point of view of consumers, electricity is a homogenous product. It does not have any particular feature that differentiates it, from consumers' perspective. After a watt-hour being generated it can be used in everything indistinctly. Secondly, the uneven distribution of demand over time (daily and seasonal fluctuations) leads to the requirement of having a significant capacity reserved instantaneously or on short time basis.

Thirdly, short run demand is highly inelastic and there are no substitutes for it. This means that changes in prices have little influence on consumption and spot electricity prices are very volatile. Fourthly, unlike other goods, electricity is nonstorable and demand must be cleared

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with production from generating capacity available to the network at exactly the same time that electricity is consumed.

Fifthly, from the point of view of generators, production costs are heterogeneous depending on the technology and energy sources used. Supply of electricity is partly characterized by a gradually increasing marginal cost function. When all available generating units are producing at their maximum capacity, no increase is possible in the short term. As a result, the generation marginal cost curve ends with a perfectly inelastic section. And finally, with generators and all end-users spatially dispersed, the network connecting all players in the market plays an essential role in this market.

The vertical structure of the electricity sector also differentiates it from other industries. Four stages can be identified in the activities of the electricity industry: generation, transmission, distribution and supply. In the first stage, electricity is generated in power stations. The second stage is transmission and the third stage is distribution, taking electricity from transmission grid and distributing it at lower voltages to consumers. The final stage is supply, which covers metering the customers' demands, billing them, collecting payment and using it to pay for the other stages involved.

Partly due to the characteristics described above, electricity industry has been, since the Second World War, organised as an integrated, state owned monopoly in all countries, namely in Europe. Moreover, unlike what occurred in some industries, liberalisation in the electricity sector was introduced only in some segments. Generation and supply were the first stages to be deregulated and liberalised. Transmission and distribution are still highly regulated.

1.2 Restructuring European electricity market: liberalisation and integration

At best, since the end of 1980's, it was clear for European countries that a competitive, reliable and sustainable electricity sector is essential for more growth and competitiveness. Deregulation and introduction of competition on electricity market is a precondition to achieve those aims.

Liberalisation is defined as the abolition of the rights of monopolies and the introduction of competition in a market. Those rights gave, for some time, protection against competition to some European energy monopolies.

Until the 90's, although each country had its own market structure, some features were common to all: there were few main players on the entire electricity chain and in some cases there was only one firm in each market producing and also supplying electricity to the final consumers.

Energy liberalisation in general, and in particular of the electricity industry, was not a new phenomenon in the world. In many other countries outside Continental Europe (United States, United Kingdom, Norway or Japan) similar processes took place aimed at liberalising markets and opening them up to more competition. However, liberalisation in the EU is considered as the world's most extensive cross-jurisdiction reform programme (Jamasb and Pollitt, 2005). Moreover, the European experience involves either liberalisation of electricity markets in Member States and integration of the national markets into a single European market for energy.

Although, the reasons for opening the markets to competition vary from country to country, the main goals are to improve efficiency, create a more competitive energy-producing industry,

ensure security of supply and as an ultimate aim to offer lower electricity prices to final consumers.

Some economic factors were relevant for the introduction of competition on European markets. The opportunities created for new entrants due to technological development made it possible. New technologies, such as gas turbines for generation, had provide the opportunity to decentralise electricity generation without any additional losses, comparing with the former centralized system. All these changes and the (even) slow increasing physical connection between European countries, started the discussion in favour of liberalisation. However, it should be mentioned that if was not only the evolution of the market but also some external pressures, as political decisions (Green, 2006) that determined the liberalisation process in Europe.

The point of departure for the defence of the liberalisation was the acceptance of new technical findings and economic studies disproving the old belief that the whole electric industry was a natural monopoly. The motivations that justified the existence of no competition on the market in the past are not valid anymore.

The former existence of monopolies in electricity was justified by the recognised presence of economies of scale along the entire range of the demand. Economies of scale were formerly achieved due to management only by one firm of all electricity chain from the electricity production to customer service and supply. However, this explanation could not be applied to the European electricity market considered as an (whole) internal market where each national utility faces, not the local demand but the aggregation of the demands from different countries. Therefore, one of the arguments that was used to support no competition was being denied by reality.

Another main criticism that was used to justify liberalisation was the persistence of high

prices associated with high costs and a low service level due to inefficiency of electricity supply. Since the EU had (and has) an important role on global trade and European firms compete with other manufacturers and service-providers from all over the world, this evolution of prices was not beneficial. Since energy is one of the main inputs, it is difficult to improve competitiveness without liberalising the sector.

Finally, the European countries agreed that liberalisation of electricity markets was not only economically justified and needed, but also imposed as a step for the full achievement of the identity of European integration. The European single market programme aimed at removing all physical, legal and fiscal obstacles between Member States in order to obtain the free movement of goods, services, capitals and labour in the EU. Since electricity is a good (even if it is a special one) it should be considered also as a part of the free movement implemented by the European integration.

Several advantages were expected from the decision of liberalising and creating an internal market for electricity. The creation of an internal market is expected to increase competition as a result of major interconnection capacity and hence a reduction in the possible negative effects of high concentration at national and regional levels. All users would be able to purchase electricity on an equal basis, thus avoiding distortions of competition and general cross-subsidisation issues.

Furthermore, as a result of greater interconnection, the single energy market would also improve security of supply due to the increase on the available resources in the event of crisis and because it decreases the need for spare capacity, thus enhances efficiency. In this way, the risk of black-outs will diminish, with more capacity available across Europe, or in the event of one it will be more easily overcome due to solidarity reinforced among Member States. The lower level of spare capacity for each country will lead to less costly power plants and to the

use of cheaper inframarginal power plants available at times of peak demand. The ultimate consequence will be lowering prices for consumers and improving quality of service.

After several years of internal debates, the EU started a restructuring process based on the concept of market liberalisation and integration. Even though deregulation on electricity market started as an end in itself and had increased close to the long term objective of achieving the single European energy market as it can be seen in the European Directives.

The set of European legislation (listed in Table 1.1) is a reflex of lessons taken from other experiences around the world in the necessary measures to achieve a competitive electricity market. The Directives included, gradually (but not by this order), the framework for: (a) sector restructuring, (b) introduction of competition in wholesale generation and retail supply, (c) incentive regulation of transmission and distribution networks, (d) establishing an independent regulator and (e) privatisation (Newbery, 2002).

Table 1.1

Relevant EU directives and regulations in electricity

"Package"	Date	Denomination	Main concern
First	19Dec 1996	Directive 96/92/EC	common rules for the internal market
Second	26 June 2003	Directive 2003/54/EC	common rules for the internal market
		Regulation (EC) no 1228/2003	conditions for access to the network for cross-border exchanges
	13 Nov 2003	Commission Decision 2003/796/EC	establishing the European Regulators Group for Electricity and gas
Third	13 Julho 2009	Directive 2009/72/EC	Common rules for the internal market
		Regulation (EC) no 714/2009	conditions for access tot he network for cross-border exchanges
		Regulation (EC) no 713/2010	establishing na agency for the cooperation of energy regulators (ACER)

Source: European Commission, DG Energy

The crucial moment for the liberalisation process was February of 1997 with the adoption of the EU Electricity Directive 96/92. The main driving force for this resolution was the European Commission's expectation that "market forces produce a better allocation of resources and greater effectiveness in the supply of services" (EC, 1996, 5).

This First Directive set the minimum conditions under which competition could be developed. One of the main issues set for the new market structure by the Directive was the openness of generation and retail of electricity to new competitors and the continuation of the infrastructure (transmission and distribution) as a monopoly business being regulated by independent entities. In addition, it determined that the access to transmission and distribution should be guaranteed to all market participants at nondiscriminatory prices.

A minimal requirement for the unbundling of generation and transmission, a minimal market opening and different approaches to the grid were also set by at that time. According to it, vertically integrated utilities had to keep separate accounts for generation, transmission and distribution activities. Market openness was defined as being gradual and achieved in three steps and a Member State could choose between three approaches for the organisation of the access to the network (negotiated or regulated third-party access or the single buyer procedure). In view of the fact that performance of the different national markets on liberalisation was not as planned, the EC decides to implement a second step in order to accelerate the process and to overcome some limitations of the previous Directive: the Second Directive (2003/54/EC) and include also regulation.

The other level of reform pursued by the EU was the effort to improve cross border transmission (Jamasb and Pollitt, 2005). In order to intensify cross-border trade, essential for effective market integration, the EU had enacted the Regulation 1228/2003, implemented at the same

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time as the second directive. This regulation recognised that promoting construction of interconnectors between national systems was an end in itself, rather than a means to enhance security or to promote competition.

In the same framework, in 2006, the EC recognised the dimension and the difficulty to achieve a single market at once for all Member States. Accordingly, the EC presented a new route to the single European market with regional markets as an intermediate stage (Jamasb and Pollitt, 2005). The existence of different market developments by countries concerning harmonisation of rules and development of interconnection justifies the regional approach. These regional initiatives allow considering all the differences, but keeping the focus on the common aim of a unique market for electricity in Europe.

Although the second package of electricity directives came to correct limitations from the previous one, several problems still exist, namely the persistence of differences among Member States concerning market design. Moreover, the achievement of the goals by the different member states was still very different and far from the expected.

The EC recognised that one new legislative package on energy was needed. In September 2007, the Commission adopted its proposals for a third liberalisation package. The package has two main parts, namely (i) measures to ensure effective unbundling of production/supply activities on the one hand and network activities on the other hand, and (ii) measures to enhance powers and independence of national regulators. Finally, the third legislative package (Directive 2009/72/EC), again containing even more strict rules, was published.

1.2.1 Assessing liberalisation and integration in EU Single Electricity market

The task of summarizing how economic analysts assess liberalisation and integration of the European market is not simple, due to complexity of the process spread by so many countries. One possible approach may be to assume that the full implementation of all main elements of the reform by all countries is a proof of success.

In terms of market opening, at the present, almost all countries achieve 100% of proportion of retail market open to competition, except Greece, Cyprus and some of the new Member States (EC, 2009). In what concerns to unbundling, the reality is less similar, with some explicit reluctance of some of the more important European countries in adopting ownership unbundling. It is the case of France and Germany.

Finally, about the achievements on the last element, the existence of an independent regulator, Pollitt (2009) found that only 5 countries had the maximum value on the score given to the regulatory agency[1] which means that there is still a significant lack of independence on national regulators. In conclusion, given the starting point in 1997, the evolution is very significant and means an important effort by all countries (Jamasb and Pollitt, 2005). From this results we can conclude that liberalisation is a relative success in Europe. In fact, of course, we have in Europe, some countries with substantial progress, as the UK and Nordic countries, and in some others there is still some way to go, as, for example, France and Germany.

Other way of assessing may be the comparison of the advances in reform of electricity markets with other sectors. Wolfl et al (2009) place the sector ahead of the telecom liberalisation, even if the last one is considered as the leading liberalised utility. Their results also give ev-

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[1]Scores related with the independence of the regulator, with 5 being the score for the highest level of independence (Pollitt, 2009)

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idence on a wide variation in the degree of liberalisation across EU countries and over time. From their analysis it can also be seen that restructuring appears to have slowed down between 2003 and 2008, as compared with the period before.

Finally to assess liberalisation in any country we can look at the benefits achieved with the process. The ultimate aims of liberalisation are lower prices for consumers and, particularly from integration, price convergence. The same was expected for the European electricity market. The test about the persistence or not of high prices after the restructuring is vital for the evaluation of the success of the process (Musgens, 2006). From raw data evidence, EC reports always very different electricity prices for member countries, which may be interpreted as a sign of lack of convergence and insufficient market integration (EC, 2009). Moreover, consumers had lower prices and price convergence until 2003, but this evolution was inverted in the last years. Nevertheless, several other reasons are pointed out for this evolution, like different cost of generation or the different availability of generation capacity for each country.

Most of the empirical research available, on more than 10 years of experiencing liberalisation the EU, focus on only one part of the restructuring process or on one or some of the effects of liberalisation / integration. Though, we can mention five studies on the effects of restructuring of electricity market on prices. Two of them report not only European countries, but OECD countries, while other three are focused on European countries.

Steiner (2001) and Hattori and Tsutsui (2004) use the same approach in different periods of time in order to infer the impact of the several elements of the liberalisation separately (unbundling, privatization, third part access, etc) on prices, industrial and household. The conclusions of either papers are that it was too early to find clear evidence of positive or negative effects on prices. Moreover, due to the additive approach they use, each element

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studied may have contradictory effects on prices, thus the evidence on the total effect was not proved to be clear.

Other three cases of empirical research examine the impact of the restructuring on prices, presented by Ernst and Young (2006), Thomas (2006) and Florio (2007). The first report, asked for the UK's Department of Trade, evaluates whether liberalisation was working. Among several questions, they ask if liberalisation lowers prices. Their conclusion is that price of electricity, in fact, is lower under liberalisation and that there is a strong significant relation between liberalisation and lower prices. Thomas (2006) is a review of several reports on electricity prices in Europe and his conclusions imply that reforms in the EU are associated with lower prices.

Finally, Florio (2007) uses a similar approach to the first two research studies above and infers the effect of several reform variables on household prices. Even if it is considered as an interesting way of inferring the effect of each element of the reform, the conclusion is that there is no clear evidence on price benefits from liberalisation.

The evolution on liberalisation and integration can also be shown in different results and conclusions concerning price convergence. In the beginning, there was few convergence between European markets, with exception to Nord Pool (Boisseleau, 2004; Bower, 2002). In the following period (2000-2004), Armstrong and Galli (2005) conclude that European electricity markets were converging. More recently, the evidence is not so consistent. Zachman(2008), for several pairs of countries, provides empirical evidence that integrated market has not been achieved by 2006. On the contrary, Da Silva and Soares (2008) find evidence of reduction of differences between neighbouring countries, thus evidence on price convergence. Since one of the "single most important indicators" of successful liberalisation is the price effect (Jasmab and Pollitt,

2005) we may conclude about a fairly positive assessment on the success of liberalisation and integration of the European electricity market.

Finally, we should mention the evidence on successful restructuring on particular experiences inside the EU. The United Kingdom was one of the countries with an "early" restructuring and therefore extensively studied (see Newbery and Pollitt, 1997).

The Nordic market is the other extensively studied market that is essential not only due to the restructuring process, but also, and mainly, the effects on prices were positive, even before the complete integration. Amudsen et al (1998) quantified the changes in prices after integration and finds that the emerging Nordic market was likely to produce lower prices and benefit consumers. The general opinion is that the Nordic electricity restructuring and integration worked well (Amudsen and Bergman, 2006). Following the Nordic example and accounting for the features of continental Europe is, for some research, the best strategy to have success on restructuring electricity market. However, individual countries may implement differently the measures and the success results from Nord Pool may not be generalized.

As was clearly shown by survey, a number of changes have occurred in the European electricity sector, over recent years, and the progress of liberalisation of energy markets has been substantial. However, the achievement of an internal market in Europe is still far from complete. The several obstacles delaying the achievement of an internal market were identified on benchmarking reports by the EC: concentration of the market, vertical integration and separation of the network and lack of interconnection capacity (EC,2009), among others.

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1.3 European concerns in liberalisation and integration of electricity markets

Looking at economic literature in electricity markets in the last 20 years in Europe, we notice that several of the topics studied, both empirically and theoretically, were related with the obstacles to market integration and the search for solutions to overcome it. The solutions proposed, both by economic researchers and by the EC are, essentially, a search for the best market design to promote competition and integration in European markets.

The aim of this section is to survey the main empirical research on some topics of concern, namely concentration and exercise of market power, vertical integration and unbundling and lack of interconnection capacity. From the beginning of the liberalisation process, these obstacles were always mentioned in the reports and their study is a permanent subject in empirical research in the EU. These are the reasons of the choice of these three concerns.

1.3.1 Concentration and exercise of market power

Although the liberalisation process has led to the disintegration of national monopolies, it has not resulted in less concentration within the sector. In fact, the increasing concentration on energy markets is recognised as the "most important obstacle to the development of more vigorous competition" (EC, 2005, 5).

The last report available still confirms that concentration is still a feature of the market, with only seven European countries considered as moderately concentrated (EC, 2009) and reinforces the perspective of a clear path towards increasing concentration. The exception are the UK and Norway, countries where liberalisation started earlier. Even if, in some countries,

such as Spain, Portugal and Italy, concentration ratios have decreased slightly in recent years, they are still considered high.

The incumbents continue to be the main actors in each national electricity market. Even after liberalisation, either in generation and retail markets, the share of the three largest firms in the market is close to 50% or above for the majority of the European countries.

Although it was expected less firms in the market with the introduction of competition, because only the more efficient would prevail, the evolution of concentration still raises concerns, namely as a result of mergers between (large) European electricity firms (Green, 2006). Naturally, all incumbents in the electricity power sector reacted to the introduction of competition by fighting for their positions in order to maintain their market share. The largest European utilities started a wave of mergers and acquisitions (M&A), in the context of friendly or sometimes hostile takeover bids, inside a country or cross-countries (Speck and Mulder, 2003). Some authors have predicted that in ten years there will be around only 8-10 significant players in the European electricity market (Codognet et al., 2003) or even less than that number (Thomas, 2003).

The merger activity and concentration may not cause negative impact on European countries if it generates mainly efficiency effects. The major concern is the introduction of some anticompetitive risks. While the entrance of new firms can lead to a decrease in the market share of incumbents, M&A activity may impose effective restrictions to competition.

The electricity industry has all the features identified in economic literature that make possible the exercise of market power. Levels of concentration that may be considered sufficiently low in most industries might be sufficiently high to have damaging effects on competition in the electricity industry. In addition, the usual instruments available in other markets to reduce

market power, such as storage or the presence of substitutes in the market, do not work in this industry (Green, 2006).

These particular characteristics coupled with the M&A trend have raised serious concerns about exercise of market power (Domanico, 2007). In fact, one of the main worries is that, after liberalisation, the electricity market will become a private oligopoly with power to increase prices, after all. A smaller number of market players may have more market power and thus more influence on final prices. If European concentration continues to prevail, and (the same) few companies are operating in each of the national markets, they may lose the incentive to compete with each other. Adding to this, the incumbents will try to increase the barriers to maintain their position and to foreclose the entrance of more efficient (new) market actors (Ringel, 2003) and to reduce the number of competitors. All the effects described probably may lead the European electricity market away from the main goals of liberalisation and integration: lower prices for consumers, security of supply and sustainable market.

Liberalisation has drawn even more attention to the potential use of market power and several empirical studies have tried to infer the state and/or the future of market power in Europe. Some identify as the main problem in the liberalisation of electricity markets in Europe the fact that restructuring overlook issues of market power (Newbery, 2002). The idea from the beginning was to introduce competition in two stages of the electricity chain (generation and supply) and wait for the best outcome[2]: the markets will become competitive and prices will fall. However, as it was mentioned before, this was not always the case. The persistence of high prices in several countries after liberalisation had to be explained. The exercise of market

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[2]Of course, the EC made other efforts, mentioned in the section before, to introduce the right elements to achieve the best results.

power was one of the more often reasons used to justify the high prices of electricity.

For the specific features of the electricity industry, the electricity market is better described as a oligopoly than a perfect competition, from which they seem to be rather far. In the electricity markets market power may arise motivated by an increase in prices with respect to competitive values and a capacity withdrawal from the market.

One of the main measures of the exercise of market power is the price-cost margin. It measures the degree by which prices exceed marginal costs and the extent to which firms are able to exercise market power. An effective economic integration and liberalisation would, on average, reduce the markups of all firms, in particular, the largest incumbent firms (Smeers, 2005). Thus, the evidence of difference between prices and generation costs may be understood as a signal of problems in the European liberalisation issue.

The market in England and Wales (E&W) had significant market power problems that have persisted for several years. Green and Newbery (1992) were pioneers in studying the British electricity market in order to infer if the reforms implemented were sufficient to achieve higher competition and to reduce market power or additional regulation was needed to fulfill the aim. They found evidence, in the short run, of the presence of market power. Newbery and Pollitt (1997) confirm that the high electricity prices in the five years after the restructuring, were based on the exercise of market power. Two years later, Wolfram (1999) did not find results denying market power but she mentions that generators exercised less market power than predicted by standard oligopoly models. Eventually, after several years, price-cost margins decreased, due to the reduction of concentration in the market (Evans and Green 2005). However, even if it would be expected, Sweeting (2007) shown that in E&W wholesale market, a decreasing on market concentration was not followed by the decrease of the exercise of market power.

The Nordic electricity market is also extensively studied. Usually for Nord Pool, the low level of concentration is usually connected with no evidence of market power. There were some doubts on this evolution for 2000 and 2001, due to relatively sharp increase on prices verified for those countries, but most of these were explained by a combination of factors: reduced hydropower availability, increased demand and higher fuel prices (Bergman, 2002). These findings supported the view that market power so far has not been a problem in this market. Therefore, the integration and liberalisation of Nordic countries have effectively diluted market power, otherwise it would have been a feature of each of the four national markets (Amudsen and Bergman, 2007), as it is for almost all European countries.

On the opposite side, Germany is an example of a problematic market where market concentration is high and it is forecasted to be increasing. Even with a favorable evolution of prices in the beginning of the liberalisation process, the result of the merger wave in this country was a substantial increase in market power and a significant rise in prices above the competitive levels (Bower et al, 2001). Empirical research found also evidence of increasing exercise of market power over time, reflected on the evolution of the difference between costs and prices (Musgens, 2006).

In the Spanish market there were no dramatic price movements in the spot market, though there is evidence of bilateral market power (Kuhn and Machado, 2004). The existence of market power on both sides of the market make the evolution of prices less conclusive for an assessment of high markup.

As it can be concluded, the study of market power is usually country or region focus and several other countries or regions were tested over the past years for the existence of market power on electricity markets, after liberalisation (as example, the South East European mar-

ket). For the European market, Zarnic (2010) in a recent work, presents a number of estimates of price-cost margins and finds evidence of a gradual decline in markups associated with liberalisation and restructuring of the electricity sector. However, he finds that electricity firms, on average, still exhibit considerable price-cost margins of about 40 percent and confirmed that greater market concentration is associated with higher markups.

In Chapter 2 of this thesis our aim is to contribute to this topic, focusing on exercise of market power on an European regional market, the Iberian Electricity market, assuming full integration between Portugal and Spain. The objective is to infer if the market power would be exercised at the same extent after full integration.

1.3.2 Vertical integration and unbundling

Before liberalisation, electricity markets in Europe were mainly controlled by large vertically integrated (regulated) state monopolies with activities from generation (own almost all generators) to transmission and/or distribution networks. To introduce free competition in the market it was necessary to guarantee free access to network to all generators and suppliers. Therefore, only undertaking some form of separation between the network and competitive activities (some form of unbundling) the conditions for competition will be attained.

The lack of a rigorous unbundling is pointed out as an explanation for the slow progress of the internal market for electricity. Four main potential problems can be mentioned as result of insufficient separation. First, an integrated company owning either the network and competitive activities may deny access to the network, discriminating or setting unfair terms (unreasonably high access and service fees) to their competitors. Joskow and Tirole (2000) show that ownership of physical transmission rights, under vertical integration, increases the ability of generators to

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exercise market power through withholding transmission capacity.

Second, the integrated firm may use the cross-subsidisation, allocating costs attributed to generation or retail to the network activity. This would lower the costs of their competitive activity artificially and would give them an unfair advantage compared with independent firms. With the same aim and the same approach, vertically integrated firms may recover generation losses by setting high transmission fees.

Third, the vertical structure reduces incentives to invest in new transmission capacity, since more transmission capacity increases the potential competition from neighbouring generators. Finally, the EC (2007) reported concerns about valuable inside information being exchanged between integrated firms in different activities. These will also represent an advantage for integrated firms and it is explicitly an impediment to achieve free competition.

Introducing unbundling has several known benefits and costs. This imposed separation may improve the network performance and creates a more independent position of the network without any other activity connected. The network firm will be more focus on its objective and it will respond better to regulatory incentives, namely on tariff regulation and the market monitoring task of the energy regulators will be easy. Moreover, a higher degree of unbundling of generation and transmission networks may boost the incentive for new entrants in generation, thus may lead to substantial welfare gains.

Nevertheless, unbundling may lead to higher transaction costs (Perry, 1989). This cost results from restructuring the industry, namely breaking existing links between network and competitive part, such as changing contracts. Even if there are no contracts to renegotiate, unbundling may increase transactions costs (Pollitt, 2008) or the costs of changing legislation by the public authorities. The loss of economies of scope, due to the former close relation between

network and other parts of the chain may also be mentioned as a potentially significant cost of unbundling.

Some analysts have also expressed concern that ownership separation of transmission and generation may distort investment decisions in generation. The reason is that generation and transmission can be substitutes for each other. Instead of investing in transmission, a firm may invest in constructing a new plant in the needed location.

To prevent some of the issues described in the EU, the First Directive required vertical separation between firms on stages open to competition and the ones still regulated. Several proposals could be supported to implement separation: accounting separation of network activities, legal separation of network activities, ownership unbundling, and separation of operation of the assets from ownership. From all the options available, the EC, in a first stage, allowed each Member State to choose between legal and accounting ownership, as well as the time path of implementation. This means that generation, transmission and distribution must be carried out by separately managed units within integrated firms and these units must produce separate sets of accounts (accounting separation) or the grid should be owned and operated by a firm whose exclusive activity is the network (legal unbundling).

Many members have been slow in implementing the directive and many have chosen the weaker (but permitted) form of unbundling. In a first stage, unbundling of generation and transmission has been successful in England, in the Nordic market, and in Spain. The countries which adopted full ownership unbundling from the start, ensured that generation competition had fair transmission access. In Central Europe, however, and more especially in Germany and France, unbundling was only done by weak internal management measures that was considered inadequate to avoid discrimination (EC, 2001).

In fact, the choice for the weakest forms of unbundling on the directives was believed to be welfare-reducing (EC, 2007). Due to these results the main problems were not avoided and firms were able to delay the introduction of competition in the market. As a consequence, the 2003/54/CE Directive specified the legal unbundling as the minimum requirement. The rationale behind the choice of a stronger unbundling level was that stronger unbundling options boost the introduction of competition and deliver more of the benefits.

However, it was clear that even so this new requirement has not been effective. Although cost allocation might be solved, the ownership shared between network and generation does not avoid other problems, namely preferential treatment. The Third Energy Package is a strong reinforcement of the role of unbundling and recognition that it may be actually the most important step of the European liberalisation process (Soares and Sarmento, 2010). The EC has proposed ownership unbundling of transmission networks as the main and preferred option (EC, 2009) and the creation of independent system operators (ISO) as an exception that may be offered to Member States which have not already implemented ownership unbundling. This most complete level of unbundling requires not only separate ownership, but also requires the firm not to be a subsidiary of another firm with generation or retail activity. While there are no connection between the network and other stages with competition, there are no reasons to believe that discriminatory treatment prevails (Thomas, 2007) or cross-subsidies will persist.

Unbundling was always at the heart of the economic debate on how to achieve integrated and competitive energy markets. Among the issues that always captured the interest of researchers and scholars are the merits and consequences of vertical unbundling. Though, there are few empirical studies which look at unbundling specifically, due to the time simultaneity of several reform elements in Europe and elsewhere.

When the objective is the assessment of benefits and costs of unbundling and analysis of the welfare effects of unbundling, some authors use checklist of cost and benefits to assess if unbundling should or not be adopted. For Netherlands, several different empirical studies can be referred. In the context of a debate about unbundling of electricity distribution networks from retail supply, Mulder and Shestalova (2005) and Baarsma et al. (2007) provide a useful checklist of the costs and benefits. The last research paper found that contract negotiation costs were potentially significant. DeNooij and Baarsma (2009) present an ex ante cost-benefit analysis of the Dutch unbundling act, in order to assess the introduction of ownership unbundling on Dutch law prior to the European imposition and they conclude that it is unlikely that this act is welfare enhancing.

Other stream of research is related with the effects of unbundling and/or vertical integration. According to empirical evidence (full ownership) unbundling revealed a general positive impact on the market by stimulating investment, contributing to the reduction of prices, facilitating competition, improving the benefits from regional integration and facilitating new entry. The main variables of interest reported are investment, prices and competition.

Alesina et al. (2005) examine the effect of deregulation in a number of sectors, namely on electricity. Using the OECD measure of product market reform for vertical integration, they find evidence that investment increases as the vertical integration score decreases. In fact, experience in Member States where ownership unbundling has been implemented is positive. Strong circumstantial evidence can be reported for the effectiveness of ownership unbundling in achieving investment adequacy (Pollitt, 2008). There is also empirical evidence on the decline of network investment along transition periods to the ownership unbundling regime (Buchan, 2007).

Another desirable effect of unbundling is that electricity prices are lower than would otherwise be with vertically integrated firms. Empirical research on this topic found different evidences from the relation between vertical separation and prices. Copenhagen Economics (2005) studied electricity price trends in the EU for 1990 to 2003 and conclude that ownership separation reduces industry electricity prices. Steiner (2001) uses panel data for 19 OECD countries covering 1986-1996 to study several elements of restructuring in electricity markets and finds that separation of generation and transmission is not associated with lower prices. Hattori and Tsutsui (2004) examine similar OECD data, over a longer period 1987-1999 and they confirm that unbundling of generation did not necessarily lower the price and may have possibly resulted in a higher price. The explanation given was that unbundling increases the transaction costs that would be pass-through to final customers and the economies of vertical integration might be lost as a result of a strict form of unbundling, making the net impact of unbundling ambiguous. The conclusions from the last two papers may be due to the definition of unbundling , because they use strict definitions of unbundling. Fiorio and Florio (2007), in an EU-wide analysis found that vertical integration seems to increase prices, thus having a damaging effect on consumers. On the contrary, Ernst and Young (2006) found evidence of a significant benefit on consumer prices from completing the full unbundling of the TSO.

Even if all EU countries have been required to unbundle and liberalize their wholesale and retail markets since 1997, some countries are still nowadays reluctant about adopting the higher level of unbundling. In half of the Member States the TSOs are not ownership unbundled yet (EC, 2010).

The imposed separation rule was always criticized and it is still a subject of debate. The main point to be discussed is the decision on which level to choose in order to achieve a

competitive market. New arguments mention that the restructuring of electricity market should be an evolutionary process and that, perhaps, for the nature of the market, there is no need to guarantee full unbundling to achieve competition (Sioshansi, 2008).

1.3.3 Lack of interconnection capacity

Due to the features of electricity, only a limited volume of electricity can be transmitted in a power grid. This is named as transmission capacity of the grid. In a restructured market, the function of the transmission system is beyond the role of connecting generation to load or to guarantee the reliability of the system.

For several years, numerous reports from the EC have been underlying the lack of interconnection capacity between Member States and the (very) often congestion problems between them. The existing interconnection infrastructures do not guarantee the limits to anticompetitive effects deriving from concentration in national markets (Jamasb and Pollitt, 2005) and do not guarantee the achievement of a European electricity market.

Therefore, in a congested framework, imports do not play the role of pressing dominant firms or the role of opposing market concentration. Actually, the limited cross border transmission capacity may lead even to an actual increase in market power. Producers can raise their price and profit in these bottleneck periods, and thereby strategically use these periods to gain market power (Joskow and Tirole, 2000). On the contrary, in total interconnected markets the competition from different generators would limit the abuse of market power even in peak demand periods.

In order to improve the introduction of competition in the EU, some solutions were suggested and studied. In the long run, the solution is to invest in extending interconnection capacity.

However, in the short run, interconnection capacity is fixed and the solution must be the efficient management of congested lines.

One of the usual solutions, coming from either the EC publications or some experts is that if transmission capacity available is not sufficient then, in a long run perspective, investments should be made to expand it(Bergman et al, 1999). Since the European Council meeting of March 2002 in Barcelona[3] the EC has called frequently for additional interconnector investment. As competition problems are reinforced frequently by limited transmission capacity, the improvement of cross-border flows should mitigate market power (Newbery, 2002b).

Insufficient interconnection capacity may result either from the fact that cost from interconnection expansion exceeds the uncertain benefits from totally free trade or from a failure to undertake an efficient level of investment in additional capacity. This last case occurs if economic incentives are not enough for investments to foster competition. The Green Paper on the energy sector recognizes the lack of incentives for investment in European markets (EC, 2006b).

The main debate is, firstly, if investment should be made. This decision is similarly related with the existence of the right incentives. Most transmission operators prefer using the extra congestion revenue for other purposes rather than investing in expanding transmission and since they may get extra revenues from congestions, they may get more advantages from the congestion problem than from investing. As a consequence, the incentives may not be enough to make them invest.

Moreover, low public acceptance is one additional major argument against investments. The

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[3]In this Meeting an agreement was made about a specific target for the volume of cross-border capacity and priority investment projects in the framework of the trans-European network were proposed.

disparity between private and public incentives may be an additional matter. On the one hand, private investors have to demonstrate the public convenience and necessity of expansion. On the other hand, from the perspective of a private firm, investments in expanding transmission capacity only is profitable if there are excess capacities in generation in at least one of the areas connected. Otherwise, there is no incentive because there is no electricity to be traded. The uncertainty of investment is the main problem for the private investor, because the main benefit will come from the difference of prices between areas and there are no guarantees if this price difference will persist after investment.

As a result of the above factors, some researchers stress that the lack of incentives requires the intervention of regulators, by setting a stable regulatory framework (Haas et al, 2008). In contrast, the supporters of free competition argue that no regulation is need and that the market itself should (and will) provide incentives for the right level of investment.

Due to it importance in the path to the European Single market it is essential to evaluate benefits and costs of expanding interconnections. Compared to the benefits, defining the costs is rather clear, it mainly consists on the value of investments made.

The main benefits are due to the price differences between countries, the impacts on competition and the security of supply. The barrier to cross-border trade may lead to persistent prices differences (Brunekreeft et al., 2005) and as, a consequence, consumers in some Member States may pay more than others for their electricity. The increasing on cross-border transmission may induce price convergence across countries and relocation of gains and losses: consumers from high cost country will have advantages at the expense of consumers located in the low cost country and there may be rent reductions for producers from imports that will be compensated by rent increases for producers in the exporting country. The reallocation of gains and losses

across countries might explain some of the resistance in the EU to a full integration of electricity markets, through increasing interconnections.

Expanding cross border transmission may also boost competition. The high degree of concentration and the ability of some players to exercise market power have impact on market outcomes and on consumers. An expansion on available interconnection capacity will create opportunities for new firms in the market and, thus, the former firms will exert power less frequently or in less extent. As a result, the average price may decrease and, due to increase competition, the price benefit will be passed on to consumers. The last benefit to be mentioned is that the security of supply can be realized against lower costs. Security of supply will be the topic of next section on this chapter.

Even so, investments in interconnection do not automatically generate positive welfare effects. The productive efficiency gains result from the increased efficiency of generation. The interconnection restriction may enable a more extensive use of the cheapest method of generation. The allocative efficiency gains follow from the fact that consumers face prices reflecting better the level of marginal costs, allowing more optimal consumption decisions. Only if these last two effects are present and not only the above mentioned distribution effects we can find positive effects from unbundling.

The effects of the expansion of interconnection capacity were tested in applications to European markets. Lise et al (2008) uses a static model of a fully opened European electricity market to study this effect and they conclude that more transmission capacity would not only benefit more the consumers in countries with relatively higher prices, by reducing its prices, but it also reduces the impact of market power.

Assuming Cournot behaviour in the spot market, Ellersdorfer (2005), analyses, in connec-

tions between the German electricity market and the neighbouring countries, to what extent network investment improves competition. The evidence found indicates that reinforcement of the transmission lines mitigates the ability to exercise market power in Germany. For Belgium, France and Netherlands, Ehrenmann and Neuhoff (2009) also find that increasing interconnection capacity reduces the wholesale prices, reduces market power and increases welfare.

Kupper et al (2009) state that increasing transmission capacity is expected to be most efficient where transmission capacity is small or nonexistent and when regions have considerable differences (heterogeneous demand profiles and generation mixes) and also when the competition between generators is expected to increase significantly. Referring to the Trilateral Market Coupling between the Belgian, Dutch, and French electricity markets, they stress that the efficient use of the existing capacity may have the same effect on competition.

The cost-benefit framework and the assessment of the effects above mentioned can be useful to decide wether to invest or not, though, as important is knowing which is the amount of the expansion on capacity enough to achieve efficiency and the full benefits of competition described. The countries more frequently studied are the ones in Central Europe, due to their main role on the integration process. On the typically congested interconnection capacity between France and Spain, Dominguez and Pérez-Arriaga (2001) evaluate the magnitude of the additional interconnection capacity that would be necessary to mitigate market power. Since the necessary investment is excessive for the result obtained, at the end they conclude that there must be other less expensive mean of achieving the same aim.

Moselle et al (2006) studied the electricity market in the Netherlands and they measure how large an interconnector with Belgium and Germany would have to be to induce a competitive electricity market. They conclude that interconnection between the Netherlands and

Belgium/Germany would have to be at least 6500 MW, when it was 3600 MW, or 30% of total Dutch installed capacity in 2005.

Finally, Valeri (2009) analyses the study effects of additional interconnection Ireland-Great Britain on welfare and competition. As the amount of interconnection increases, the evidence shows positive effects of competition in Ireland, the less competitive of the two markets. However, she stresses that it is unlikely that private investors will pay for the optimal amount of interconnection since their returns are significantly smaller than the total social benefit of interconnection. This difference between private and social benefits may lead to inadequate level of investments.

The expansion of interconnector capacity, which would be necessary to avoid congestion, may not be feasible, so some degree of congestion may always remain. We can say that congestion occurs when demand is higher than the existing network transmission capacity (Knops et al., 2001). In the EU, congestion occurs at least occasionally at almost every border and half of the connections are permanently, or at least frequently, congested while only less than a third are seldom or never congested (Parision and Bosco, 2008). Therefore, by principle, congested lines need to be managed efficiently in economic terms.

Although congestion management was always an issue in the electricity industry, it manifested itself primarily inside the control areas of single TSOs. With the increasing cross-border electricity trade and the aim of the EU of becoming an integrated electricity market (IEM), this subject became more complex.

The congestion mechanisms to allocate interconnection capacity play an important role in market integration. The frequency of congestion and the size of the resulting submarkets in Europe depend on the one hand on the capacity and, on the other hand, on the management

of the network (Ehrenmann and Smeers, 2005).

Transmission congestion must be managed so that transmission capacity is used efficiently with minimal social welfare loss. Some market based methods are available to achieve that aim. Usually these methods[4] are classified in two groups. Table 1.2 describes briefly these two groups of methods for congestion management.

Table 1.2

Methods for congestion management

(1) *congestion price methods*		
	explicit auctioning	*price mechanism; send a price signal to market*
		players indicating the cost of congestion; result:
	implicit auctioning	*players have incentive to relocate in order to reduce*
		the congestion; give correct economic signals
	market splitting	*provided there is no exercise of market power.*
(2) *corrective methods*	*redispatching*	*they do not affect the market transactions directly;*
		do not send a price signal to market players, but
	counter trading	*leave it to the TSOs to find a solution to congestion,*
		since it provides an incentive to minimize congestion.

In Europe, the limited available cross-border transmission led to the use of either market based and non-market based allocation methods to manage cross-border congestion, depending on the period and on the countries being interconnected. Non market- based solutions comprise first-come-first-serve (priority list) and pro-rata rationing and are considered as non efficient.

The congestion management regime in European interconnections was, before 1996, a bilateral set of agreements between TSOs, mainly based on non-market solutions. The first Directive did not provide strict rules on either capacity or congestion management. The Second Directive (2003) was more focused on this subject and introduced a single regime designed to integrate

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[4]See Knops et al (2001) for a description and evaluation of the different congestion management methods which seem most appropriate for Europe.

the national electricity markets. Nevertheless, it failed to provide "any explicit provisions on the regulation of cross-border electricity trade" (Meeus et al., 2005: 28). In the same year, the Regulation 1228/03 on 'Conditions for access to the network for cross-border exchanges in electricity' clearly states that the implementation of market based methods was preferred. However, it only set the general principles and not an obligation. In the work of the Florence Forum, created with the specific aim of giving guidance on this subject, amended in beginning of December 2006 the need for improved regional cross-border electricity trade was reaffirmed, with greater coordination and cooperation amongst transmission system operators.

However, despite pushing for a harmonised approach to interconnection and congestion management, a common European method is still absent. One of the main difficulties to choose one (and only one) management method is the existence of different regulatory approaches and market structures in Europe. Any scheme chosen for the management of congestion should consider these features (Perez-Arriaga and Olmos, 2005). Even if the tendency is the convergence on the methods due to agreement between TSOs, perhaps it is not feasible to have a single solution for Europe.

Cross-border transmission management raised academic and policy interest. The literature on congestion management in electricity markets presents proposals on a number of mechanisms for managing transmission constraints efficiently and its effects in several limited interconnections in Europe. At best of my knowledge, the literature on congestion management methods is mainly theoretical. Even the applications to European countries are, in most of the times, on a theoretical and comparative perspective.

For the assessment on the on social surplus from different ways of dealing with transmission constraints in the Nordic grid, Bjørndal and Jornsten (2007) considered the possibilities of

improving the utilisation of the capacity of the grid, by coordinating the methods. They conclude that the lack of coordination of congestion management within the Nordic power market may induce considerable additional cost, and that there is a potential for significant savings by a harmonisation. This may be used to support the definition of a common method for Europe or at least close harmonisation between TSOs as the best way to improve integration between markets.

The method studied more often in the last years was market coupling, alone or in comparison to other methods. This method is only slightly different from market splitting, Under market splitting there is only one power exchange operates across several price zones, whereas market coupling links together separate markets in a region. However, the effect is recognised to be the same (Gilbert et al, 2004 and Ehrenmann and Smeers, 2005). This method was adopted by many countries (trilateral market coupling between France, Netherlands and Belgium) and was been called to be extended to others (for example, Central West European region and British and Dutch markets). The market splitting was chosen in Nord Pool to manage congestion inside the integrated market.

Brunekreeft et al. (2005) compares coordinated auction and a decentralized market coupling and emphasizes that the latter is superior to joint explicit auctions because it limits the market power of generators located in frequently congested areas. They mention that even if all arguments seem to favor market coupling rather than a coordinated auctions for transmission capacity, the implementation of market coupling requires the coordination of a large group of stakeholders. This condition makes more difficult the implementation.

In what concerns to geographic focus on this topic, the importance of interconnections in Central Europe (France, Germany, Netherlands, Belgium) made it the principal focus of

research. Both Amudsen and Bergman (2002) and Hobbs et al. (2005) study the welfare effects of coupling between two equally sized markets, the Belgian and Dutch market. Their analysis shows that it clearly benefits the Belgian consumer, while the Dutch consumer's benefit depends upon the producer's behaviour. Hobbs et al (2005) show also that coupling would increase electricity trade. Neuhoff (2003) compares the explicit auction between Germany and the Netherlands and the market coupling between Sweden and Northern Norway and finds that explicit auctions allow for more exercise of market power, because generators face lower effective demand elasticities.

In a numerical model of the meshed network between France and Germany, Ehrenmann and Neuhoff (2009) show that market coupling would reduce prices relative to a coordinated auction of interconnectors. Moselle et al (2006) conclude that market coupling in the interconnection between Netherlands and Belgium / Germany would increase the effectiveness of interconnector capacity by increasing cross border flows in 15%.

In Kristiansen (2007b) we can also find a price assessment of the explicit auctions on the cross border between West Denmark (DK1) and Germany and on the Kontek cable between East Denmark (DK2) and Germany. There was a change to market coupling in the latter interconnection mentioned and he found evidence that the introduction of explicit cross-border auctions resulted in significant improvement in capacity reservation system compared to the earlier.

Valentin et al (2005) focus on the cross-border congestion management as practiced by the French TSO. Since France is a key player, due to its geographical position, it is essential establishing efficient cross-border trading mechanisms that comply with EU regulations. He describes cross-border management in all French borders and assesses the best approaches in

order to promote competition and ensure the secure operation of all network. He concludes that the best solutions are either allocation of transmission rights through explicit auctions, or the implicit treatment of the transmission rights through the coupling of energy markets.

Other congested cross-border interconnections in Europe were also studied. An example is Kristiansen (2007) with a description of the current applied and future possible congestion management methods in Europe, including the still emerging South East Europe region. He identifies the potential benefits of a regional electricity and cross-border trade within the region and neighboring countries.

Despite efforts from the European Union and Member States, interconnection congestion has remained a problem and it still is a serious impediment to the development of the IEM.

1.4   Regional integrated markets: interim stage to IEM

The EC recognised the presence of some obstacles, the ones described before and several others. Moreover, they recognised that the European-wide internal market will not emerge instantaneously.

The proposal to foster competition and to build the IEM, as foreseen by the Directive 96/92/EC, includes an intermediary stage: a bottom-up regional approach. The creation of regional integrated markets is based on the fact that certain groups of countries, inside the EU, have already adopted common harmonised rules (like the Nordic countries). A second step would be to connect these regional markets into the wide IEM.

In fact, a significant effort has emerged to create the conditions for a higher degree of market integration. In recent years, several regional initiatives, included in this perspective,

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were implemented, namely the agreement between Spain and Portugal for the organisation of the MIBEL. The main advantage of the regional approach is that it enables the involvement of the relevant stakeholders more than it is usually possible on an European level. In addition, the regional approach can also better take account of regional specificities.

In order to overcome the obstacles, the main challenge is also to develop and maintain a suitable framework to enable each regional market to operate in a way that promotes effective competition in order capture the full benefits of restructuring. This is the basis of the search of the best form of market design.

Different markets have adopted different solutions, because there is no universal "first-best" solution. However, from the literature, it can be mentioned that the overall design of an electricity market should have three fundamental components: the regulatory framework, the trading arrangements and the design of transmission tariffs.

In Europe and even in the world, the Nordic Power Market was the first common, integrated, inter-country electric power market. The general opinion among analysts is that the Nordic electricity market is a well functioning market, regarding restructuring (Amudsen and Bergman, 2005: Amudsen and Bergman, 2007), with increased competition and efficiency. This recognised efficiency clearly depends on its regulatory framework and its market design.

These will be our departure point for the description of the factors driving the success of the Nordic experience and also to answer the question: is the Nordic electricity market a relevant model for other experiences or, in other words, can the Nordic experience be replicated for other regional integration? The aim of this section is to explore why this is the case and to what extent the Nordic experience is relevant for other regional integration experiences, namely for the MIBEL.

1.4.1 A success story: the Nordic electricity market

The Nordic electricity market comprises Norway, Sweden, Finland and Denmark. The development towards an integrated market began in 1996 when Norway and Sweden began joint trading their national markets for physical power contracts. At the same time, the Nord Pool was established. Finland joined the market area in 1998 and the Finish power exchange began representing Nord Pool in Finland. In 2000 Denmark was fully integrated into the market area and the Nordic market had become the first internationally functioning electricity exchange market (Von der Fehr et al, 2004). This market is a result of the transformation from five electricity markets in four nations to one electricity market.

The experience of the Nordic countries provides a rich source of information and conclusions that can be used to identify the best market design to improve the effects of the liberalisation and integration process. If the success of the Nordic market is due to a good design of regulations and market institutions, then the experience may be useful for other countries. But if the favorable outcome primarily depends on country-specific factors or temporary circumstances, there is not much for other European countries to learn and apply.

The question of what constitutes a well functioning competitive market is not trivial. Joskow (2003) and Pierce (2005) suggest general preconditions for a competitive market of electricity, listed in table 1.3.

Table 1.3

General pre-conditions for effective restructuring in electricity markets

(1)	*introduction of a wholesale electricity market*	horizontal integration of transmission and network operations to create the wholesale market
		creation of a single independent system operator to direct the operation of network and maintain frequency, voltage and stability of network
		establishment of wholesale spot electricity market that are open
(2)	*design of transmission tariffs*	creation of mechanism to allocate the scarce transmission capacity and attract new investment to create new or expand transmission capacity.
		non-discriminatory access to transmission network under transparent prices
(3)	*establishment of independent TSOs*	creation of independent grid operator
(4)	*allowing consumers to choose their suppliers*	
(5)	*separation of competitive and monoplistic activities*	Structural and functional separation of generation and retail activities from transmission and distribution activities

Source: Joskow (2003) and Pierce (2005)

The Nordic integrated market has benefited from a number of positive experiences that have contributed positively to the achievement of a competitive market and may be attributable to a simple and sound market design. These are key factors that justify the use of this market as benchmark for comparison.

One of the steps of the electricity sector liberalisation process has been the introduction of a wholesale electricity market. Wholesale markets constitute a tremendous driver for market integration and the development of the power exchange was a part of the development of the

Common Nordic electricity market. The highest degree of harmonisation among national markets was found, where one power exchange (Nord Pool) manages capacity and energy auctions for all involved countries.

A second key prerequisite for a competitive electrcity market is the third party access to the network infrastructure. Even though the Nordic countries have used a regulatory framework similar to the criteria and requirements of the first EU electricity market directive, they have chosen the alternative that is most likely to foster competition. The non-discriminatory Regulated Third Party Access was introduced at all grid levels: all companies with grid concessions had to connect anyone who wished to their grid in a neutral way, with objective conditions and fair tariffs.

In addition to the creation of the Nord Pool, the establishment of a close cooperation between the transmission system operators (TSO) in the four countries has been the key element for the process.

The treatment of transmission constraints, and the resulting congestion of the network, represent also a major design issue. Transmission constraints arise on transmission networks from time to time due to changing patterns and costs in generation and demand. These constraints can be handled with several methods. The Nord Pool market uses two different models: as a whole uses market splitting model and "buy back" (also called counter trade) model, when congestion occurs within the defined price areas during the "operational phase".

All Nordic countries have ownership unbundling for transmission, which effectively separates the interests of the transmission and production companies, and legal unbundling for distribution. The Commission states that a strict transmission unbundling is the single most important variable to ensure that a market functions properly and the weak unbundling chosen by most

of the continental power markets must be seen as one of the main reason to their concerns on restructuring.

However, the Nordic market has also some properties, that distinguish it from the rest of the EU, and whose specificity also justifies the success of this market (Amundsen and Bergman, 2006). Firstly, the complementarity of the countries' resources (Norwegian and Swedish hydro-based with the Finnish and Danish thermal-based power systems), the large share of hydropower, matched with significant inter-connector capacities allowed a smooth integration. Secondly, the very strong mature networks and the low demand growth facilitate the restructuring due to the minimum needs of new investment.

Thirdly, much of the generating capacity of Nord Pool was fully or partially state-owned and this dominance of the public ownership implies an informal commitment to public service by the power industry. Lastly, mentioned as one of the most important factor, was political will to liberalise and unify the markets and a tradition of cooperation between Nordic countries (Thomas, 2006).

The replication of some elements of the Nordic example in other European regions may not be easy and may not guarantee the same achievements concerning competition and integration. However, there are some lessons that can be learned. In particular, the Nordic example suggests that a "deregulated" market for electricity works well if there are no price regulations and constraints on the development of financial markets and there is continued political support for a market based electricity supply system also when electricity is scarce and prices are high.

Chapter 2

Market power and integrated regional markets of electricity: a simulation of the MIBEL

2.1 Introduction

One of the proclaimed aims of economic integration of the EU is the liberalisation and integration of national energy markets (for gas and electricity). After the first EU electricity directive that came into force in 1997, almost all European countries are already involved in the process of creating an Internal Electricity Market.

A way of achieving greater integration,as proposed by the EC, is through gradual integration of regional markets. Some examples of integrated regional markets (in EU) are the (first) Nord Pool (Norway, Sweden, Finland and Denmark) and, more recently, prior to the final aim of full

integration of all European energy, MIBEL (Iberian Electricity Market), between Portugal and Spain. Since it was assumed as an intermediary aim, the achievement of regional markets is also seen as experimental fields to infer advantages and inconveniences of integration. Since it has specific characteristics the MIBEL can be used to pursue the same purpose, namely studying pro-competitive and anticompetitive effects of the integration of electricity markets.

Moreover, the promotion of good governance in the market, according to free competition, is one of the main principles written in the protocol for the creation of the MIBEL. Therefore, it is possible to start by studying some concerning questions in MIBEL and then trying to learn from this experience to achieve the Single Electricity market.

While the benefits of the electricity sector reform have been substantial, experience has shown that a liberalised market for electricity is prone to the exercise of market power. The Report on Progress in creating the internal gas and electricity market (EC 2005, 2007) claims that in most Member States a high level of concentration persists in generation, which creates a scope for market power from incumbent generators and significant efforts are still needed to create a competitive common market for electricity (and energy in general).

According to the literature, the opening of any market to greater competition should deliver greater efficiency and, over the long term, lower than otherwise would be without competition. However, the current structure of the market and the special features of electricity may mean that the benefits of integration may not be maximized. The major generation companies are large enough to be able to influence prices using their generation capacity (exercise market power), and thus prevent the potential gains of integration to be fully realised. Therefore, it is important to study the evolution of electricity markets in Europe with respect to market power and its influence on the advantages of restructuring.

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The purpose of this chapter is to give a contribution to the existing literature on market power and restructuring of electricity markets by studying the integration of two oligopolistic markets that are not symmetric (in number of firms, in demand or market dimension). The model applied in our research is a partial equilibrium one. In our case, the behaviour of generation firms after integration will be based on a Cournot model with competitive fringe.

The rest of the chapter is organised as follows. Section 2 describes the Iberian market (Portugal and Spain), before and after integration. In section 3 we present several procedures used in the literature to analyse market power and we justify our choice for the assumptions on the behaviour of firms in the market. In section 4, we describe our model with the specification of costs and demand. The main idea is the comparison of Portugal and Spain in four chosen days in a particular year (2004) considering two realities: no integration and full integration. The results of the simulation exercise are shown in section 5.

We can conclude that market power will be lower or at least not higher, after integration, as expected, but the exercise of market power by electricity generators will still be a feature of the market. A key finding is that larger firms might use market power in all periods of time (on peak and off peak). There is also market power on some off peak periods, surprisingly, where the Lerner Index assumes higher values. This is due to the presence of nuclear plants in the market that postpone the use of thermal plants, namely in periods of low demand. In section 6, we conclude and give suggestions for future research and extensions.

2.2 Iberian Electricity Market (MIBEL)

The success of any integration process depends on the coordination between individual participants. MIBEL is a regional integration within Europe between two very different countries: Portugal and Spain. For the past several years, Portuguese and Spanish authorities have been cooperating in order to solve some of these differences. In this section it will be shown, first how markets are characterised before and after integration and secondly, how different Portuguese and Spanish electricity markets are.

The liberalisation of the Portuguese electricity market started in 1995, through a series of decree laws. The Portuguese wholesale and retail market is divided into two subsystems: Public Electric System (PES) and non-binding electric system (NBES). A special regime system (PRE) was also created for renewable energy sources and cogeneration, under which producers benefited from feed-in-tariffs with buy back obligation by the network operator.

The PES is responsible for the majority of the electricity purchased in the market. The NBES is formed by independent generators and generators from the special regime and promotes supply to non-binding consumers[1]. There is not an organised market in Portugal, i.e, the spot market or forward market or intra-daily market are inexistent and all the transactions are made through bilateral private contracts between generators and REN (National Electricity Grid). The prices for the PES are fixed by law (regulated tariffs), according to several criteria such as fuel prices and payments for CO_2 emissions.

In Spain there is a spot market where generators and consumers can purchase electricity. Since 1999, by royal law, liberalisation and deregulation in generation and supply of electricity

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[1]Non-binding consumers are consumers that, given the permission from the electricity regulator may freely choose their supplier.

was established . Transmission is still regulated and dominated by REE (Red Eléctrica de España). In this system created with the liberalisation, generators sell electricity to a pool and the prices are set in a competitive bidding process. The structure of the market includes the day ahead market, the intra-day market, the ancillary services market and physical bilateral contracts.

Mibel is expected to operate to guarantee, to all agents established in both countries, access to the Iberian Market Operator and also access to interconnections with third countries under free and equal bilateral trading conditions. MIBEL will be made up by different organised and non-organised markets in which electricity transactions and contracts are made. The organised markets will be a forward market, a day-ahead market and a intra-day market. The non-organised market comprises bilateral (OTC) contracts. According to the agreement signed on the 1st October 2004, in each market the legislation should be applied according to the country in which those markets are constituted. The spot market will follow the current model of the Omel (Spanish) and the forward market will be managed by the Omip (Portuguese). The integrated market will maintain two stages of the electricity chain completely deregulated and liberalised, namely generation and supply. Transmission will continue to be a regulated sector. Officially the 4th September 2006 was the first day of operation for the MIBEL.

Table 2.1 shows a comparison between the two countries before integration and after integration for the MIBEL. For the values of the integrated market, as it was not a reality at the time, we assume the addition of both markets for all items. The prices of purchasing electricity have always been one of the main differences between Portugal and Spain. For values of December of 2004, prices in Spain were in average 20% lower than Portuguese prices.

Table 2.1

Comparative features of electricity market, Portugal, Spain, MIBEL, 2004

	Portugal	Spain	Mibel
Production - market shares			
EDP	61.7		8.9
Tejo Energia	11.1		1.6
Turbogás	15.7		2.3
EDIA	0.3		0.03
Special Regime Generators	11.4		1.7
Endesa		41.8	35.8
Iberdrola		29.8	24.7
Union Fenosa		12.2	10.4
Hidrocantábrico		7.2	6.1
Viesgo		3.1	2.6
Gas Natural		2.7	2.3
Others		3.1	2.6
TOTAL (TWh) - Production	39.4	233.5	272.9
Relative size (Portugal/Spain)		17% (1 to 6)	
Installed Capacity - market shares			
EDP	69.4		10.6
Tejo Energia	5.3		0.81
Turbogás	8.5		1.3
EDIA	1.0		0.15
Special Regime Generators	15.9		2.43
Endesa		34.5	29.23
Iberdrola		37.2	31.52
Union Fenosa		12.7	10.76
Hidrocantábrico		5.1	4.32
Viesgo		4.5	3.81
Gas Natural		3.1	2.63
Others		3.3	2.8
TOTAL (MW) - Installed Capacity	11708	64971	76679
relative size (Portugal/Spain)		18% (1 to 6)	
Generation Mix (%)			
Hydropower	20.0	11.9	
Gas/Fueloil/CCG	25.0	14.7	
Net imports	14.0	-	
Coal	31.0	30.5	
Nuclear	-	24.4	
Special Regime Generators	10.0	17.5	
Maximum Annual Power (MW)	8249	37724	45973
Wholesale price of electricity (Dec 2004 - €/MWh)	60	41	
HHI (production)	4306.6	2862.5	2145.9
HHI (installed capacity)	5170.51	2802.14	2132.3
CR3 (production)	88.7	84.4	70.9
CR3 (installed capacity))	83.2	84.4	71.51
Liberalized sectors:	gen + supply	gen + supply	gen + supply
Transactions based on	bilat. contracts	spot + contracts	spot + contracts

Source: EN, ERSE, Annual Report for the European Commission, 2005; Endesa, Iberdrola, Union Fenosa, EDP; Spanish Regulator's Annual Report to the European Commission, CNE, 2005; European Commission; "El sistema eléctrico español 2004", REE. ; Own calculations.

Although generation and supply of electricity were totally liberalised in 2004, we cannot consider that there is competition in the Portuguese electricity market and Public ownership is still dominating. The electricity sector is still dominated by the incumbent *Electricidade de Portugal* (EDP), with a market share of around 62% of total Portuguese consumption. On table 2.1 we can see the relative contribution made by the different generators to meet national consumption.

In Spain, the electricity market can be considered to be more competitive than in Portugal. Nevertheless, as a result of merger and acquisition transactions carried out in the 90's, Endesa, the largest Spanish generator, has around 42% of all electricity generated in Spain. Together with Iberdrola and Union Fenosa, they have a market share of around 84%. The fourth largest generator is Hidrocantábrico, whose major owner is EDP, with only around 7% of the market. All the remaining firms have less than 5% of the market each.

The analysis of HHI and CR3 allows concluding about the comparative concentration in both markets and in the integrated market. Concentration is higher in Portugal, compared with Spain. When considering the integrated market, the concentration level is lower, as expected, than within each country separately, due to the higher number of firms in a larger market.

Another important way of analysing and comparing wholesale markets is to characterise the installed generation capacity, namely total installed capacity and distribution of installed capacity by generator. In 2004, the total installed capacity in Portugal showed a value of approximately 11.7 GW. However, this value is very unevenly distributed: Group EDP is dominant with almost 70% of the total installed capacity. In Spain, two companies, Endesa and Iberdrola, own the majority of generating capacity, while Union Fenosa and Hidrocantábrico are smaller competitors. This means that, even if the installed capacity is more evenly distributed,

there is also some concentration on the supply side of the market.

With 29 million consumers and around 280 TWh of annual consumption, MIBEL will be the 5th largest electricity market in the EU. However, if the features in the market are extrapolated to the integrated market, MIBEL will be dominated by five business groups that will control a very high percentage of electricity generation (around 86%) plus a number of smaller companies from the two countries, which may constitute a competitive fringe.

Since these are the features of the markets, only by analysing simple statistics, can a high level of concentration be forecasted. Therefore, it is very important to infer the possibility of exercising market power in this regional integrated market, considering the strategies of the firms involved. The objective is to be able to conclude about the achievement of all aims of full integration of electricity markets in Europe.

2.3 Market power analysis

The effects of market integration have been studied before, either in partial equilibrium literature or in general equilibrium literature. In either theoretical or empirical studies, there is a standard assumption that integration of markets will promote competition.

In partial equilibrium, several literature was concerned with examining the relation between integration (shift from two separate markets to a unique integrated market through gradual elimination of all barriers to transactions) and market power of firms. Ishikawa (2004) refers to a model with a monopolistic firm producing for two markets and claims the existence of pro-competitive effects of economic integration, under oligopoly. Venables (1990) with the same purpose and conclusions considers a model with one firm in each market. We can find

a model with several firms in each market in Venables (1990b). All this literature is based on static models of competition where the firm's behaviour is given and thus it assumes that firm's reaction to their competitor's behaviour is the same before and after integration.

Dynamic models can also be reported to study procompetitive effects of integration (see Colonescu and Schmitt, 2003, Fung, 1992 and Lommerud and Sørgard, 2001). In these models it is assumed that firms interact repeatedly through time.

Previous work assesses various aspects of an integrated electricity market in several countries based on a model on the existing generating infrastructure. The study by Berger et al (1991) evaluates the cost savings from electricity trade in the American-Canadian Northeast. The general approach is similar to Amudsen and Tjøtta (1997) but in the former research they consider that demand is totally price inelastic and they apply linear programming to find the equilibrium solution in a long run model. Bjorvatn and Tjøtta (1993) consider the effects of various market forms. Bergman and Andersson (1994) study a more complex conjectural variation model restricted to the Swedish electricity market. Amudsen et al (1994) consider some Northern countries in their long run model in order to determine both transmission and generation capacity. The model of Fehr and Sandsbråten (1994) is restricted to two countries and two technologies for electricity generation (hydro power and thermal power).

Market power is one of the subjects that was most often studied in all markets and, in particular, on wholesale electricity markets. Several methods have been used in industrial organisation to measure market power in electricity markets. Multiple studies found in the literature analysed how prices are affected by competition in electricity markets and measure the departure from marginal cost pricing. Researchers have developed alternative approaches to analyse the potential for market power which basically involve the simulation of market

outcomes using the available cost data and oligopoly equilibrium concepts. These models can be divided into either Cournot (simulation) approach or Supply Function Equilibrium (SFE) approach.

An electricity market simulation model is appointed for the cases where we have more than one firm in the market leading to a higher complexity of the reality, as it considers interactive effects between different generators at different points in the supply curve at different times of the day. These are the main features of an electricity market. According to these models, if one finds a difference between oligopolistic price and competitive price then it means the presence of market power.

It is commonly accepted in the literature that Cournot quantity setting is not perfect to model reality in electricity market, but the existence of generation capacity constraints (at least during peak periods) in these markets and the presence of increasing marginal costs of producing electricity justify the choice. Another fact that justifies the use of this approach is the existence of a centralized price mechanism in electricity markets. The capacity constraints on generation are significant in both the medium term and the short term when plants are turned into "unavailable" due to maintenance or other reliability considerations. Short term constraints are more relevant in our study, since the capacity investment of the major players have already taken place. Therefore, Cournot competition seems to represent (fairly) realistically firm behaviour in an electricity market where generators are competing with relatively "steep" marginal costs and where capacity constraints exist.

There have been numerous studies of oligopoly behaviour in restructured electricity market that rely on the Cournot framework to infer market power. For the Californian wholesale market, Borenstein et al (1996) and Borenstein and Bushnell (1999) use a Cournot model with

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competitive fringe. The inefficiencies due to deregulation of the wholesale market was also studied in the same framework through the application of a Cournot model in Borenstein et al (2002). The question of the impact of strategic hydro scheduling on market power may also be analysed using this approach, as Bushnell (2000) did. Adding to the Californian market, also the Spanish market (Ocaña and Romero, 1997) and the Swedish market (Andersson and Bergman, 1995) were simulated with this approach. All these examples illustrate the flexibility of the Cournot simulation to study electricity markets.

The alternative approach, the SFE, is based on the assumption that under uncertainty firms adopt supply functions[2] as strategic variables rather than prices or quantities. The most important advantage of SFE approach is the better representation of firms' behaviour when they have to bid a single curve that will be applied to different demand states. However, the supply function model also has a weakness that may limit its usefulness particularly when applied to certain electricity markets: the inability to combine the model with detailed production costs data. Generally, the studies using SFE make use of stylised representations of generators costs to develop smooth continuous curves, because solving for supply curve equilibria requires relatively well-behaved cost and revenue functions.

Moreover, in some markets, trade does not occur exclusively, or even primarily, through a supply function bid process. Bilateral trading of specified quantities is usual in many restructured markets as are in future markets and in different forms of spot markets. According to its features, SFE models are not well suited to markets where these situations happen or where competitive characteristics vary between different periods, as it was pointed by Bushnell (2000).

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[2]In SFE models, firms compete by bidding supply functions which state the relationship between the price and the supply offered by a firm at that price.

Additionally, the SFE approach does not feature well in markets where there is a competitive fringe. This is due to the fact that supply function models are based on the assumption that the slope of the demand function does not vary across time periods. The introduction of a significant price-taking fringe results in demand curves that are kinked at the points at which these constraints become binding. The slope of demand does not only change as demand increases, but this change is endogenous to the output decisions of the strategic firms. Overall, the SFE approach is accurate in one important aspect of restructured electricity markets related with the rule of bidding, but it is not as flexible as the Cournot approach in incorporating other institutional aspects of the market.

Klemperer and Meyer (1989) have developed the first model using the SFE approach. Some of the most important literature in this vein is concerned with market power on wholesale spot market, particularly after deregulation in several different countries. Green and Newbery (1992) apply this approach to the British Electricity spot market, assuming a sectorial structure dominated by two firms and considering an affine demand function and linear marginal cost to construct the corresponding bid curves. It can be also found some attempts to overcome some disadvantages pointed out before, namely incorporating the role of a market for futures and/or forward contracts to mitigate market power in electricity markets (Newbery, 1998).

Our choice: Cournot simulation market

In our research, the role of marginal cost curves of each firm is very important and one of our concerns is the accuracy on the assumptions about costs. Thus, we do not assume smooth and well-behaved cost curves and we use detailed production data that lead to steep functions that are not convenient for solving with a SFE approach.

Our choice for the Cournot simulation model is also justified by the adequacy to the real market. First, in MIBEL, firms will bid supply curves, but they are permitted to bid a different supply curve for each hour of the day. Second, in MIBEL, according to the current features of each market and the expected evolution of the integrated market, there will be a competitive fringe, so it is relevant for the final conclusions and results considered it in the simulation model.

For all the above reasons, the Cournot simulation approach seems to be an appropriate starting point. Even as a base scenario, the Cournot analysis will be useful as an indicator for the need for regulation in the case of potential exercise of market power.

2.4   Oligopoly simulation model

Our model is constructed along the same base lines of Borenstein and Bushnell (1999)'s analysis of California's power pool, with a different purpose and some different assumptions. They use it to infer market power after deregulation and we use it to assess the exercise of market power after regional market integration. The electricity market is modelled at the level of the wholesale markets, as in Amudsen et al (1994). In our case, differently from Borenstein and Bushnell (1999), the market size increases as both electricity markets integrate. The benefits of enlarging the geographical scope of power markets are, according to economic theory, increasing economic efficiency and lowering market concentration. Even though the literature has extensively explored the question of how integration affects the welfare properties of electricity markets, more results and conclusions on market performance and on the exercise of market power are needed under realistic assumptions and considering the special features of electricity markets.

The simulation will have, essentially, three steps and is similar to a merger assessment. First, it is necessary to choose the nature of competitive interaction between the firms in both separate markets, before integration. The model that best describes firm´s behaviour in both markets is an oligopolistic model. According to the features of each market (described in section 2.2) we conclude that for Portugal we will use a model of leadership with competitive fringe and for Spain a Cournot model with competitive fringe.

According to Scherer (1970, 164), a "Dominant firm price leadership occurs when an industry consists of one firm dominant on the customary sense of the word", i.e. controlling at least 50% of the total industry output – plus a competitive fringe of firms, each too small to have influence on price through its individual output decisions. Since EDP had, in 2004, more than 60% of the total electricity in Portugal and we infer from market information that the remaining firms do not have any ability to change prices with their actions or decisions the choice for the model of a leader with a competitive fringe for Portugal is justified.

For Spain the choice of a Cournot model with competitive fringe is justified by the presence of the four firms with similar importance on production and installed capacity. The remaining firms with less than 5% of the market compose the competitive fringe.

Next we should choose the model that better fits the integrated market, the MIBEL. In order to simulate the Iberian market, we decided also for a Cournot model with a competitive fringe. After integration we assume that only the five largest firms present in both markets behave strategically as Cournot competitors (Endesa, Iberdrola, Union Fenosa, EDP and Hidro-cantábrico). In equilibrium, each of the five firms considers the output of all the other firms as fixed and sets its own output that maximises its profits. All other producers (from both countries) are assumed to behave competitively and are modelled as a competitive fringe, taking

market price as given.

In a second step we should have a fully specified model through some specification assumptions and through parameter calibration based on pre-integration data. At this point we must decide on the specification of demand and we should have available information on marginal costs of the firms and installed capacity for each firm. To calibrate the parameters of the model we use the specification for the demand function chosen and we substitute data in current wholesale prices and quantities into the model. The last step is to determine prices and quantities before and after integration and specify the changes occurred with the integration process.

We follow Wolfram (1999), Borenstein et al (2002) and Joskow and Kahn (2002) by measuring market power by the difference between simulated (oligopoly) market prices and estimates of competitive prices. The competitive price is defined as the expected marginal cost of the highest generating plant in the industry required to meet electricity demand.

The idea of the simulation is to compare four time periods in a defined year (2004) considering two cases: without integration (two separate markets) and with full integration. The year chosen was 2004, because it was, according to hydrological conditions, the most recent year that could be considered as "normal" (not too dry or too wet). The choice of a normal hydrological year allows us to identify a base case for comparison. However, the simulation conclusions may be extended to allow for years with different hydrological conditions.

The equilibrium at the demand levels is determined for four Wednesdays: two in December (15th and 22nd) and two in June (16th and 30th). Wednesday is the weekday usually described in the generators' reports as having typical features. The selection of the month was made to account for seasonal variations in availability of hydro generation capacity. For each of these

days, we chose market price and quantities for two representative hours: a peak demand hour and an off peak demand hour.

Each day is traditionally divided in three periods: peak, mid-peak and off peak. The definition of each period depends on the year's season (summer or winter). The summer period is May through October and the winter period is January through April and November and December. The following table (Table 2.2) shows the definition for both countries of peak hour time and off peak hour time.

Table 2.2

Definition of peak hours and off peak hours, Portugal and Spain

		Peak hour	Off peak hour
Portugal	Summer	9h15 to 12h15	2h to 6h
	Winter	9h30 to 12h 18h30 to 21h	2h to 6h
Spain	Summer	8h to 16h	0h to 6h
	Winter	16h to 23h	0h to 6h

Source: ERSE, CNE

In Table 2.3 are presented the real values for the market outcomes for both countries in the chosen days. A more detailed description of the data can be found in Appendix A.

Table 2.3

Market prices and quantities, Portugal and Spain, 2004

		WINTER				SUMMER			
		15th Dec		22nd Dec		16th June		30th June	
		on peak	*off peak*	*on peak*	*off peak*	*on peak*	*off peak*	*on peak*	*off peak*
		20h	3h	20h	3h	11h	3h	11h	3h
Portugal	MWh	7617.1	4486.7	7558.6	4576.8	6657.5	4083.1	6703.1	4094.7
	cent€/KWh		5.243				5.243		
Spain	MWh	29797	22272	26006.4	21486	27201	19408	27263	22142
	cent€/KWh	5.846	3.077	3.994	1.955	2.7	1.452	3.5	2.437

Source:EDP and OMEL

The replication of the strategic behaviour of each player in the market as a Cournot competitor allows the definition of the oligopolistic market price. If we compare it to prices from perfect competition (according to marginal costs), we define the Industry Lerner Index.

The model considered in our research is static and is a short term model in the sense that the capacity for generation of each firm is exogenously determined. Therefore, our model does not incorporate explicitly any dynamic aspect, such as the effect of current and potential new entry into the market or possible exit from the market. The main difficulty in introducing these aspects into a short run analysis is considering the measure of the velocity of the changes. However, it is possible to infer some results in our model for these aspects allowing for long run elasticities of demand in the demand specification. Hence, entry and exit considerations are implicitly considered by examining long run (more elastic) demand functions. The results for the long run own price elasticity may be used as guide for the ability of firms in the market to exercise market power in the presence of potential entry.

2.4.1 Specification of demand of electricity

Each market price-quantity pair chosen is an anchor point for each period. Given that there is only one pair for each period, it is not possible to directly estimate the electricity demand function. Therefore, we will choose an appropriate functional form and following we parameterise it, using each period´s anchor point and the assumption for the values of the price elasticity of demand.

The functional forms specified for the electricity demand equations have mostly been the double logarithmic form and the linear form. The log-log form is convenient because the parameter estimate measures elasticity directly, while linear form is preferred by those who question the reasonableness of assuming constant elasticities at all price levels. In the first case, the dependent variables and the independent variables are both expressed in terms of their logarithmic values and the elasticity of demand is assumed to be constant.

We represent the demand for electricity in each market with a constant elasticity demand function of the double log form used in the literature on electricity demand, where Q_t would represent the total demand, P_t the price and ϵ_t the own price elasticity of demand. The function is fully specified if the value of parameters a_t and ϵ_t are known,

$$\ln Q_t = a_t - \epsilon_t \times \ln P_t$$

As in Green and Newbery's study (1992), we have chosen to pre-set values for the price elasticity of demand and then determine the values of slope ϵ and a_t according to real data of demanded quantities and market prices. Therefore, a_t and ϵ_t are positive parameters determined by a calibration process. The calibration process determines the parameters in such a manner that the market prices match market quantities for the given own price pre-set elasticities. The

slope parameter (ϵ_t) is calculated such that it equals the price elasticity at the demand level and the intercept a_t is calculated to fit the anchor-pair quantity- price. Both parameters are different, depending on the period analysed.

The chosen price elasticities are used to define the specification for demand functions on peak and on off peak times for the chosen days in 2004. Therefore, different demand specifications for each period considered are available for the simulation model. All specifications will be used as input for the Cournot model in order to assess the existence of market power in several realities, before and after integration.

Although a constant elasticity demand curve with elasticity less than one may cause a monopolist to charge an infinite price, it is guaranteed in the model that the Cournot firms would, in this scenario, face their residual demand, insuring a finite price. Cournot players choose their output facing the result of subtracting the aggregate fringe supply from the market demand. This residual demand will be more elastic than the initial demand for every price. To obtain the aggregate fringe supply at any price, we add together the quantity that each price-taking firm would produce if it produced every unit of output for which its marginal cost was lower than the price.

Demand for electricity and own price elasticity

The purpose of this section is to survey the results of several academic literature on own price elasticity of electricity demand in order to choose the appropriate values to be used in our demand specification. This same approach was used in other past studies of market power in European electricity markets (see Andersson and Bergman, 1995 and Borenstein and Bushnell, 1999).

Within the last decade, the demand for electricity has been the focus of numerous econometric studies and the price elasticity of electricity demand is one of the main concerns found. Although this literature is not limited to the residential sector, it contains a good part of it.

Typically empirical papers on this topic have related electricity consumption to a variety of economic and demographic variables and have yield estimates of long run or short run price elasticities, or both. Demand elasticities estimations vary considerably and this may be attributed to the different time periods considered, the different consumer categories studied or the different models and methods employed.

Most price elasticity studies before 2000 are captured in one of the following surveys. Taylor (1975) is one of the first surveys on this subject. He reviewed 10 studies on residential, commercial, and industrial electricity demand. All studies are on aggregate data and he finds large differences in estimated long run and short run elasticities. For residential electricity, he reported that short-run price elasticities varied from −0.90 to −0.13. Long-run price elasticities ranged from −2.00 to near zero. The only study on commercial price elasticities that distinguished between long-run and short run elasticities reported a short-run price elasticity of −0.17 and a long run elasticity of −1.36. For industrial demand, on the short run, he reports one research stating -0.22 and for the long run the range goes from -1.25 to 1.94.

Taylor (1977) extends the former survey with eight additional studies, where he reviews the existing econometric evidence until 1976 on price (and income) elasticities for each major type of energy. His conclusions include a lower long run price elasticity with a maximum price elasticity of 1 in absolute value for residential demand. On demand for industrial and commercial sector he finds it still to be under researched. Both surveys led to the conclusions that the overall short run price elasticity for electricity is -0.2 and the long run elasticity is between -0.9 and

-0.7.

Bohi (1981) does a more extensive survey and draws conclusions from a larger sample of studies. He divided the 25 studies of residential demand for electricity into reduced form models, structural models, or fuel share models, with subdivisions according to aggregate data, disaggregate data, or data by industry and whether the price variable is average or marginal. He notes the wide difference between short run elasticities varying from -0.54 to -0.03 and long run price elasticities varying from -2.10 to -0.45. He found that the few existing studies on commercial demand indicated that long-run demand is elastic, while studies of industrial demand, which are severely criticised, have a consensus estimate of price elasticity of -1.3.

Another comprehensive review of studies on energy demand is Bohi and Zimmerman (1984). They surveyed the existing research on demand in the residential, commercial, and industrial sectors not only for electricity, but also for natural gas, fuel oil and gasoline. As pointed out by Taylor (1977), in what concerns electricity price elasticity, they conclude that for residential consumers it equals –0.2 in the short run and –0.7 in the long run, but they also state that the values for estimates in commercial and industrial sectors were too variable to take any clear conclusions. Moreover, they conclude that even if the long-run estimates vary considerably between studies, overall it is below 1 in absolute terms.

Dahl (1993) provides a wide survey of energy price elasticities for the developing world. Similarly to previous surveys, they mention that there is a wide variance in price elasticity estimates. The conclusion, even if cautious, shows a long run price elasticity for aggregate demand for electricity to be near -1.0 and a long run price elasticity for the residential sector between -0.91 and -0.75. Atkinson and Manning (1994) provide an overview of elasticities estimated mainly for developed countries. In general, in the long run, price elasticities vary

from about -0.2 to -1, while short-term price elasticities are reported to be about half those values.

A meta - analysis by Espey and Espey (2004) states that price elasticities reported in the literature published between 1971 and 2000 range from 0.076 to -2.01 for the short run and from -0.07 to -2.5 for the long run. They show that the average residential electricity price elasticity among these earlier studies is −0.35 in the short run and −0.85 in the long run.

We can find applications to non European countries (Bernard et al, 1996; Houthakker et al, 1974; Houthakker, 1980; Hsing, 1994; Silk and Joutz, 1997; Narayan and Smyth, 2005) and to European countries. Since our aim is to find an appropriate value for price elasticity for Portugal and Spain, the last group of research will be more suitable for comparison. Previous examples of research works are for the United Kingdom (Dodgson et al, 1990; Henley and Peirson, 1998), Greece (Donatos and Mergos, 1991), Switzerland (Filippini, 1999), Denmark (Bjørner et al, 2001; Bjørner and Jensen, 2002) or Southern European Countries (Iimi, 2010). Table 2.4 summarises some estimates of own price elasticities found for European countries or European regions.

Table 2.4

Comparison of some past empirical results for price elasticity of electricity demand, European Countries

Country	Authors	Empirical method	Period	res/ind	Own Price elasticity	
					short run	long run
Finland	Ilmakunnas and Torma (1989)	Factor substitution model	1960-1981	ind	-0.74	
England and Wales	Dodgson et al (1990)	panel data model	1974/75 to 1984/85	res	-0.08	
England	Henley and Peirson (1998)	panel data model	April 1989 - March 1990	res	-0.25 to 0.07	
UK	Baker and Blundell (1991)	Extended Almost Ideal Model	1978-88	res	-0.673 (wint) / -1.033 (sum)	
Norway	Nesbakken (1999)	cross sectional model	1993-1995 each year	all res	-0.5 -0.24 to -0.57	
	Halvorsen and Larsen (2001)	discrete-continuos model	1975-1994	res	-0.433	-0.442
Denmark	Bjørner et al (2001)	panel data model	1983- 1996	ind	-0.48	
	Bjørner and Jensen (2002)	panel data model	1983- 1997	ind	-0.34; -0.28	
Sweden	Brannlund et al (2007)	Almost Ideal Model	1980-1997	ind	-0.24	
Cyprus	Zachariadis and Pashourtidou (2007)	Cointegration and error correction model	1960-2004	res / services	-0.10	-0.30 to -0.43
Italy	Bianco et al (2009)	time series model	1970-2007	res	-0.06	-0.24
EU *(and US)	Azevedo et al (2011)	panel data models	1990-2004	all only EU	-0.20 to -0.25 -0.20	
9 West European Countries**	Hesse and Tarkka (1986)	Translog	1960-72 e 1973-80	all	-0.3	

Note:*Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, Turkey, UK, US, Canada, Australia, Japan and New Zealand.** Belgium, Finland, France, West Germany, Italy, the Netherlands, Norway, Sweden and the UK.

Past empirical studies have estimated widely varying price elasticities, ranging from -1.0 to zero. This wide interval reflects differences in the geographic regions examined, as well as considerable variation in data quality and statistical techniques.

Nesbakken (1999) studied the price sensitivity of residential energy consumption by using cross section data from the Norwegian consumer expenditure survey for the 1993-1995 period. The results show that the energy price sensitivity in residential energy consumption varies from year to year but it is higher than the surveyed values.

Azevedo et al (2011) assess the price elasticity for household electricity consumption in (the US and) the EU. For all models tested, EU price elasticity is estimated to be around -0.2. Bianco et al (2009) investigate demand of electricity in Italy. Their results are also different from other research already mentioned, -0.06 on the short run and -0.24 on the long run.

Moreover, other conclusions seem to be clear. First, the estimated elasticities have wide variation and cannot be easily compared directly with one another and there is a risk of over-generalizing our results. Second, most of the results are for residential demand and there are fewer commercial and industrial studies to survey. Even if price elasticities for the industrial sector are significantly lower than those for the non-industrial sector, there does not seem to be a consistent pattern. Therefore, it might make sense to use the same estimates in all sectors.

Thirdly, the short run price elasticity is assumed to be lower than the long run elasticity and with respect to season there seems to be no reason to assume any differences in price elasticities (Amudsen and Tj⌀tta, 1997). Finally, in all cases electricity demand is inelastic to own price.

However, it is difficult to draw any firm conclusion from previous literature with respect to the values of price elasticities estimated for the countries included in our study (Portugal and Spain), because for both countries research on electricity demand is scarce. For Spain,

few works can be mentioned that may guide our choice. Labandeira et al. (2006) estimate residential and industrial electricity demand using panel data within a context of individual demand equations. They concluded that residential own price elasticity ranges from -0.96 to -0.45 for short run.

Labandeira et al (2011) show only a short-term estimation per group of consumers. Their results present a residential demand of electricity that is more rigid than the one obtained by Labandeira et al (2006), with elasticities ranging from -0.03 (firms) to -0.25 (households). For the long run, we should mention results from Buisan (1992) about residential demand in Spain. On her conclusions she finds a price elasticity for the long run of -0.5.

Academic literature on electricity demand for Portugal is even more limited. According to our best knowledge there is no available research on this subject. Given this lack of information to guide our choice, our approach was to find results for a European country similar to Portugal concerning the dimension of the market (total consumption of electricity). According to this criteria, Portugal may be similar to Greece and Switzerland. In what concerns research on Greek electricity demand, we can find several results. However, the interval of estimates is, even in this case, large. The short run elasticity goes from -0.51 to -0.21 and in the long run takes values on the interval -0.85 to -0.24. The range of price elasticities estimated in some of these studies is shown in Table 2.5.

Table 2.5

Review of own price elasticity estimates for electricity demand for Greece

		Short run	Long run
	Greece		
Vlachou and Samouilidis (1986)	ind	-0.31	
Donatos and Mergos (1991)	res	-0.21	-0.58
Caloghirou et al (1997)	ind	-0.51	- 0.77
Christodoulakis et al (2000)		-0.23	-0.24
Hondroyiannis (2004)	res	inel	-0.41
Rapanos and Polemis (2006)	res	-0.31	-0.60
Polemis (2007)*	ind	-0.35	-0.85

Note:* also estimates an oil demand function separately.

Due to the large variation of price-elasticities estimates available in the literature, the usual approach followed in the literature is to report the results of the model for different values of elasticities. Borenstein and Bushnell (1999) assume a constant elasticity of demand and estimates the model for -0.1, -0.4 and -1.0. Andersson and Bergman (1995) use -0.3 as the value of own price elasticity. Bushnell (1998) assumed -0.1 at peak forecasted price/quantity point and Wolfram (1999) uses a linear demand with a price elasticity of -0.17. In particular, usually the market demand is usually estimated for several assumptions of own price elasticity of demand.

In some other literature the authors assume a unique value, based on former knowledge. Andersson and Bergman (1995) based their analysis for the deregulated Swedish electricity market assuming -0.3 and -0.6, for short run and long run respectively. The Department of Energy has used short-run and long-run own-price elasticity values of - 0.1 and - 0.6. For current government agency practice, the Energy Information Agency (EIA) historically employed a short - term price elasticity of -0.15 for non-electric sectors. In their 2010 report, the EIA

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adopts a price elasticity of -0.3 (Alberini et al, 2011) for the short run. For the long run the values assumed were higher, from -0.31 for 1999 to -0.49 for 2003.

For our research we choose the second option and we set the value of price elasticity for each country reflecting our survey of previous literature and the conclusions above. The values assumed, displayed in Table 2.6, are measured at the anchor points and in line with the widespread perception that electricity demand is not very sensitive to own price changes. Once the value of price elasticities of electricity demand are chosen, we use this information to simulate the market in order to analyse the exercise of market power in the Iberian Integrated market.

Table 2.6

Choice of own price elasticities for the demand specification

	Portugal	Spain
Short run	0.3	0.25
Long run	0.6	0.5

Note: Values in absolute terms.

2.4.2   Firm's marginal costs

The total cost of any good is the sum of all expenses to produce it. In electricity generation, the good is electricity generated and supplied to distribution. To generate electricity, a generation plant and fuel is needed. Consequently, the marginal cost of generation includes fuel consumption and operational and maintenance expenses. To estimate the marginal cost of production for each firm, we need data on all generation plants that constitute the capital of the generation firm or, in our case, data on all generation plants by source of generation. Transportation or distribution costs will not be included in the relevant costs, because the purpose is to study the wholesale market and we do not need to account for the costs in the distribution sector.

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An inverted L is the typical shape of the cost function of generators, with each step corresponding to a different fuel for generation. This means that generators have constant marginal costs up to the capacity constraints, where the costs increase very rapidly.

Following Borenstein and Bushnell (1999), three categories of generation plants must be considered, taking into account the specific generation mix of the firm: fossil fuel generation, nuclear generation and hydroelectric generation. This separation is essential to accurately determine generation marginal costs, since the treatment of marginal costs on each of them is different. We assume that marginal cost are the same as the average variable costs, and can be divided into costs of fuel and operational and maintenance (average) costs.

The cost of fuel comprises the major component of the marginal cost of fossil fuel generation. Therefore, each firm's marginal cost curve is specified using fuel prices for electricity production, efficiency rates of each fuel and heat rate of each fuel. The expression used for the calculation is the following:

$$\text{Fuel cost } (\text{€/KWh}) = \text{Fuel price} * (\text{Efficiency Rate} * \text{Heat rate})^{-1}$$

The efficiency rate and the heat rate for each fuel are displayed in the Table 2.7.

Table 2.7

Heat Rate and Efficiency Rate for each fuel type

		Heat Rate	Efficiency Rate
Coal	Kcal/Kg	5500	0.33
Natural Gas	Kcal/m^3	9047	0.55
Fueloil	Kcal/Kg	9400	0.33
Gasoil	Kcal/Kg	9700	0.28

Source: CNE, AIE

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As an example, the variable cost of coal for Spain is given by

$$\text{Cost of Coal } (\text{€}/\text{KWh}) = 8{,}94*(5500*0.33*0.001163)^{-1} = 4.236$$

To calculate the marginal cost of each type of fuel we should add the operational and maintenance cost per KWh to the fuel cost. This data was obtained on generators' reports, by dividing all the operational and maintenance expenses in the year by the total production of electricity.

For the nuclear marginal cost we use the information released by the *Foro de la Industria Nuclear Española*. Their report determines the cost of nuclear generation using a method similar to the one used by us for the remaining sources. The cost of each KWh is divided in three components: fuel, operational and maintenance costs. The last fraction of the cost is obtained as a mean value for all the forecasted time of a nuclear plant.

Hydroelectric plants are considered, usually, as zero marginal cost facilities, due to their negligible amount. Another alternative assumption that can be considered is the also traditionally idea that hydro energy has an opportunity cost equal to the operating cost of the thermal power plant that replaces marginally in each period. We use the first assumption for simplicity purposes. More on the treatment of hydrogeneration will be discussed in a latter section.

The special regime generators (wind, solar generation and cogeneration) operate under a regulatory side agreement, thus it is always infra-marginal to the market. These facilities always operate when they physically can and the production is always acquired by the unique distributor. Consequently, we are not considering the generation from these utilities in our model. Moreover, special generation represented a small part of the supply in 2004 so this absence is not determinant for the market equilibrium.

After calculating the marginal cost per source of generation, merit order will be assumed on generation plants for each generator. This means that the firm always starts using a source with lower marginal cost before a source with higher cost and that the firm does not start using a new source before reaching "full capacity" in the previous one. According to this assumption we are able to construct the cost function of each firm only after determining output capacity for each fuel.

The maximum output capacity must also be allocated to each firm which corresponds to the capacity constraint. Full capacity should be defined as less than the plant's engineering capacity (maximum capacity) since it may not be possible to run the plant at the theoretical engineering capacity. Each plant, by generation source, has defined an outage rate, OR, which represents the probability of an outage in any given hour. We use the total outage rate for each type of plant, reported by the generators. Therefore, according to Borenstein et al (2002), the capacity of each firm should be determined using the concept of effective capacity, re-rating the maximum capacity using an availability factor (1-OR):

$$\text{Effective Capacity} = \text{maximum capacity} * (1\text{-OR}).$$

Following this procedure we finally find the steep marginal cost functions for each generation firm. Figures B1 to B3 in Appendix B show some of the marginal cost estimates for the generators in Portugal, Spain and MIBEL, as explained in the present section.

2.4.3 Other assumptions

Electricity is sold in different sub-markets such as the spot market, the day-ahead market, the long term contracts market (physical or financial) and the ancillary services market. All these

sub-markets outcomes should emerge in price in wholesale electricity market. If the system rules are appropriately designed and do not give an advantage to transactions in a particular sub-market, the price for electricity in each of these markets is likely to be the same. This is due to the fact that the existence of arbitrage will remove all the significant price differences between the markets. We assume that arbitrage is possible in MIBEL and that the system rules are set in order to provide the same advantages to all markets. Therefore, in our case, the price of electricity will essentially depend on firms' marginal costs and generation capacities and on demand elasticity.

In order to infer potential market power, we have to make two further assumptions. First, marginal costs of the firms will not change with the integration. And, second, the demand function after integration will be the sum of the individual demand functions before integration for each country.

2.4.4   Implementation of oligopoly simulation methodology

The presence of marginal cost functions from each firm that are not continuous makes it impossible to apply the usual maximisation procedure. The existence of capacity constraints does not allow also the usual method for solving a Cournot model. Therefore, in this case, Cournot equilibrium is iteratively estimated, determining profit maximisation output for each generator under the assumption that the other competitors will not change their production level decisions. This will be repeated for each Cournot firm, until equilibrium is found.

The iterative process is described as follows. First, one of the (larger) generators sets output assuming the others will have no output; the second sets it output assuming that the first will maintain its output at the level that was calculated in the previous iteration; the

third will choose the profit maximising output, considering that the two firms before do not change their decisions (found on previous steps) and so on. All this iterative process will be repeated, returning to each maximisation problem for a given generator, based upon the most recent output decisions for the others. The process will continue to the point that no generator can profit from changing its output, given the output decided by others. At this point the equilibrium is found.

Due to the shape of the marginal cost of electricity generators, the residual demand has flat regions. Therefore, the marginal revenue curve related to the demand curve may have discontinuities. This may result in a multiple local maximum for the maximisation problem. To solve the problem we use different starting points for the iteration, that means starting the iteration with different firms being the first to set output, assuming the others produce nothing and redo all the iterative process, trying to find if this change in the starting point will lead to different final solutions. If it changes, we should pick the solution that is most similar to the market data collected. If otherwise, the solution is not sensitive to that change and the equilibrium solution was found for the generated quantity of each firm and, therefore, for the market.

2.5   Simulation results and discussion

A first question for the analysis of market power is the identification of the geographic scope of the market or the relevant market (Werden, 1996). In our analysis, the relevant market is the Iberian Peninsula (as defined in a previous section), considering absence of transmission constraints after integration (all the problems of interconnections are assumed to be solved)

inside the Iberian market. We will also assume that transmission losses are not very significant.

Our main aim in this chapter is to describe and discuss our results from the simulation model in two perspectives: static (short run) and incorporating some dynamic aspects (long run). The main difference between the two perspectives is the assumption for the own price elasticity on the demand function.

We will infer the evolution of market outcomes and market shares from the Iberian integration. In a second part, we should confirm that market power will decrease, as expected, after integration and, if this is the case, infer by how much it will decrease. In both parts our aim is also to discuss who wins and who loses with the integration process.

2.5.1 Static perspective (short run)

Effect on market outcomes

In 2004 electricity prices (tariffs) in Portugal were set by law and consequently the simulated outcomes (from the leadership with a competitive fringe model) do not match the real data very well. Even for the Spanish market, the model chosen leads to results above the real data. One of the main drawbacks of Cournot simulation models is that generators' strategies are expressed in term of quantities and not in terms of supply curves. This implies that prices are determined only by demand functions and therefore these are extremely sensitive to the demand representation. One of the consequences of this sensitivity is that calculated prices tend to be higher than observed. As we focus on analytical results, this is not such a drawback.

Table 2.8 shows the simulation results for the two scenarios, before and after integration, showing prices and outputs of the competitive solution, the Cournot solution and real price and quantity in each of the demand hours selected.

Based on the comparison of the simulated values, we can conclude that there will be a decrease in the wholesale price after integration in both on peak and off peak hours, as was expected. This impact finds evidence, regardless of the hydrogeneration conditions. For on peak hours the decrease on price seems to be higher than on off peak hours for both countries. This evolution was expected, because in a fully integrated market, a decrease in prices is forecasted, also due to the increase in the dimension of the market. To this fact should contribute the availability of more diversified and efficient (Spanish) firms. Another justification for this evolution of prices is the presence of more competition in the market and the role of imports as a limiting factor to the exercise of market power.

Table 2.8

Market outcomes: Portugal, Spain and MIBEL *(Short run)*

	before integration				after integration	
	Portugal		**Spain**		**MIBEL**	
Winter (December) — 16th						
Simulated	*on peak*	*off peak*	*on peak*	*off peak*	*on peak*	*off peak*
competitive price (c€/KWh)	0.00	0.00	1.10	0.00	1.07	1.07
Price (c€/KWh)	132.3	25.9	18.0	7.3	7.7	3.4
Mkt Quantity (MWh)	2527.598		16928.567	12945.444	26988.696	20411.737
Real Price (c€/KWh)	5.24		2.7	1.45		
Quantity (MWh)	6657.5	4083.1	27201	19408		
30th						
Simulated	*on peak*	*off peak*	*on peak*	*off peak*	*on peak*	*off peak*
competitive price (c€/KWh)	0.00	0.00	1.10	1.10	1.07	1.07
Price (c€/KWh)	135.4	26.2	21.4	9.3	7.7	3.4
Mkt Quantity (MWh)	2527598.63		17344.326	15850.934	26988.696	22621.966
Real Price (c€/KWh)	5.24		3.5	2.44		
Quantity (MWh)	6703.1	4094.7	27263	22142		
Summer (June) — 15th						
Simulated	*on peak*	*off peak*	*on peak*	*off peak*	*on peak*	*off peak*
competitive price (c€/KWh)	0.00	0.00	1.10	1.10	1.10	1.10
Price (c€/KWh)	190.7	32.7	28.8	8.6	7.06	4.04
Mkt Quantity (MWh)	2591.440		19998.982	17216.161	26460.724	20981.220
Real Price (c€/KWh)	5.24		5.85	3.08		
Quantity (MWh)	7558.6	4576.8	29797	22272		
22th						
Simulated	*on peak*	*off peak*	*on peak*	*off peak*	*on peak*	*off peak*
competitive price (c€/KWh)	0.00	0.00	1.10	0.00	1.10	0.00
Price (c€/KWh)	185.9	34.9	15.0	7.2	4.28	2.25
Mkt Quantity (MWh)	2591.440		18620.458	15486.286	23666.140	18293.677
Real Price (c€/KWh)	5.24		3.99	1.96		
Quantity (MWh)	7617.1	4486.7	26006.4	21486		

As well as price decreasing when there is integration of markets, total production will be higher than the sum for the two markets before integration. Therefore, for consumers in both countries, there will be more electricity available for consumption, namely during peak hours.

Table 2.9 shows the simulated values of generators' market share, before and after integration. In this table, we try to infer which are the firms that will have more benefits with the integration and the ones that will not. We compare the simulated market share of the firm on the total of the two countries before integration and after integration.

Table 2.9

Market shares: Portugal, Spain and MIBEL *(Short run)*

	before integration		after integration		before integration		after integration
	Portugal	**Spain**	**MIBEL**		**Portugal**	**Spain**	**MIBEL**
	On peak				*Off peak*		
16th							
Mkt shares (%)				Mkt shares (%)			
firm P1	3.9		15.37	firm P1	4.91		20.32
firm S1		21.75	22.36	firm S1		20.92	27.61
firm S2		12.66	25.98	firm S2		9.68	28.67
firm S3		6.25	7.74	firm S3		3.49	2.71
firm S4		9.99	13.13	firm S4		6.79	11.13
fringe	9.09	15.6	15.43	fringe	11.43	19.62	9.57
Mkt quantity (MWh)	2527.598	16928.567	26988.696	Mkt quantity (MWh)	2527.598	12945.444	20411.737
30th							
Mkt shares (%)				Mkt shares (%)			
firm P1	3.82		15.37	firm P1	4.13		18.34
firm S1		21.82	22.36	firm S1		21.56	24.91
firm S2		12.97	25.98	firm S2		11.85	25.87
firm S3		6.25	7.74	firm S3		5.86	2.45
firm S4		10.61	13.13	firm S4		8.77	10.04
fringe	8.90	15.28	15.43	fringe	9.62	16.52	18.40
Mkt quantity (MWh)	2527.599	17344.326	26988.696	Mkt quantity (MWh)	2527.599	15850.934	22621.966
15th							
Mkt shares (%)				Mkt shares (%)			
firm P1	3.44		15.68	firm P1	3.92		19.77
firm S1		22.13	23.09	firm S1		21.73	26.86
firm S2		14.95	27.40	firm S2		12.87	27.05
firm S3		6.21	7.85	firm S3		5.86	2.96
firm S4		12.47	12.68	firm S4		8.65	10.71
fringe	8.03	16.62	13.31	fringe	9.16	18.96	12.65
Mkt quantity (MWh)	2591.440	19998.982	26460.724	Mkt quantity (MWh)	2591.440	17216.161	20981.220
22nd							
Mkt shares (%)				Mkt shares (%)			
firm P1	3.67		17.53	firm P1	4.30		22.67
firm S1		21.95	23.81	firm S1		21.42	30.80
firm S2		13.92	27.68	firm S2		11.58	32.59
firm S3		6.21	3.89	firm S3		4.08	3.00
firm S4		10.41	12.22	firm S4		7.85	8.75
fringe	8.55	17.70	14.88	fringe	10.03	20.77	2.19
Mkt quantity (MWh)	2591.440	18620.458	23666.140	Mkt quantity (MWh)	2591.440	15486.286	18293.677

Winter (December) — rows 16th, 30th

Summer (June) — rows 15th, 22nd

The firms that take more advantages from integration are the largest firms whose market shares always increase in all scenarios. We should stress that these results are based on the assumption that there are no transmission constraints. Only in this case it is feasible for all larger firms to seize all the benefits from integration.

The smaller firms in the market lose their position to the larger firms, as expected. For the smaller firms (fringe firms) we can see a decrease in the market share in all cases. Moreover, the new fringe of the Iberian market will have a lower market share compared with the one represented by the sum of the two separate fringes before integration. The most efficient firms may seize more benefits from the enlargement of the market. The smaller firms on the fringe seem to feel some detrimental effects from integration. The firm S3 also loses a higher percentage of market share with integration, namely in off peak hours.

In what concerns which country benefits most with the integration, the evidence seems to be that Portugal will take more benefits. Not only Portuguese consumers may benefit from the decrease on prices, if benefits pass on to the final market, but also the main incumbent firm, P1, is the generator that has a higher increase on the market share, compared with before integration.

Effect on Market Power: Lerner Index and HHI

The exercise of market power is evaluated by the Lerner Index, which is defined as (P-c)/P, where P is the market price and c is the industry marginal cost at the Cournot quantity. The Lerner index may assume the maximum value of one if prices are set above marginal cost and value 0 if this price set in the market equals marginal cost. Table 2.10 shows the measure of exercise of market power for each of the scenarios, before and after integration. Additional

information is present in this table, the Hirshman Herfindahl Index[3], in order to infer the differences on concentration level in the market.

Table 2.10

Lerner Index and HHI: Portugal, Spain and MIBEL *(Short run)*

				Lerner Index			*HHI*		
				before integration		after integration	before integration		after integration
				Portugal	Spain	MIBEL	Portugal	Spain	MIBEL
Winter (Decemb)	15th	on peak			0.9	0.9		2678.58	1881.27
		off peak		1.0	1.0	0.7	5797.6	2905.00	2219.58
	30th	on peak			0.9	0.9		2119.83	1881.27
		off peak			0.9	0.7		2111.39	2071.20
Summer (June)	16th	on peak			1.0	0.8		2144.74	1929.00
		off peak		1.0	0.9	0.7	5799.98	2137.67	2127.58
	30th	on peak			0.9	0.7		2130.10	2025.95
		off peak			1.0	1.0		2202.65	2615.21

Before integration, and for all scenarios, there is evidence of the exercise of market power in both countries and regardless of the hour considered (on peak or off peak). Market power seems to be higher in Portugal for the majority of cases and even in Spain for some scenarios the Lerner Index also assumes the value one.

In the literature we can find conclusions supporting the idea that market power is higher during high demand periods (on peak) than it is during low demand periods (off peak). We can confirm this for almost all the periods, except for the 30th of June. This is a period of dry hydrological conditions.

After integration, we can conclude that market power will be lower, as expected. There is an improvement, or at least we can find that the exercise of market power does not increase with the creation of MIBEL. The decrease is higher for off peak times, for both countries. However,

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[3]The HHI is the sum of the square of each firm's market share times 1000. For Cournot firms, market share was defined as total firm output divided by market output.

for the integrated market, higher market power seems to persist in both periods, on peak and off peak period. It seems clear that market power is lower after market integration, as expected, and that even decreasing it is still a feature of the regional integrated market.

Concentration measures may help to screen the potential exercise of market power. Even if generators do not need to be large (in terms of market share) to have market power, it is true that larger and fewer generators have more often ability to set prices above marginal cost than smaller and more generators. In our model, the evidence seems to confirm a relation between concentration and potential market power for most of the cases.

Competition authorities in Europe regard any industry with an HHI of above 1800 as being concentrated. According to this criteria, Portugal, Spain and the MIBEL can be seen as having highly concentrated markets. Portugal is by far more concentrated than Spain, as we had expected. However, according to HHI there seems to exist also a huge improvement in concentration with the integration of markets, namely for on peak hours in both hydrological conditions and for both countries. These conclusions are also due to our assumptions that the same generators are present before and after the integration and that we have not considered entry or any other strategy that may change the number of firms in the market.

2.5.2 Incorporating dynamic aspects (long run)

In order to implicitly include some dynamic aspects in our model, as we explained before, we have considered also the analysis for long run (more elastic) demand functions for the four days chosen. The next three tables (2.11 to 2.13) present the results for the procedure from the section above according to a long run analysis.

Effect on market outcomes

The simulated market outcomes for the two scenarios, before and after integration, are described in Table 2.11. It shows prices and outputs of the competitive solution, the Cournot solution and real price and quantity in each of the demand hours selected. The simulated values for the Portuguese and the Spanish markets are more similar to the real data on this analysis than in the short run analysis.

Table 2.11

Market outcomes, Portugal, Spain and MIBEL *(Long run)*

			before integration				after integration	
			Portugal		**Spain**		**MIBEL**	
16th								
			on peak	*off peak*	*on peak*	*off peak*	*on peak*	*off peak*
Winter (December)	Simulated	competitive price (c€/KWh)	3.32	3.32	2.30	1.10	1.07	0.00
		Price (c€/KWh)	10.40	4.60	3.89	2.01	2.68	1.15
		Mkt Quantity (MWh)	4408.203		23392.710	16488.364	23622.514	19752.948
	Real	Price (c€/KWh)	5.24		2.70	1.45		
		Quantity (MWh)	6657.5	4083.1	27201	19408		
30th								
			on peak	*off peak*	*on peak*	*off peak*	*on peak*	*off peak*
	Simulated	competitive price (c€/KWh)	3.32	3.32	2.40	1.10	1.07	0.00
		Price (c€/KWh)	10.50	4.60	4.10	3.50	2.68	1.15
		Mkt Quantity (MWh)	4408.203		25178.171	19498.374	236622.514	19752.948
	Real	Price (c€/KWh)	5.24		3.50	2.44		
		Quantity (MWh)	6703.1	4094.7	27263	22142		
15th								
			on peak	*off peak*	*on peak*	*off peak*	*on peak*	*off peak*
Summer (June)	Simulated	competitive price (c€/KWh)	3.80	3.80	3.80	1.10	2.44	1.10
		Price (c€/KWh)	12.40	5.20	6.22	3.63	3.52	2.78
		Mkt Quantity (MWh)	1814		28898.175	20505.469	32005.682	20607.430
	Real	Price (c€/KWh)	5.24		5.85	3.08		
		Quantity (MWh)	7558.6	4576.8	29797	22272		
22th								
			on peak	*off peak*	*on peak*	*off peak*	*on peak*	*off peak*
	Simulated	competitive price (c€/KWh)	3.80	3.80	2.40	1.10	1.10	0.00
		Price (c€/KWh)	12.30	5.30	4.00	2.40	2.89	1.87
		Mkt Quantity (MWh)	1814		25824.046	19362.392	25614.454	19438.616
	Real	Price (c€/KWh)	5.24		3.99	1.96		
		Quantity (MWh)	7617.1	4486.7	26006.4	21486		

From the evolution of market outcomes we can see that the market price decreases and the quantity of electricity traded in the market also decreases after integration. Even when considering dynamic elements, the Portuguese consumers will benefit more from the integration

of the Iberian market due to a higher decrease in prices, assuming that the effect on the wholesale market is passed on to consumers. This decrease is higher in periods of higher hydrological availability (December) for off peak hours and in dry months for on peak hours. This same tendency can be witnessed if we compare the price in Spain before integration with the price after integration, but in a comparatively lower proportion. The same description can be made for the evolution of total electricity available in the market.

In Table 2.12 we can see the simulated values of the market share for each generator, before and after integration. The MIBEL seems to improve the already important position of larger generators in the market. On one hand, for P1 the market share always increases, compared with before integration and in a higher proportion for on peak hours. On the other hand, one of the larger incumbents in generation in Spain (S2) before integration seems to increase its market share more in off peak hours. For the other larger generators (S1 and S4) the evolution in the market share is not so clear with some periods where it increases and some periods where it decreases.

Table 2.12

Market shares: Portugal, Spain and MIBEL *(Long run)*

	before integration		after integration		before integration		after integration
	Portugal	Spain	MIBEL		Portugal	Spain	MIBEL
	On peak				**Off peak**		
16th							
Mkt shares (%)				Mkt shares (%)			
firm P1	9.49		17.56	firm P1	12.63		21.00
firm S1		29.75	29.93	firm S1		26.97	28.21
firm S2		24.74	32.29	firm S2		22.82	38.62
firm S3		2.64	2.34	firm S3		1.66	2.05
firm S4		8.77	9.61	firm S4		6.79	8.10
fringe	6.36	10.92	8.27	fringe	8.46	1.92	2.03
Mkt quantity (MWh)	4408.203	23392.710	23622.514	Mkt quantity (MWh)	4408.203	16488.364	19752.948
30th							
Mkt shares (%)				Mkt shares (%)			
firm P1	8.92		17.56	firm P1	11.04		21.00
firm S1		30.48	29.93	firm S1		30.48	28.21
firm S2		27.85	32.29	firm S2		27.85	38.62
firm S3		2.64	2.34	firm S3		2.64	2.05
firm S4		8.77	9.61	firm S4		6.79	8.10
fringe	5.98	10.26	8.27	fringe	7.4	9.64	2.03
Mkt quantity (MWh)	4408.203	25178.171	236622.514	Mkt quantity (MWh)	4408.203	19498.374	19752.948
15th							
Mkt shares (%)				Mkt shares (%)			
firm P1	8.14		18.80	firm P1	10.87		20.13
firm S1		26.80	27.81	firm S1		28.57	27.34
firm S2		31.77	33.19	firm S2		22.82	37.02
firm S3		6.21	2.87	firm S3		2.75	2.66
firm S4		10.42	9.04	firm S4		8.19	10.91
fringe	5.43	11.23	8.29	fringe	7.24	8.25	1.95
Mkt quantity (MWh)	1814	28898.175	32005.682	Mkt quantity (MWh)	1814	20505.469	20607.430
22nd							
Mkt shares (%)				Mkt shares (%)			
firm P1	8.96		16.19	firm P1	11.39		21.34
firm S1		29.31	31.20	firm S1		23.58	28.99
firm S2		27.99	31.20	firm S2		22.82	39.24
firm S3		2.75	2.27	firm S3		2.75	2.82
firm S4		8.65	8.77	firm S4		6.72	5.55
fringe	5.98	12.37	10.36	fringe	7.59	12.27	2.06
Mkt quantity (MWh)	1814	25824.046	25614.454	Mkt quantity (MWh)	1814	19362.392	19438.616

Winter (December) applies to the 16th and 30th blocks; *Summer (June)* applies to the 15th and 22nd blocks.

For the smaller firms, S3 and the fringe firms, the integrated market seems to be a major inconvenience, according to the evolution of its market shares. In both cases, there are decreases in the weight of each of them in the whole market. If the position of the price taking generators is smaller compared to the market share on each separate markets, it may be the case that some of the firms will exit the market after integration.

In this long run analysis, we can see that the generator whose market share increases most is still the Portuguese incumbent, namely for on peak periods. We should keep in mind again that these results are based on the assumption of total integration of the market. However, in the long run the variations in the market share seem to be lower to all generators, except for the fringe firms.

Effect on Market Power: Lerner Index and HHI

To evaluate the exercise of market power before and after integration in a long run analysis we can see in Table 2.13 values for the Lerner Index for each of the scenarios. In addition to this information we also have the HHI to measure concentration in the market.

Table 2.13

Lerner Index and HHI, Portugal, Spain and MIBEL *(Long run)*

			Lerner Index			*HHI*		
			before integration		after integration	before integration		after integration
			Portugal	Spain	MIBEL	Portugal	Spain	MIBEL
Winter (Decemb)	15th	on peak	0.7	0.4	0.6	5195.24	3295.67	2412.88
		off peak	0.3	0.5	1.0		3633.28	2801.87
	30th	on peak	0.7	0.4	0.6	5195.24	2943.34	2412.88
		off peak	0.3	0.7	1.0		2907.52	2801.87
Summer (June)	16th	on peak	0.7	0.4	0.3	5199.95	2678.27	2386.78
		off peak	0.3	0.7	0.6		2900.93	2652.84
	30th	on peak	0.7	0.4	0.6	5199.95	2850.26	2398.58
		off peak	0.3	0.5	1.0		2785.67	2025.95

Before integration, market power seems to be higher in Portugal for on peak hours. For Spain, the conclusion about the higher value of market power in on peak cannot be supported, in a long run perspective. Our explanation is that during low demand hours, lower cost generation units, such as nuclear power and hydrogeneration plants, satisfy a large fraction of demand so that the residual demand faced by the thermal plants is very small or perhaps even zero. As a result, the thermal plants are less likely to set the price. This is the case, as it can be seen in Table 2.8. The Lerner Index assumes higher values for off peak hours where nuclear and hydro plants are supplying the demand. Therefore, the competitive price corresponds to the marginal cost of nuclear plants.

After integration, the conclusions about market power are different according to the period considered. In general, we can conclude that considering some dynamic aspects, namely the existence of exit and entrance in the market by assuming a more elastic demand function, it seems that the exercise of market power on the integrated market will be higher. The values for the Lerner Index are higher in off peak than in peak hours, always in the integrated market. The feature of existence of market power seems to be even more present after integration.

According to the HHI, there is an improvement in the concentration in the Iberian market. However, in our model, the integrated market still seems to be a highly concentrated market, according to competition authorities criteria. Portugal is more concentrated than Spain before integration, as expected. After the integration of the Iberian electricity market the concentration seems to diminish, namely, for on peak hours for both countries and considering all hydrological conditions. This result may be also due to the assumptions of our model: same number of firms and a market with larger dimension.

As expected, in the long run perspective, market power is lower than in the short run, at least before integration. The unexpected result is the higher market power on off peak hours after integration. The justification for this is the above explanation of the presence of nuclear plants in the Spanish market and consequently on the MIBEL, after integration.

In both analyses it is also clear that firms may exercise considerable market power even after integration. These conclusions are similar for short run and long run analyses. The reason for this can be that only a very few firms compete in the oligopolistic model, with only four strategic competitors. Two of them are of a similar size, whereas the others are comparatively much smaller. The fact that in all periods the fringe firms lose market share may be an indicator that in the long run only the larger firms will stay in the market and therefore market power and concentration will be higher, as the simulation results allow to conclude.

2.5.3 Discussion on marginal cost for hydrologic generation of electricity

We have assumed zero marginal cost for hydrogeneration plants in both countries, due to the very low variable operating costs from water. Since only reservoir and pumped hydro plants can be strategically used, only these types of plants assume particular complexity in what concerns marginal cost. The marginal cost of run river plants is assumed to be always zero because the water flows anyway, whether being used or not to generate electricity.

We should be aware of the alternatives to determine the marginal cost of these plants, since the importance of hydrogeneration on generation mix in Iberian markets should not be ignored. In 2004, for the months chosen (June and December) hydro resources assumed around 18% in total generation for Portugal and between 11% and 15% for Spain.

The other alternative approaches available in the literature are based on the potential strate-

gic use of hydrogeneration plants. Even recognising that using water to generate electricity has literally no direct cost, this approach assumes that it may have high opportunity costs. Therefore, an alternative assessment of marginal costs may consider the opportunity costs of water or marginal water value.

Hydroelectric plants should be run according to their marginal value of water stored in the reservoirs. With this approach, the simulation procedure would be the same as we describe, but with the hydro plant treated as a thermal plant using the water value surface[4] to determine the marginal cost of water, given the period and the storage level at that period.

Using hydro resources for electricity generation, introduces some dynamic elements into the model because firms start considering that more water used today, means less water available tomorrow. These inter-temporal constraints turn the treatment of hydroelectric generation more complex than other production technology. Our model as a static model of competition for analysing market power does not capture this dynamic aspect.

Introducing a new methodology to determine the marginal cost of hydro sources may lead to different results. The higher values for the Lerner index found in our simulations, namely on off peak times, may be justified by this assumption about the marginal cost of hydro source. The marginal cost used on the index calculations corresponds, several times, to the null costs of the hydro resources. Since a zero cost type of plant on the merit order will be used to full capacity and only then any other source will be used leads, several times in our case, to compare the market power with a zero marginal cost, as it can be seen from the null competitive prices

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[4]The water value surface consists on a set of curves, one for each period, which relates the storage level at a certain period to the marginal value of water. It is derived recursively. The storage level at the beginning of a certain period is calculated by adding to the end of period storage level a demand curve for release of water, which is a function of marginal value surface, and subtracting the (expected) water inflows of the period. This is done recursively starting from the end of the planning horizon, resulting on a water value surface.

in table 2.8 for Portugal, for example.

Therefore, considering a non zero value for the marginal costs of hydro generation may at least change these results. However, since the value of costs for hydro plants will be in any way lower than thermal and nuclear plants, it will not change the merit order. Therefore, it is uncertain that the final conclusions in exercise of market power will change.

2.5.4 Discussion on transmission issues

Markets are interconnected by a transmission network allowing imports and exports of electricity. Each wholesale market is served by the region´s own producers but may, in addition, receive imports from other markets. Also the wholesale market satisfies the region own end-use demand through the distribution network. However, each market may also export electricity to other wholesale markets. Therefore, market power and market concentration may depend on the boundaries of the market, and on internal and external transmission networks.

The impact of transmission constraints may be greatly intensified because electricity is a non storable product. Consequently, the geographic scope of the market may change seasonally and even hourly. Some markets may appear to be very competitive during off peak hours and still show potential for exercising market power during peak demand periods. The lack of storage of electricity may also create the potential for rather complex strategic manipulation of transmission constraints.

The main idea of the present chapter was to consider the results and conclusions for a full integrated regional market scenario. Therefore, the results presented up to this point assume that there are no binding transmission constraints inside or outside the MIBEL that would create geographic sub-markets.

The national networks are assumed to have no capacity problems and no tariffs are assumed for the network. The international network consists of transmission lines between the countries which are described for their capacity and physical losses. No tariffs or limits are assumed also for the international transmission network.

These assumptions are clearly not very realistic. We should mention two constraints of concern: one internal interconnection between Portugal and Spain and two international interconnections: between Spain and France and between Spain and Morocco.

It is crucial to understand that the flows that would result from a Cournot equilibrium where the competitors assume there will be no in-market congestion are not the same as the potential congestion that would arise if strategic players explicitly account for potential in-market congestion in their output decisions (Borenstein et al, 1997). According to Borenstein et al (1996) the interactions between strategic firms in a very simple network may be complex when transmission capacity is limited. A Cournot player knowing that potential imports into that region would be limited by transmission constraints may very well reduce its output below the level of output chosen if there were no limits on transmission capacity.

The transmission capacity between the two Iberian markets is limited and this is one of the main obstacles that are delaying the MIBEL. The actual flow limits over these paths vary with supply and weather conditions. In table 2.14 are listed the interconnection capacities between Portugal and Spain, for the present and the future.

Only if there is sufficient transmission capacity between the two markets, will they behave as one. If not, then the ability of a generator in one part of the market to participate in the other part of the market will be limited. This means, for example, a Spanish firm generating electricity to be able to supply Portuguese consumers. For this purpose, interconnection capacity has to

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be used, since in our case, the transmission grid may be at times congested and electricity may not be delivered as firms desire. This constraint has impact on the exercise of market power.

Table 2.14

Interconnection capacity

From-To		Interconnection capacity (MW)	
		2004 - 2005	2010*
PT - SP	winter	1390 - 1545	1600
	summer	1200 - 1375	1300
SP - PT	winter	1000 - 1225	1600
	summer	1250	1300

Note: * forecasted

Sources: MIBEL - Progress report about the state of the interconnections (December 2004), REN-REE; "Descrição do funcionamento do Mibel", Conselho de reguladores do MIBEL, 2009

If we simply take the interconnection level as an exogenous factor in the framework, transmission capacity may determine restrictions in each of the markets. Taking the electricity generated by firms in each country and comparing it with the quantity demanded in each country after integration we may conclude that Spain is a net importer for the days and hours chosen and Portugal is a net exporter. This means that some parts of Spanish consumers are supplied by a Portuguese firm.

Since there are constraints on the transmission capacity between the two countries we may compare the amount of electricity that, according to our model, the Portuguese firms are willing to export to satisfy Spanish demand and the interconnection capacity to infer if the required transfer of electricity is feasible or if there will be congestion problems. The main values from this analysis are reported in Table 2.15.

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Table 2.15

Detection of congestion problems

| | | | Portugal TO Spain | | |
			Import as % of Spanish demand	over the capacity (GW)	increased need as % of existing
Winter (Decemb)	**15th**	**on peak**	7	280.0	18
		off peak	9	406.0	26
	30th	**on peak**	7	280.1	18
		off peak	8	903.9	59
Summer (June)	**16th**	**on peak**	6	140.0	11
		off peak	8	640.4	47
	30th	**on peak**	7	539.2	39
		off peak	9	290.2	21

Note: We only consider the short run results on this analysis.

For any of the cases studied, our Cournot results imply always congestion problems. The main problems are presented on off peak hours in Winter.

Considering interconnection limits in our model would also imply that there will be different prices for each country, instead of a unique market price. We forecast a higher market power in each of the markets as result of the introduction of these limits, because generators know that imports do not work fully as competition and as a limit to the exercise of market power. Interconnection constraint will have similar consequences to entry barriers, increasing wholesale prices for electricity in both countries.

To achieve full benefits of competition the transmission capacity between these two markets must be large enough that each firm prefers to compete over the larger market than to act as a residual monopolist in its own local market (Borenstein et al,1999). Their results show that expanding transmission capacity between sub-markets where there is exercise of market power may have very high payoffs in terms of reduced prices and increased consumption.

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We may conclude that it is necessary to invest in more extensive interconnection to create additional capacity to allow for full integration and free functioning of the market and competition. Investment in new capacity is only possible in the long run. For some periods, an increase of more than 50% of the present capacity is needed. According to the forecasted values for 2010 the improvements in interconnection capacity are still not enough.

Even if there were enough interconnection capacity, we would still need to consider whether the interconnection would be binding when it is incorporated into the firm's output decision. It is worth stressing that the expansion in the interconnection capacity to achieve the full integration, according to our model, may not be enough to insure no exercise of market power. The network enforcement would lower prices, as can be forecasted in the model, but the oligopolistic players will still be able to exercise market power at some extent. However, the expansion of transmission paths, meaning greater integration, may reduce the incentive of any producer to restrict output in order to raise prices (Borenstein and Bushnell, 1999).

The geographic isolation of the Iberian Peninsula from the rest of Europe resulted in one interconnector link connecting Spain to France and other connecting Spain to Morocco. The border between Spain and France is among the most heavily congested in Europe. The lack of interconnections may provide more opportunities for the incumbent generators to behave strategically and unilaterally profit from limited competition. The reinforcement of the international interconnections with France and Morocco should be priorities as they would allow the horizontal concentration of the MIBEL to be reduced and therefore the exercise of market power predicted.

The impact of introducing the information on interconnections with external countries will be similar to the one pointed out before for the interconnections between Portugal and Spain.

Therefore, as we have shown with this simple analysis, considering information on transmission capacities on the analysis of market power seem not to change our main simulation results and conclusions.

2.6 Conclusions

Market power in the wholesale market is one of the major concerns for electricity markets. One of the questions raised during the integration of electricity markets is about the impact of this process on the exercise of market power.

Due to the particular characteristics of electricity markets, generation firms may have significant potential market power, namely the larger incumbent firms. The exercise of market power has considerable damage for consumers and may make it difficult to seize all the benefits of an integrated market. Therefore, the most advisable is to follow a strategy that structures the transition to an integrated market in order to avoid or minimise the potential exercise of market power.

For the purpose of assessing what will happen after integration of Iberian markets, this chapter analyses how the Iberian electricity wholesale market would operate and the impact of this integration on electricity equilibrium prices and quantities, comparing them with the levels before integration. Finally, the chapter evaluates the likelihood of significant market power problems once the market is fully integrated, using the Lerner Index.

The importance of studying the MIBEL is due to three reasons. First, physically the MIBEL is a peninsula and has limited transmission lines with its neighbouring countries (France), causing import of electricity to be needed to insure the stability of the system. Thus, the

MIBEL must primarily rely on internal generation and it is important to know how the market will work. Second, several generators in either markets potentially possess market power, before integration. It is essential to determine how it will evolve with the integration process. Third, since is an integrated market in Europe, it is a part of the preliminary step for the Single electricity market. Thus it is important to assess its success, namely on the impact on the exercise of market power.

Our research is relevant due to the unique characteristics of the market studied and for the application of a method to assess ex-ante the evolution of market power. This method may be applied to infer market power concerns in other regional markets in Europe, only adjusting to the specific features of the market.

We use real data on plant costs, capacities, an analytical model and quantitative simulations of generators' behaviour to simulate the competitive market for electricity, following integration. A Cournot model of oligopolistic competition with competitive fringe is used to represent the operation of a Pool free of energy restrictions.

Since the Cournot analysis is a stylized representation of both the costs and range of strategies available to firms, the results should be thought as a first indication of the ways market power might be exercised, rather than an exact forecast or prediction of market price. The choice of the models to represent either markets was justified by the real features of each market. However, the simulation results seem more appropriate for Spain than for Portugal. The Portuguese case is particular due to the law enforcement for the price and the inexistence of a competitive pool.

The results obtained with our model depend on assumptions. Price, production level and markups and other variables are a function of own price elasticity of demand, a value for which

there is no precise estimation yet. Even if there were, it is likely that after all the changes due to the integration process demand for electricity will change. Therefore, the main contribution of this chapter are the qualitative results. Moreover, this model is expected to be a useful tool to evaluate the impact of different policies and reforms that could be implemented in this industry to mitigate market power.

The most important result of this chapter is the reduction of exercise of market power in the integrated market, as it was expected. Notwithstanding, the simulation shows that there is still evidence of incentives to raise prices above marginal cost, either on peak and off peak time, but it is lower than before the integration. This potential problem may be even more serious if there is also a problem of entry in the integrated market. Otherwise, the existence of a temporary excess profit can be solved by the entry of a new generator in the market.

The simulations suggest that, in the MIBEL, there will be an average mark up of 60% on the perfect competition price (when price equals marginal cost), dependent on the hour of the day. Despite the decrease on the Lerner Index, there is evidence of a high difference between price and marginal costs. This means that market power is still an important feature of the regional integrated market.

The Iberian electricity market produces lower electricity prices, as expected, for both countries, and thus benefits electricity consumers, if we assume that the evolution in wholesale prices will be passed on to consumers. The Portuguese consumers are the ones that benefit the most with the integration. Moreover, it is also the Portuguese larger incumbent firm that benefits the most from integration, with the highest increase in market share, compared to before integration. For the remaining smaller firms it seems that the effect of integration is to lose market share. This is due to the efficiency of the Portuguese firm, reflected in its marginal cost with a

considerable large part assuming a null value associated with the hydro resources.

We should notice some simplifications of the model that should be kept in mind when analyzing its results. First, the model has no dynamic perspective, even if we try to introduce some dynamic elements with the analysis of long run demand specifications. It may be important to consider the assumption of changes the production capacity through time and the effects of these investment decisions on the exercise of market power.

Secondly, even though high margins may likely attract new entrants to the market, we do not take into account the role of the entrants or the case of failure of firms (mainly on the fringe). We assume that the number of firms in the fringe will be the same after integration. Therefore, the model does not consider any change in the strategic behaviour of firms, such as for example the change of smaller Cournot firms to price-takers and to be included in the fringe.

Thirdly, the model treats all firms as being independent. Cross-ownership may, in a number of ways, modify production decisions and alter the incentives to exert market power. Introducing cross-ownership into the model would most likely sharpen the results. All the omissions result in this model misestimating market power. However, they should have impact only on how intensely the market power is used and not on the existence of market power. The inclusion of all these factors in the model may make the results more robust, since there is evidence that market power is still present in the MIBEL. This chapter calls for further research in extending the model to take into account of these issues in the simulation model.

Chapter 3

Mergers between natural gas suppliers and electricity generators: should European household consumers be concerned?

3.1 Introduction

The liberalisation of energy markets creates opportunities for gas and electricity firms to enter each other's markets for the final product, by acquiring firms in the other fuel market. All energy mergers pose distinct challenges for competition policy. Namely, the features of electricity as a commodity, determine these challenges: demand is highly inelastic in the short run, storage is limited and transmission constraints limit the ability to use generation capacity in different

locations. Since natural gas is not only an important input into electricity generation, but also a competing energy source in the retail market, vertical mergers between electricity generators and gas suppliers may raise additional concerns and questions.

During the past decade, the electricity and gas industry around the world and in Europe, in particular, have witnessed a trend towards integration. Mergers between gas and electricity firms, actual or attempted ones, seem to have been in fashion in the EU. The importance of this wave was not so much on the high number of mergers, but on the dimension and on the attention attracted by them. Three of such mergers (or attempts of merger) were news throughout Europe: the takeover bid of *Endesa* by *Gas Natural*, the serious competition concerns about the *EON-Ruhrgas* merger, controversially cleared by the Ministry of Economy of Germany and the acquisition of *Gas De Portugal* (GdP) by *Electricidade de Portugal* (EDP) blocked by the EU Commission.

These also have attracted the attention of regulators, researchers and consumers associations, as it raises questions on how merger policy should act to face this phenomenon. The increasing interest on this subject can also be seen in the evolution of regulator's interventions on merger processes. Some regulators had concerns about the effects on economic efficiency and on consumers welfare and some have consequently reacted. More recently, the acquisition of *Union Fenosa* by *Gas Natural* and the merger between *Edf* and *Suez* show that this topic is still live.

Most of the literature on this topic is focused on the ability of mergers to create value for merging parties' shareholders and not on the effects on final consumers. It is well documented that corporate acquisitions via mergers and tender offers are wealth-increasing events for shareholders. The existing evidence shows that shareholders of acquired firms almost always gain,

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while the shareholders of acquiring firms do not lose. However, since not all consumers are shareholders, the existence of gains or losses for consumers is still a contentious issue. This question is important to be answered as it should be one of the main concerns for regulators on assessing any merger.

Usually these cases should be analysed within the framework of vertical integration theory, which usually do not lead to anticompetitive concerns. However, given the specific features of a network industry, anticompetitive problems may be present. Some researchers recommend that merger control in electricity (energy) markets should be more cautious and stringent than in other sectors (Barquin et al, 2006). Even the EC promised to apply more rigorously the competition law in the electricity sector (Vandezande et al, 2006).

The aim of our research in this chapter is to empirically assess the effects of vertical integration between gas suppliers and electricity generators on consumer welfare. In the short term, consumer welfare analysis in any particular case focus on price and quantity available for consumption. In the first instance, a practice is against the consumer interest if it raises prices. These findings can help distinguish cases where vertical integration is more up to benefit consumers from those where it is more likely to be detrimental.

Therefore, we assess the extent to which changes in final household electricity prices following mergers can be attributed directly to the merger that occurred. It is the sign of the coefficient of the dummy variable for the existence of a merger which provides a test of the hypothesis that markets with mergers have higher prices. The focus is on gas-electricity mergers that occurred in European Energy markets[1] after liberalisation, between 1997 and 2007 (first half).

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[1] Austria (AU), Belgium (BE), Denmark (DK), Finland (FI), France (FR), Germany (DE), Greece (GR), Netherlands (NE), Norway (NO), Portugal (PT), Spain (SP), Sweden (SW), Italy (IT), UK (UK).

Some simple policy questions are important to be answered such as, for example, if European consumers are facing lower prices in countries with less mergers of this type or if mergers that are allowed by competition authorities are detrimental for consumers. Knowing these answers is vital for public policy on the European energy market, since it is important to develop the merger policy in order to attain all the benefits of full integration of energy markets. Moreover, the focus is not so much on whether the cross-sectional mergers should be prohibited or not but, instead, how it affects final consumers.

The chapter is structured as follows. The next section reviews the relevant theories and the previous empirical studies on vertical integration and vertical mergers and presents the main drivers for cross-merger activity in Europe. Section 3 describes the mergers selected for analysis and it main features. Following the empirical model, methodology and data issues. The empirical results and discussion will be presented in section 5.

The main results of our analysis are evidence of negative effect of vertical cross-sectorial mergers on household consumers: the existence of an acquisition between an electricity genera-tor and a natural gas supplier increases final price of electricity for household consumers. From the results and conclusions of this chapter we can summarise three main findings. First, we found that the existence of a vertical merger between an electricity generator and a natural gas supplier seem to increase in average the final price of electricity on markets where it occurs. The comparison of prices before and after the merger for each country where it occurs allows to conclude for the negative impact of these events on market outcome. Second, we found evidence that any household consumer in Germany pays a price for their electricity 1.8% higher because there was the merger between EOn and Ruhrgas. It is worth mentioning that German com-petition regulators found, during their assessment, reasons to block this merger. However, it

was authorised by the Government based on the interest to create a national champion. Third, even in Finland, where the merger was not controversial, because it involved public firms, the effect on prices was equally detrimental to consumers. Household prices after the merger are around 2% higher than they would be without the merger between IVO and NESTE. Section 6 concludes.

3.2 Theory and previous empirical evidence on Vertical Integration

Mergers between electricity generators and natural gas suppliers can be studied according to two perspectives: as a vertical integration (upstream gas and downstream electricity) or as convergence merger (extending the firm's focus from one energy source into two). On the one hand, wholesale natural gas and electricity markets may be seen as vertically interrelated markets (Brennan, 2001). On the other hand, electricity and gas can also be seen as actual and potential competitors in a broader market for energy services, because they are also substitutes in some final markets (as heating, for example).

According to the first perspective, existing evidence of the effects on prices should be found on vertical integration literature. Past research does not suggest that VI would necessarily have an adverse impact on final consumers. Instead, there is some ambiguity on the conclusions found about their consequences and there are few clear predictions on the effects on final consumers.

More often, economic literature focus on the effects of VI on competition, instead of effects on final prices. Usually, theoretical models or empirical research studies one or both of the two effects of vertical integration on competition: efficiency gains and market foreclosure. From the

balancing of these effects (one pro-competitive and another anti-competitive) it is possible to conclude on the effect of VI on competition and competitors.

Integration of two vertically related activities may result in a more efficient, lower-cost entity and in an improvement in resources allocation. Some problems of coordination between activities may be solved and costs of transaction, originated by the existence of contracts between firms, are eliminated (Williamson, 1971). This restraint of the "double margin" is a result commonly stated on the literature (Spengler, 1950). If the two activities are integrated, the first of the two margins disappears, due to the new internal input transaction. Moreover, the creation of the new vertical bonds may create economies due to the difference of costs between producing two goods or services separately and to produce jointly (Baumol et al, 1982).

In contrast, mergers may increase market power and affect competition negatively and, therefore, decrease social welfare. The firm resulting from the merger may have capacity to increase the costs of its competitors with the intermediate product by refusing to sell it or to set a higher price (Salinger, 1988; Hart and Tirole, 1990). This is the so-called foreclosure.

Nevertheless, the same balancing has been used to infer effects of VI on prices and on consumer welfare. The standard argument to support the idea that vertical mergers are benign to consumers is that, by reducing the inefficiency of transactions between upstream and downstream operations, they decrease prices in the final market. If the upstream market involved mark-up on marginal cost before the merger, in the absence of a change in market power, this integration may eliminate or reduce the mark-up, thus prices may fall. Hence, the fact that the merging firm is more efficient might make the merger desirable, not only for competition, but also concerning consumer welfare.

However, the presence of cost advantages *per se* does not necessarily imply anticompetitive

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nor welfare reducing behaviour. Only if these cost savings are passed on to consumers by lowering prices, it means that the merger could be welfare enhancing. Only in this case we can mention positive effects on consumer welfare.

If there are no efficiency gains and instead the merger increases the exercise of market power then this behaviour may push up the overall price in the market. Hence, vertical integration driven by market power may be potentially beneficial to merging firms and to their competitors but at the expense of consumers.

Overall there is an extensive body of theoretical literature regarding vertical mergers while the research containing empirical analyses is remarkably small and does not provide substantial evidence on whether such mergers are harmful or not for consumers. Even though it is a major component of antitrust enforcement, relatively few studies directly estimate the price effects of mergers. We can divide the existent literature according to their conclusions on the effect of VI on final prices.

The report on theoretical results starts with Spengler (1950)'s conclusions on the beneficial effect to consumers from VI by solving the double marginalisation distortion. Lafontaine (1995) finds that prices do differ after VI, and in fact, prices in integrated firms are slightly below those in franchised units. The same researcher in 2003 concludes that only the presence of technical synergies, which allows the firm to exploit economies of scale, would lead to lower prices to customers, in a oligopoly framework. In a different context (a dominant firm with an exogenous cost advantage), Riordan (1998) states that vertical mergers may be welfare improving. On the contrary, according to Michaels (2004), consolidation may, in the short term, lead to adverse price changes.

Most of the empirical research report studies on markets where concentration was an impor-

tant feature, even before integration, and where regulators showed important concerns before the merger. For this reason, in almost all these cases, it was forecasted, before the assessment, that there was evidence of negative effects to consumers. This is the case of gasoline, cement and concrete, cable TV, soft drinks, hospital-physician and energy. Nevertheless, empirical evidence on many of these industries conclude that, considering efficiency effects, VI mostly benefits consumers, or at least there is no evidence of harmful effects for them.

Regardless the industry analysed, we can find either conclusions for beneficial effects or detrimental effects on the final consumer. The first four of the following examples show evidence of lower prices due to the merger. Shepard (1993) uses cross-section regressions of a reduced form price equation for gasoline to test the relationship between price and the contractual form in the market and found evidence that retail price of some gasoline products are lower when there is VI. McBride (1983) finds that price of cement goes down in a VI with concrete firms, using a panel data approach.

Ford and Jackson (1997) studied empirically the effect of VI on the programming cost and price of cable operators. Through a system of equations they find that both concentration and integration lower the programming cost and that the economy of costs is partially passed on to consumers with lower prices. On carbonated soft drinks market, Saltzman et al (1999) take the same conclusion of lower prices as result of vertical events (in average a decrease of 4%).

Gasoline industry is one of the most studied industries with respect to the effects of VI. The main difference between the several empirical research are the methods used to prove it: from event study to simultaneous equations and data estimation. In spite of the method used, several papers report higher wholesale prices as consequence of VI (Gilbert and Hastings, 2001). The reasons pointed out to explain the price evolution are either that foreclosure dominates the

efficiency benefits (Buehler and Aydemir, 2002) or decrease in market competition (Hastings, 2004). However, like in some other research mentioned already, it was not reported any evidence of effects on retail prices.

It can also be found evidence on hospital-physician integration where price increases (Cuellar and Gertler, 2006) , even in the presence of (insignificant) effects on efficiency. After studying five US mergers in several markets (oil, feminine hygiene products, ready-to-eat cereals and distilled spirits) Ashenfelter and Hosken (2008) also found that prices increase for four of the products involved as result of VI. Some studies also find no significant effects on prices, as it is the case of Waterman and Weiss (1996) and Hortacsu and Syverson (2007) for pay cable programming networks and cable systems, and cement and concrete industry, respectively.

Two recent surveys on the effects of vertical integration should be mentioned. The first, by Church in 2008 strongly supports, on both theoretical and empirical grounds, a presumption that vertical mergers are welfare enhancing and good for consumers and also that cases and conditions that are harmful for consumers are not very frequent. The second is Lafontaine and Slade (2007). They survey empirical literature on the effects of vertical integration on several variables. Among the several studies they also mention consequences on welfare. From the 16 studies considered, they report an increase in welfare for downstream consumers on 13 of them. For the other 3 cases, the effect on consumers' welfare is reported to be ambiguous. Lafontaine and Slade (2007,680) conclude by noting: "We are therefore somewhat surprised at what the weight of the evidence is telling us. It says that, under most circumstances, profit-maximizing vertical-integration and merger decisions are efficient, not just from the firms' but also from the consumers' points of view. Although there are isolated studies that contradict this claim, the vast majority support it".

In what concerns to prior research on price effects of cross-sectorial energy mergers, the literature is even more limited, though a few studies are worth referring to, even if in some of them the focus was not on price effects. Knittel (2003) compares prices for electricity and natural gas for markets where there are VI with prices of markets where separate firms supply separately the two energy goods, in a monopolistic framework. He uses reduced form regressions and finds higher relative prices for the first case. Based on a sequential relation between the two markets, Micola et al (2008) use a new approach (agent-based model of a multi-tier energy market) to show how interdependence within a vertically integrated firm increases market prices, using as explanation the existence of netback effects. In Kennedy (1997), efficiency gains and synergies coming from dual fuel in retail sector are stated as the main advantages of a vertical merger. Nevertheless there are no mentions to price effects.

In theoretical literature, Gilbert and Newbery (2006) assume these mergers as convergence mergers and conclude that the merged firm would likely have an incentive to increase natural gas prices above their premerger levels. However, they report that electricity consumers are not necessarily worse off as a result of the merger. Assuming the same view of convergence, Brennan (2001) presents a model to be used on identification of problematic convergent mergers with an application to two mergers in the US. His model considers all the special features arising within a gas-electricity merger. However, we do not find mention to any effect on market outcomes and therefore on consumers in any of the cases. Keeping the same point of view about the cross-sectorial mergers, Hunger's concern in his paper of 2003 is to measure the ability of the merged firm to abuse market power. He highlights as concern for consumers the capacity of the merged firm to restrict output and using estimation of electricity supply curves, he argues that "the conditions have to be just right for a merger combining natural gas and electric generating

resources to harm competition". Therefore, it seems more likely that a vertical merger has no detrimental effects on consumers.

More common is the research on vertical integration inside each market separately (natural gas and electricity market) and some results found are also interesting. By running simulations (with a supply function equilibrium) based on the performance in the three largest and oldest US electricity markets, Bushnell et al (2008) state that the exercise of less market power contributes, in a vertical integrated sector, to lower retail prices, compared with an unbundled sector. Hogan and Meade (2007) through a theoretical approach, support these findings by concluding that retail prices are higher with vertical separation than with integration. Both allow to conclude for beneficial effects for final consumers.

Most of the effects due to merger activity lack of definite theoretical basis, and the empirical evidence of post-merger outcomes has been conflicting. With all these different theoretical and empirical evidence there is no consensus on whether VI has positive or negative effects on final prices, particularly between electricity and gas activities.

While the goal of merger policy is clear - blocking the harmful and allowing the beneficial - the accomplishment of this aim is often complicated because sometimes information available is insufficient to distinguish it. Thus, an important task for economic analysis is to identify those particular conditions in which vertical mergers may reduce consumer welfare.

According to our literature review, there is a vast literature on this subject, but the contribution of our research is not only the concern about a particular case of vertical integration with special features but also the method chosen to infer the effects of vertical integration: a retrospective study of some effective mergers to verify whether these type of mergers lead or not to higher prices and therefore harm or not household consumers. If it is the case that

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there is evidence of harmful consequences for consumers, then European consumers should be concerned.

3.3 Cross-sectorial mergers in Europe: its main drivers and evolution

Following the liberalisation of energy markets, European firms appear to be reshaping their business strategies accordingly. As a reaction, firms in the energy sector engage in a wave of mergers. Above all, firms are now interested in managing several activities inside energy industries, as witnessed by some of the recent operations.

The increasing importance of convergent mergers, defined as an electricity firm acquiring a firm with activity in the gas sector or vice-versa, may be also understood as an obstacle to achieve the Single European energy market. The exception is the case of crossborder mergers which are beneficial to integration of markets. The growing number of new gas combined cycle plants can be justified by the technological development of the turbines. However, it does not explain everything on the trend towards vertical integration between these two sectors.

These mergers can be driven by efficiency, but they can also strengthen market power of incumbents by raising other anticompetitive barriers. Cross-sector vertical integration may be justified by reductions in transaction costs (Eikeland, 2007). This explanation is reasonable namely because many of these vertical relations are regulated by long-term contracts. Additionally, the acquisition of firms on other sectors with several similarities can generate experience and scope economies from the joint production (Vaitilingam and Bergman, 1999). Third, these mergers allow power generation firms to hedge against the risk of uncertainty in its own market

(Waterson, 1984). For gas suppliers the merger guarantees buyers for their commodity. More-over, generators can produce electricity from natural gas, or arbitrage and sell gas in this way, and to exploit price differentials between gas and electricity. The same applies to natural gas suppliers. Mergers may be seen as a strategy of diversification of risks (Armstrong, Cowan and Vickers, 1994).

The vertical integration raises also some concerns due to related anti-competition problems. Merging parties will no longer compete with each other in each of the two markets. Moreover, convergent mergers make it feasible to use the market power held in one market, in the other upstream or downstream market. This problem may be exacerbated if the two firms operating in the same geographical area and/or are larger or dominant firms in each of the markets. This is the case of vertical mergers between electricity firms and natural gas firms with market power in gas[2], which are problematic, since the incentive to raise gas prices may be enhanced through ownership of electricity generation.

These mergers also guarantee to one electricity generator the control over one of the most important energy sources for the production of electricity, what represents an advantage com-paring with to its competitors. Vertically integrated incumbents may be able to manipulate the wholesale price in order to create obstacles for new entrants and thus may result in potential incentives for foreclosure. The last problem concerns the strategic use of privileged information about its competitors' gas needs, as well as its costs, in the generation of electricity.

In past years, in Europe, the relation between these two energy sectors changed as a result of several reasons that drove them to combine. The revocation of the 1975 EC Directive, which

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[2]The market power is often secured through their control over the pipeline network and storage and balancing services.

was in force until the beginning of the 1990s, restricting the use of gas in electricity generation, was an historical development that can help justifying the wave of mergers. The removal of this constraint opened up a new opportunity for natural gas as an input for electricity generation. A new connection was created between the sectors with the increase in demand for natural gas for generation purposes.

Since, in the medium run, the best placed potential entrant into the electricity market may be a gas supplier, this also increases the inter-relation between the two sectors. According to Newbery (2002c: 14) "Gas-fired CCGT (combined cycle gas turbine) is almost everywhere the least-cost form of entry ...". Therefore, the opening of electricity markets favours gas-fired power plants, which are better suited to more competitive markets, given their short construction time and not so high up-front investment costs. Natural gas is also a technology more flexible to adapt to the development of markets with regard to timing and location. Unlike some other fuels, natural gas fired power plants can quickly start generating electricity either during periods of peak demand or to back up intermittent renewables.

Technological development that increased the efficiency of gas-fired turbines and the availability of gas reserves was another incentive to use natural gas as a main source for electricity. All these features make the construction of a CCGT plant an attractive, short-term option for expanding electric generation capacity. Moreover, as a result of the use of Take-or-Pay (TOP)[3] clauses in natural gas supply, European gas firms try, through mergers with electricity firms, to reduce the uncertainty characterising their demand and to secure the captive demand in order to fully respect TOP obligations in their import contracts with strong extra-EU producers.

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[3]TOP clauses are mandatory in the European Union, in order to avoid that some importers reserve capacity they do not need so that they could foreclose import capacity to their competitors.

Natural gas can also be seen as the cornerstone of the national energy policy because it is one of the energy sources currently available that can bridge environmental concerns and economic requests: gas is less carbon intensive than coal, emits fewer traditional air pollutants and does not bear the waste burden of nuclear power. Since energy policies have aimed to decrease the CO_2 emissions, the use of natural gas in power generation can be seen as one of the best options. In fact, the 2008 World Energy Outlook confirms that most of the gas-fired generating capacity is being built in Europe because of the tightening of CO2 regulations.

These same main drivers were identified and listed by McLaughlin and Mehram (1995) for a similar phenomenon in the US. Furthermore, US experience suggests that European utilities are reacting to liberalisation by returning to the creation of new "energy firms", vertically integrated, operating both in the gas and in the electricity sectors and that this behaviour will still persist.

Since cross-sector merger activity is deeply reshaping the structure of the market, it is crucial to have a precise understanding of its effects, in order to foresee future measures to overcome this potential obstacle and to draw a coherent and effective energy and competition policy. Economic research recommends that control of mergers and acquisitions should be more strict in the energy sector than in other sectors (Barquin et al, 2006) thus, this growing integration between the two activities in the same firm presents challenges to competition authorities. Additionally, given the size and the nature of the energy sector, as well as the number of consumers potentially affected, it is essential to assess the effect on final consumers.

We have information on all mergers occurred in Europe from 1998 to 2007 in electricity and gas sectors from Lévêque and Monturus (2007) and we may identify some patterns to describe the evolution in the European energy market. Almost all main European energy companies have

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recently shown an unprecedented activism and the wave of M&As seems far from being over. The number of mergers in the energy sector increased in the past decade although growth has not been uniform. Between 1997 and 2007, 247 mergers and acquisitions (M&A) are reported involving firms with businesses along the electricity and gas value chain in Europe. From those mergers, 101 are cross-sectoral, therefore 41% of all merger cases in European energy markets involve a firm with business in the gas sector and a firm with business in the electricity sector. In table 3.1 we can see the distribution of mergers occurred between (at least) a firm in the electricity sector and (at least) one in the natural gas sector in the chosen period.

Table 3.1

Cross-sectorial mergers by country and year, 1998 to 2007

	1998		1999		2000		2001		2002		2003		2004		2005		2006		2007		Total
	s1	s2	s1	s2	s1	s2	s1	s2	s1	s2	s1	s2	s1	s2	s1	s2	s1	s2	s1	s2	
AU	1								1												2
BE									1		1		1			2					5
DK	1						1								1		1				4
FI	1		1				1		1				1				1				6
FR														1	1				1	1	4
DE			1		5		3		8	1	2		2		2		2				26
GR													1								1
IT							1		1	1	3	1	5	1	1		2	3	3	1	23
NE			2	1	2	1			1		2		1		1						11
PT					1										1		1		1		4
SP									1		1	1			1		1		2		7
SW	1		1			1	2		1				1								7
UK		2	2	1	1	1	1		2	2	2		1						1		16
Total	4	2	5	3	10	3	9	0	17	4	11	2	13	2	8	2	8	3	8	2	116

Source: Own calculations from Lêveque and Monturus (2007).

Note:To set the dates of the mergers: (1) the end year of the process was considered as the year to infer the post-merger period; (2) for the case of mergers occurred in the last quarter of the year we consider the effect on the following year.

Incumbents in several countries have diversified into other utilities. It was the case of firms whose activity was in electricity diversifying into gas, through merger processes (Thomas 2003). The driving forces in this process were a few European companies (E.On, EdF, RWE, Suez, Vatenfall, Iberdrola, Enel, Endesa).

As it can be concluded the M&A activity was present in all European countries, with special emphasis to Germany and Italy with more than 20% of all mergers in these sectors in Europe. The countries where there were less mergers were Greece and Austria, with 1% and 2% of the total. In what concerns time distribution, we can see the number of mergers spread along the period with a peak on the first semester of 2002, with 17% of the 116 mergers. In the second half of 2001 there is no registration of cross-sectorial mergers in any European country. Some of the mergers occur between firms with different nationality, therefore we consider it as a merger in both countries. This accountancy method is the reason for the difference of total mergers and the 116 from the table above: 15 of the mergers are also between-country mergers thus they are affected to more than one country simultaneously.

Among all the M&As, the already vertically integrated electricity companies[4] have been the most active. Firms with activity in the electricity sector which acquired gas targets preferred the downstream segment (distribution and supply), with the aim of seeking for a suitable fuel supplier and to control the source of fuel. Firms on the gas sector invested in the electricity industry mainly in the downstream segment as well, in order to secure a stable sale for their product. Gas companies have mainly been targeted by bidders which already had gas related businesses (2%). In table 3.2 we present a summary of the cross-sectorial mergers according to

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[4]Firms whose activity is distributed through all the value chain of electricity (from generation to supply).

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the sector of the firms involved.

Table 3.2

Cross-sectorial mergers according to the parts involved, European countries, 1998

to 2007

(1) acquires (2)		
(1)	(2)	
P+G	G	28
P+G	P	27
G	P+G	1
P+G	P+G	39
P	P+G	3
pure mergers		3

Source: Own calculations from Lêveque and Monturus (2007).; Note: P - power sector; G - natural gas sector.

We found mergers where a firm in the electricity sector acquires a firm in the natural gas sector or vice-versa. These are the ones called "pure mergers". However, there are also firms present already in both sectors acquiring a natural gas/electricity firm or vice-versa. And, finally firms present already in both sectors acquiring competitors also present in both sectors. Considering the features presented for the mergers and the aim of this chapter, we will restrict our analysis to the effects on only some of those mergers.

3.3.1 Mergers selected for our analysis

The selection of mergers to be analysed in this chapter was based on a set of conditions determined by the aim of our research. The first condition was that the acquisition represents more than 50% of the acquired firm. None of the mergers involving only a plant as the acquired firm was considered as a merger to be analysed.

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The second and more important condition was that a merger has to be a cross-sectorial one, that is to say, between firms in different energy sectors: one in the electricity sector and another one in the gas industry. We have not considered cases between already vertically integrated firms in each sector or already cross-sectorial firms wishing to expand the activity to other sector.

Even recognizing that nowadays electricity and gas industries are already highly integrated (in each sector), our data contains only mergers where a gas supplier acquires a firm whose activity on electricity value chain does not include supply. From all mergers in natural gas and electricity sectors (between 1998 and 2007), we are only interested in those that are inter-industry mergers and that represent the entrance of a natural gas supplier in the electricity sector or vice-versa.

From the conditions explained above, we focus on two of the three pure mergers presented in the previous section: (i) Neste/IVO in Finland; and (ii) EOn/Ruhrgas in Germany. Therefore, we have decided to exclude also the remaining pure merger between British Electricity and Swalec in UK, due to the lack of confirmation and information on the description of this merger.

The mergers chosen at the end were controversial and posed some question on the risk of competitive harm. However, somehow the risk was not large enough to cause the antitrust agencies to block the transaction or, alternatively, the case was blocked but there were some other factors that justified allowing the transaction after all. The fact that all cases were allowed after all by the competition regulator, turns their study more relevant because the idea is to find if the effects on consumer ,following the decision, were as it was expected.

Next we have a description of each of the chosen mergers. The main purpose is to briefly describe how every process occurred, which authority played the role of supervision and how,

which was the result of the process and finally to state similarities and differences in both processes.

Neste-IVO (FI)

On 14th of April of 1998 the EC received a notification of a proposed concentration between two stated-owned firms in Finland. The notification was mandatory due to the European dimension of the merger.

IVO was the largest Finnish company in the energy sector, with activities in generation, wholesale and distribution of electricity. Neste was active in oil, energy (gas, liquefied petroleum and heat supply) and chemical business. Neste had no activities in the generation of electricity prior to the merger and, through its subsidiary Gasum Oy, was the only importer, supplier and seller of natural gas, which was used as a primary fuel for electricity generation. The role of only importer was granted by the Finish government to import and distribute natural gas from the Former Soviet Union to Finland since 1971.

In 1992, Neste was considered by the Finnish Competition Authority as having a dominant position in the Finnish natural gas market. The main role of Neste was forecasted to increase over time, given the main position of natural gas on electricity generation and the new national energy policy implemented.

The firm resulting from the merger is a holding company where the State keeps 100% of the capital. Following the merger, the proposal was for the Finnish State to sell shares of IVO-Neste to public and institutional investors, national or foreigner, in a public offering. However, the State was allowed to retain a majority holding of the shares (more than 50%).

In its assessment the EC stated that the first phase of the operation was considered just as

an internal reorganisation within the State, whereas the second stage was considered a merger, according to European merger regulation. In conclusion, this merger was under the scrutiny powers of the EC, however, only a part of it was eventually assessed.

The integration proposed raised particular concerns from the beginning due to the potential monopoly position assumed by the new merged firm in the market of natural gas in the future. Moreover, the EC understood that this merger might lead to effective monopoly, not only on natural gas market but also on electricity market.

The report from the EC mentions that the merged entity would, as a result of the vertical links between the sectors and the accumulated position in both markets, be in a position to successfully adopt market strategies, namely control on prices or quantities in both markets. Several potential strategies were identified as detrimental. The merged firm could use strategies of threat to successfully increase electricity prices, because any price increase on natural gas would have the effect of increasing the costs for competing electricity generators. Another potential strategy could be to compensate a decrease in the sales of natural gas by increasing sales of electricity, through vertical integration. Due to these reasons, the new firm's decisions on pricing natural gas would be essential not only on the market for natural gas, but also on the market for electricity.

On the basis of this assessment, the EC concluded that the merged entity may enjoy a superior competitive position in the Finish electricity market that may represent an advantage compared to other generators. Since these points were all proved, the EC concluded that the operation, as it was, would threaten to create or strengthen a dominant position on the market for electricity and therefore raised serious doubts as to its compatibility with the common market. As determined by principle, the EC decided to block the proposed merger.

The main aim to avoid competition concern was to ensure that the merged firm would not have a control position over the market and consequently on prices. Subsequently, the parties submitted proposals. The main proposals were to resign Neste's control over Gasum (a subsidiary firm) by the divestiture of 50% of the company's shares. The Finnish Government made a commitment to ensure that the merged firm would remain a minority shareowner of Gasum.

The proposals were considered sufficient to solve the competition problems raised on the assessment and the EC decided not to oppose to the notified operation and to declare it compatible with the common market and with the functioning of the European Economic Area Agreement.

EOn-Ruhrgas (DE)

The regulation on E.On-Ruhrgas merger offers a very particular case for study for several reasons. The dimension assumed by the merged firm along the years and the fact that the merger occurred in Germany justify the importance of this case.

A new global player in the power industry was created, comprising vertical integrated services from gas imports to supply to the final consumer. Germany is the largest energy market in Europe and its central location gives the country a strategic importance for any company wishing to engage in European-wide energy transactions. Furthermore, if the creation of a national champion worked as an obstacle to slow down the German liberalisation process it sets an anti-competitive precedent for other European countries.

The firms announced the intention to merge in 2001. Either firms were already very important players in German energy markets, prior to the integration. EOn (with RWE) held a joint

dominant position in the electricity market and Ruhrgas was the dominant gas supplier in the country. In the gas sector, Ruhrgas controlled almost all gas deliveries to regional and municipal companies, almost all German gas imports and almost all storage facilities and high-pressure transmission pipes inside Germany.

In their assessment, the two competition authorities called to intervene identified several reasons for concern. This proposed merger raised a multitude of competition policy questions, both in the electricity and the gas sector. The Federal Cartel Office had refused the merger on competition grounds. The Monopolies Commission gave a negative evaluation on competition implications from the merger and possible arguments from public interest. Both reports clearly showed that without appropriate remedies, this vertical merger could pose several constraints to competition.

The main issues pointed were the major implications due to vertical integration. The German competition authorities feared significant market foreclosure effects on gas sales (as much as 20% of annual amounts). They also feared that the merger might have consolidated the prior market dominance in both the gas and the electricity sector. Authorities also mentioned that the new merged firm would have an incentive to discriminate against new competitors in the electricity generation by setting unfair terms for gas transportation and supply. Moreover, both firms would no longer compete in the markets in which they were both present. Finally, the synergies obtained from the merger would place other competitors at a competitive disadvantage, both in the electricity and in the gas markets.

Concerns were also pointed out about implications of the merger on consumers. A lack of competition in the German energy sector removes the incentive for the merged firm to pass the benefits from the vertical integration to consumers.

According to the identified concerns, both authorities blocked the merger. Then, some proposals were presented by the parties. However, these remedies were considered very limited in scope, inappropriate and of little significance to prevent the main problem of strengthening the dominance in gas and electricity markets.

After this prohibition decision, the merging companies appealled to the German Minister for Economy and Technology. Although all negative evaluations and warnings, on 5th July 2002, EOn obtained a ministerial permit to purchase the dominant gas company, Ruhrgas, for 10.4 billion euros. This permit was granted under a special procedure in the German anti-trust laws that allow the government to authorise ostensibly anticompetitive behaviour[5]. Among the reasons mentioned by the German Government was the role of the merged firm to ensure security of supply in the gas market. This is a particularly important motive for Germany, because the country depends greatly on gas imports from Russia. Therefore, the merger was cleared politically under the condition that the firms would work toward achieving security of supply.

Many economists criticised this decision as an anticompetitive result designed to create national champions and, mainly, as a result that it is opposed to the aims of liberalisation. Considering that the negative assessment from the competition authorities was based on competition and consumer welfare concerns, the Ministry's decision on allowing the merger did not consider any of these concerns, namely consumers' interests on their decision.

The EC was also called to give its assessment, but it has repeatedly stated that the merger fell outside its jurisdiction. This claim was increasingly controversial, because beyond the legal-

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[5] Act against Restraints of competition: "if the restraint of competition is outweighed by advantages to the economy as a a whole following from the concentration or if the concentration is justified by an overriding public interest"

istic question of jurisdiction, this merger had wider implications for the liberalisation process in Europe, for the reasons mentioned above. Therefore, this merger also puts the scope of EU jurisdiction in the spotlight making its study even more significant.

3.4 Empirical model, data issues and method

This section describes and explains the econometric model and the data used in our analysis to reply to the research question: "should European household consumers be concerned with cross-sectional mergers?". In order to examine this issue we construct a model on determinants of electricity final prices for households. On a first step, we identify the relevant market, according to commonly used criteriums and then, we discuss the empirical model, data issues and method used.

We encounter some data and econometric issues, namely missing data and endogeneity problems. These issues are also discussed and solutions are proposed and implemented to solve them. To solve endogeneity, we use instrumental variables estimation and to solve the missing data problems, we decide for the multiple imputation method.

3.4.1 Relevant market

The identification of the relevant market is a key factor in any study of a merger case and it may affect the final outcome of any merger assessment. The requirement of defining relevant markets has been also part of the EU competition assessment and a pre-condition under article 81 and 82 of the EU Treaty. According to the Commission Notice, the definition of the relevant market for the purpose of competition law is:

"(...) the area in which the undertakings concerned are involved in the supply and demand

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of products or services, in which the conditions of competition are sufficiently homogeneous and which can be distinguished from neighbouring areas because the conditions of competition are appreciably different in those areas".

We may consider the European market as the relevant market for the merger analysis, though several reasons made us define it according to the traditional approach: the market in each Member State has still to be considered as a separate market. Several indicators as price differentials between countries, interconnection capacity and cross-border trade are referred to as relevant criteria for the definition of the relevant market. Different regulatory regimes, complex capacity allocation systems and different market design in neighbouring countries may also explain it.

Even the EC recognises in several reports that the integration of energy markets is still far from a success and with very few exceptions, electricity in the EU remains national in economic scope. For merger and acquisition cases, the EC has, so far, nearly always defined the relevant market as being national, arguing that development leading to wider than national electricity markets is not fulfilled yet.

It can be confirmed that the price differences between countries in Europe are still significant. Figure 3.1 illustrates real household prices for the analysed countries for the beginning and the end of the chosen period (first half of 1997 and first half of 2007). For both periods we can see that electricity prices for household consumers differ quite considerably between countries, what may be a sign of insufficient market integration. Similar conclusions can be taken from the evolution of prices in the remaining periods studied.

Figure 3.1

Electricity prices (household consumers, Dc[6]), with taxes 1997 and 2007
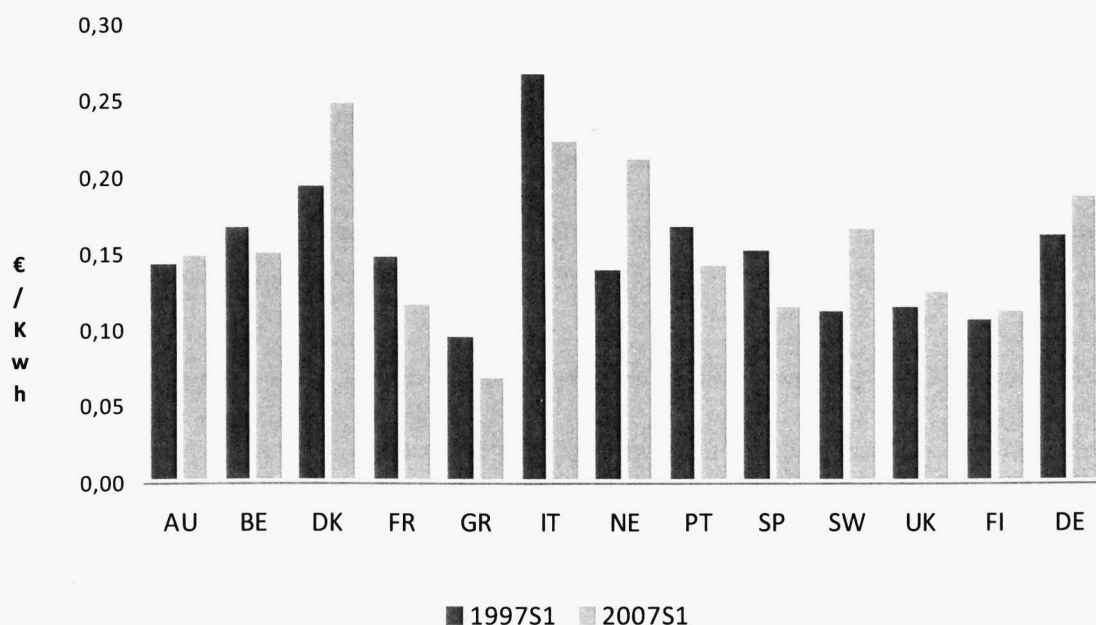
Source: Eurostat

Multiple other factors can explain these differences between prices in each country. The different costs of generating electricity according to the generation mix of the country, the different availability of generation capacity, the role played by the level of competition on the wholesale and retail market and, finally, regulated prices also lead to price differences on the EU electricity markets.

The coexistence of open markets and regulated electricity prices is still common among EU countries. Almost half of the countries studied still have regulated prices for electricity[7] for the

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[6] **Real prices, based on Eurostat figures in Euro, with taxes, category Dc for consumption. According to Eurostat, there are several categories to distinguish consumers. Dc is the one where consumers have an annual consumption of 3,500 kWh that are connected to low-voltage networks.**

[7] Denmark, France, Italy, Portugal, Spain and Greece. Germany only abolished regulated electricity prices in 2007.

period considered and regulation is mainly for prices for household customers. The number of households covered by regulated prices represent a significant proportion of the population in some countries, such as in France and Italy.

To define a market wider than national, the price differences should occur only in roughly 10% of the time. In contrast, between European countries it happens in 50% of the time (Valdezande et al, 2006). Thus the relevant market should not be considered wider than national.

Another key prerequisite for an effective integrated European electricity market is that markets should be adequately connected, and that interconnections should be efficiently used. Interconnection capacity is still scarce across Europe and little progress has been made to improve it. The available capacity of interconnectors is still limited between many of the countries studied when compared to installed capacity, as it can be pictured in figure 3.2. This is the case for Spain, France, Italy or UK.

Trade based on differences in production costs is more efficient and load balancing can be better achieved if neighbours could exchange electricity more easily. The possibility of trade may reduce the overall reserve margins needed by diversifying the sources of supply. The existence of trade increases the important role of transmission grids on sustainability of all the European system, due to the growing interdependence between European markets.

Figure 3.2

Electricity Market: Cross border capacity across Europe, 2006

(Interconnection capacity in relation to installed capacity)
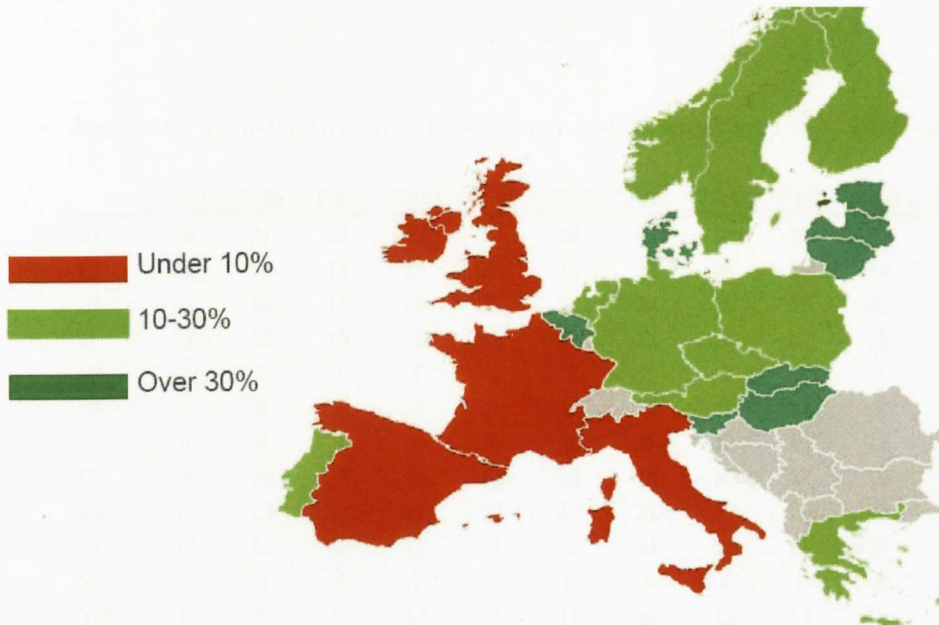
Source: ERGEG, 2007

Therefore, when considering whether the market should be defined more widely than a national market, data on exchange between countries (imports and exports) may also be informative. Significant imports of electricity may indicate that the market could be considered wider than national. In contrast, a slow development of cross-border trading may be interpreted as the presence of isolated markets.

Although, the trade of electricity between neighbouring countries is common in Europe, for almost half of the countries, the import of electricity hardly covered 10% of national consumption in most of the period analysed, as it can be verified in Table 3.3.

Table 3.3

Imports as percentage of national consumption (%), 1997-2007

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
AU	19	21	23	27	27	29	35	30	35	37	37
BE	14	11	12	15	20	21	18	18	18	23	19
DE	12	10	15	26	25	27	22	26	39	20	31
FI	12	13	15	16	15	17	15	14	22	16	18
FR	1	1	1	1	1	1	2	2	2	2	3
GE	8	8	9	9	9	10	10	9	11	9	9
GR	8	6	4	4	8	10	9	10	11	12	12
IT	16	16	16	16	18	18	18	16	17	15	16
NE	15	13	24	23	22	21	21	20	23	26	21
PT	17	12	10	12	9	13	14	19	21	18	20
SP	3	5	7	7	5	6	4	4	4	4	3
SW	8	5	7	14	8	15	19	12	11	13	12
UK	5	4	4	4	3	3	2	3	3	3	3

Source: Eurostat

In what concerns exports, in all European countries, except France and countries from Nord Pool, exports are marginal, assuming also less than 10% of national consumption of electricity[8]. As it can be concluded, cross-border trade is still too limited for the markets to be considered larger than national markets.

As a result of the national scope nature of the European electricity markets, we assume that firms have differentiated strategies based on national dimension. Even for the case where a firm spreads its activities in several countries and assume global strategies (for the merger) it might

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[8] Own calculations with data from Eurostat.

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not be able to exert the same influence outside the country where it started as incumbent. Therefore, we will study the consequences of a merger on market outcomes only on a single national market.

In conclusion, the relevant market for the analysis of the effect of the merger on market outcomes will be the country identified on the merger descriptions and not all the markets where the participant firms have activities. This is one of the main implications of recognizing national scope of the market for merger analysis in our research.

3.4.2 Empirical model

Econometrically we are focused on assessing the effect of mergers on final electricity prices for household consumers. To determine the empirical model for our purpose, we should identify all relevant variables considered as the main determinants of demand and supply of electricity.

Nevertheless, given that the demand and supply of electricity could be highly interconnected, it may be difficult to identify sufficient exogenous variables. For that reason, instead of estimating the single structural equations directly, our option was to formulate and estimate a reduced form model for the determinants of electricity final prices on several European markets.

With our purpose in mind, we set up a standard function where price enters on the left hand side to be explained and to all other explanatory variables, on the right hand side, we add a dummy variable representing the existence of a merger. After writing down this reduced form model, we may then use it to quantify the impact of any variable on prices, namely, for our aim, the existence of a merger.

The results and conclusions may be very sensitive to the demand specification chosen. Therefore, we should choose demand specifications carefully. The choice should be based on

the idea that the demand systems should end on conservative estimation results.

When deciding the functional form, we may conclude that there is very little consensus about the correct one for electricity prices. Although, most studies use a linear form, a log-linear or a logit form. The main problem of the log-linear model, also named constant elasticity form model, is that it omits the influence of a change in market shares. The logit model is based on a random utility model and yields results that are easily derived and are in the range of conservative estimates. However, this last demand system is not suitable for the analysis of electricity, because it finds application more often for differentiated product markets.

In the context of our research, it is sufficient to choose a simple linear demand model. Firstly, the linear demand function produces a conservative measure of the price change for homogeneous goods, as is the case of electricity, and reduces the error of false conclusions. Secondly, although attempts have been made to find a demand model that adequately explains the demand for electricity (Taylor, 1975) there is no detailed analysis of the European electricity markets. Therefore, without a more comprehensive analysis of the electricity industry on European markets it is difficult to firmly decide which of the demand specifications best represents the actual demand structure in each country. In conclusion, the main motivation for this choice was the relative ease with which it can be analysed and the conservative conclusions that allows to take.

Assuming the linear function, as motivated above, the price equation for our research may be described, in general terms, as follows:

$$P_{it} = v_i + \beta M_{it}^j + \lambda' X_{it} + \text{Time} + u_{it}$$

In this equation, P_{it} stands for final price of electricity for household consumers in country

i in period t; u_{it} is a standard stochastic error term that includes other unobserved factors that are uncorrelated with the existence of a merger. For each country $i=1,...13$ the fixed effect is given by v_i. The country effects account for all unobservable heterogeneous country level variables that affect prices but that are time invariant, such as the market structure. Though it would be expected that with liberalisation the market structure would change over time, it was not the case for the majority of European countries.

M_{it}^j is a dummy variable taking a value of zero for periods before the merger for all countries and a value of 1 for post-merger observations for countries where a merger, as we define, take place. For each merger analysed we consider a specific dummy variable (j refers to the particular merger). Each merger has particular features that should be considered and, therefore, the effect on final prices may be different.

A linear time trend is also included into the equation. A trend variable is a monotonically increasing variable. This time trend captures the effect of constant factors that vary uniformly across countries over time as is the case of environmental regulation, mandatory by the EC and adopted by all countries, for example, which has changed during the time of our analysis.

X_{it} represents observed control variables that also influence final prices for electricity. To control for demand and cost determinants, the covariates, we include several relevant variables. These variables are chosen through a review of the literature in electricity industry, as well as information on European electricity markets. It should be mentioned that variable selection was also guided by the likely availability of data.

To generate electricity, there is a choice of a wide-array of generation technologies and fuel sources. Due to the dominance of fossil fuelled power plants in European electricity generation, primary energy (as natural gas, coal and fueoil) prices are crucial determinants of the evolution

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of electricity final prices.

However, changes in the price of a fuel should affect only the country where the fuel is included on the generation mix. Therefore, instead of including just the price of fuel, we include the weighted average of cost of thermal generation, lagged. Since the decisions to buy the inputs (fuels) are made before the time of generation we have tried different lags for the weighted costs and the more significant was one period, i.e., six months. The expected sign for the estimated coefficient of generation fuel cost, lagged one period, is positive and it means that higher generation cost on the period before leads to higher final price of electricity.

Besides this determinant, production of inframarginal technologies or non conventional production (hydro run-of-river and nuclear power) may also directly influence price formation. While the relative use of most generation conventional techologies is a choice, the relative use of hydroelectric resources is largely exogenous, driven instead by the availability of water resources in the country. The expectation is that due to the lower marginal cost of hydro compared with other technologies, the availability of hydro generation would have a negative impact on price of electricity. However, in drought years, the marginal cost of hydro generation is not as low as usual, due to the high value of opportunity costs associated with the use of water, and may have a positive effect on final prices. Hence, depending on the rain characteristics of the period, the expected sign of the coefficient of Hydrogeneration ($hydrogeneration_{it}$) may change.

Compared with conventional thermal generation, nuclear power is commercially more exposed to risk because it has high fixed costs. This means that it has an economic incentive to run at maximum load. For existing nuclear power plants, the determinant costs in a competitive market are the marginal costs of operation including applicable repair and refurbishment

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expenses. Typically, nuclear plants have lower marginal costs. However, electricity prices have to be enough to cover both the marginal costs of operation and the investment costs of nuclear power plants. Therefore, it is possible that a higher percentage of nuclear generation ($nuclegeneration_{it}$) will drive final prices of electricity up.

The disposable income of each country is also added as a proxy for electricity demand, mainly for two reasons. One, even if, in the long run, the effect of demand on price may be neglected, short term variation in demand due to changes in income may affect price. Two, it may be said that consumers with higher income demand higher levels of electricity. As a result, we expect that higher disposable income ($Income_{it}$) leads to higher household price for electricity.

As any good, the final price of electricity may be positively determined by the cost of labour ($LabourCosts_{it}$). Due to the low intensity in labour of electricity generation sector, we may find a non significant coefficient for this variable, though.

The reestructuring of European electricity markets, following the EU Directive in 1996, forced EU member countries to open their retail markets. Though, European countries opened their markets at different points in time. Regulatory changes that boost competition in the electricity industry are expected to have impact on final prices of electricity. Since the third party access (TPA_{it}) was usually established at the same time as the retail access, we may use the TPA indicator, as Steiner (2001) defined. The introduction of choice for the consumers in retail market will boost competition between generators and suppliers. Due to the higher competition, suppliers are more able to supply industrial consumers than household consumers. Therefore there is a possibility that industrial prices will decrease and prices for households will increase with the diminishing cross-subsidiarisation presented in the past on the market. To

conclude, the introduction of TPA in a market may penalise household consumers through the increase in final prices.

Finally, a determining factor in electricity prices may be the generation mix of each country. In the past years, the main change concerning the sources of fuel for electricity generation was the shift from coal to natural gas inside thermal sources ($\%natgas_{it}$) for generation. Natural gas plants are faster to site and build and are less carbon intensive, compared to coal. Therefore, in most European countries new gas fired power stations were replacing old coal plants and natural gas is taking market share away from coal due to more competitive electricity costs. A higher percentage of natural gas in the total thermal sources may have a beneficial impact of final prices of electricity due to the construction of more efficient plants.

The general specification for the reduced-form equation for electricity final price, including all variables described and explained above, is as follows:

$$P_{it} = \upsilon_i$$

$$+\beta_1 M_{it}^{DE} + \beta_2 M_{it}^{FI} + \beta_3 Costs_{it-1} + \beta_4 hydrogeneration_{it} + \beta_5 nuclegeneration_{it} + \beta_6 Income_{it}$$

$$+\beta_7 LabourCosts_{it} + \beta_8 Time + \beta_9 TPA_{ij} + \beta_{10}\%natgas_{it} + u_{it}$$

It is important to notice that there are a number of other variables suggested in various other studies that may be determinants of electricity prices. These have been omitted due to the limited number of variables that can be included in a short period dataset, as ours, and some others were excluded due to lack of data availability.

3.4.3 Data issues and descriptive statistics

Our research question is answered using panel data covering all the period after the deregulation and liberalisation of energy markets, from 1997 to 2007, and considering a set of 13 European countries (Austria, Belgium, Denmark, Finland, France, Germany, Greece, Italy, Netherlands, Portugal, Spain, Sweden, UK).

We have not considered either Luxembourg nor all recent members of the EU. The first choice is due to the fact that since Luxembourg has got very special conditions for the choice of groups of consumers and has got different functioning rules for the electricity market it would be very complex to compare it with the other countries. The second choice is due to the lack of data available for the entire period. All countries considered embarked upon liberalisation under the 1996 Directive. This Directive did not immediately apply in the more recent EU Members and most of them have been undergoing a transformation from socialist to market economies, often implying additional measures, as for example gradually removing cross-subsidies, and these changes can have specific effects on market prices, namely on final prices for electricity.

We choose the final prices of electricity and not the wholesale price for our analysis for several reasons. First, the weakness of the data available from power exchanges. Electricity is not significantly traded in power exchanges in some of the countries considered and it is still largely traded bilaterally over-the-counter so it may not be relevant to infer the impact on wholesale prices. Second, it is proved that the evolution of prices for final consumers is not similar to the one in the wholesale market and if our final aim is to study the impact on final consumers analysing the consumer final price it seems to be the best choice.

Since household consumers tend to show lower price elasticity than industrial consumers,

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it is expected that household consumers will feel less any effect (liberalisation, regulation or as is our case, change in market structure). Hence, if, for example, household prices would fall significantly, it can be assumed that other prices will decline at least in the same order.

In conclusion, the dependent variable is the price for household consumers, valid on 1 January and on 1 July of each calendar year, available from EUROSTAT. We are concerned about the effect on welfare of final consumers. Therefore, we use the definition of price that is more relevant for household consumers: prices including all taxes[9]. The analysis was limited to the consumer category Dc. According to Eurostat, there are several categories, namely Dc where consumers have an annual consumption of 3,500 kWh that are connected to low-voltage networks. All end-user prices are based on values in euros and when we had to covert it, we have used the currency exchange at the period considered. Additionally, each price was deflated by the Consumer Price Index of the country.

In figure 3.3 it can be seen the evolution of real prices for some countries where the mergers did not occur (above) and in Germany and Finland (below). In the same figure it is also drawn the time of each merger analysed in order to distinguish the period before and after the merger. From the evolution of real prices, it is not completely clear the conclusions about the effect of mergers on prices, namely if we compare the evolution of prices before and after the merger for the country where it occurs with prices in other European countries.

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[9]The prices include electricity/gas basic price, transmission, system services, distribution and other services.

Figure 3.3

Evolution of real prices for electricity, Household consumers, 1997 to 2007, pre and post cross-sectorial mergers
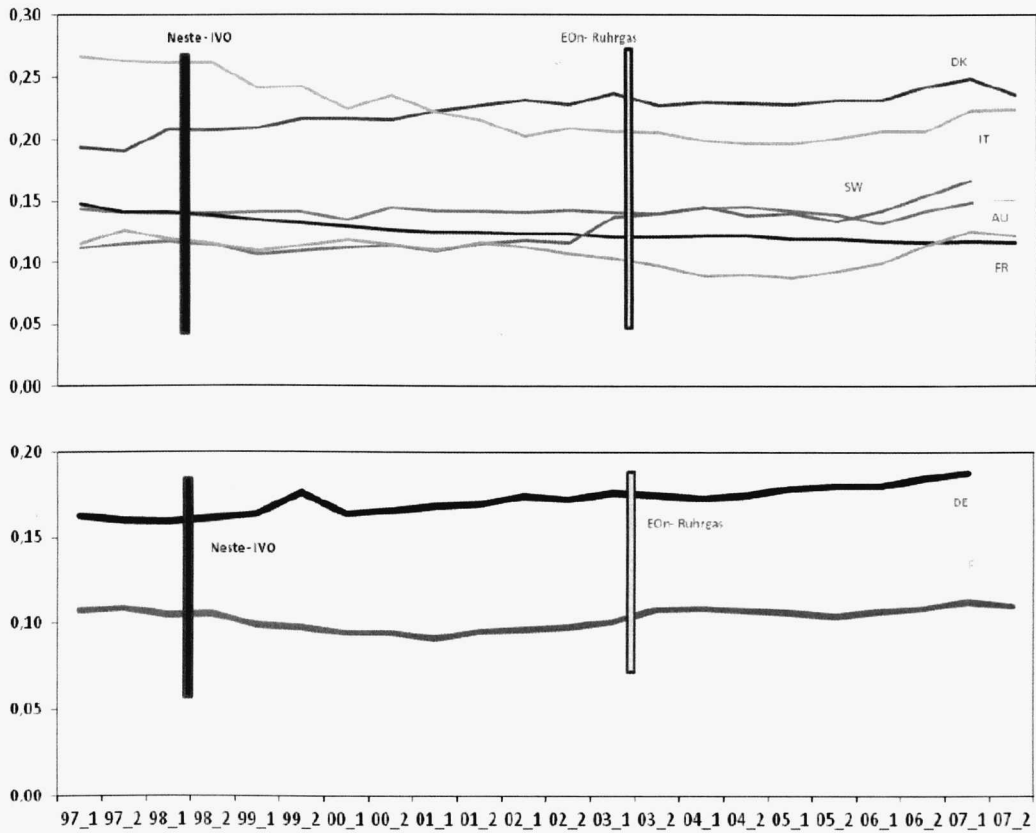
Source: Own construction with Eurostat data.

The remaining data used to estimate our model are obtained from a variety of sources. All the data used is publicly available (reports from regulators, from firms, statistical institutes and international organisations) and is half-yearly. All independent variables used are listed in table 3.4. In order to adjust all monetary values to overall price developments, we use the Consumer Price Index of each country.

Table 3.4

Description and sources of (some) Independent Variables (X_{it})

Variable	Description	Source	Expected sign (coeff)
Hydrogeneration (%)	% of hydro generation on generation mix	Eurostat	+/-
Nuclegeneration (%)	% of nuclear generation on generation mix	Eurostat	+
LabourCosts (1000eur)	Average personnel costs on electricity generation (per employee)	Eurostat	+
Income (millions eur)	Net national disposable income (B6NS1)	OECD	+
Costs (eur/Kwh)	weighted average of thermal fuel costs used on generation; <u>weight</u>: % of each fuel on country total generation mix	OECD	+
% natgasTh (%)	% of natural gas generation on total thermal generation	Eurostat	-
TPA (0/1)	Definition by Steiner (2001) Dummy variable takes value 1 if there is negotiated or regulated TPA and zero otherwise	OECD	+

The generation costs used as independent variable is the weighted cost of generating electricity. The fuels considered for the weighted average were the fossil fuel sources for generation: heavy fuel oil for electricity generation, natural gas for electricity generation and steam coal for electricity generation. When the price of some fuel for generation was not available for any period studied we have used the industrial price of the same fuel (when available). Otherwise it is assumed no value for the period. We just use the data available thus, we have several missings (described in next section) on this variable. To calculate the weighted average, we use

all the prices available even if for some period we have, for example, only the price of one of the thermal sources of fuel.

Since we found several data non available for Sweden and Denmark, we assume the price of generation fuels for all Nord Pool countries. The reason for this assumption is that, differently from the remaining European countries, these countries are part of a recognised integrated market.

Table 3.5 lists the summary statistics for the dataset, which shows the between and within standard deviation for each variable. The table shows that some variables have relatively little within country variation as compared to between country variation, as it is usual in micropanel databases.

Table 3.5

Descriptive statistics of the Variables

Variable	variation type	Mean	Std. Dev
P_H	overall	.146	.044
	between		.044
	within		.014
Mde	overall	.033	.179
	between		.119
	within		.138
Mfi	overall	.055	.228
	between		.198
	within		.126
Costs_1Lag	overall	.0043	.0033
	between		.0023
	within		.0009
Hydrogeneration	overall	.179	.1831
	between		.1839
	within		.0469
Nuclegeneration	overall	.246	.258
	between		.267
	within		.020
LabourCosts	overall	51.42	13.14
	between		12.53
	within		4.78
Income	overall	9638958	3.23e+07
	between		3.34e+07
	within		3059201
% natgas	overall	.405	.181
	between		.164
	within		.089
TPA	overall	.846	.361
	between		.138
	within		.336
Auth1	overall	-.617	.793
	between		.623
	within		.519
Auth2	overall	-.271	.919
	between		.721
	within		.604
Auth3	overall	.308	.462
	between		.263
	within		.387

Missing values and the solutions

As it was stated before, we have data in 13 European countries for several determinants of final electricity prices. Our database is an unbalanced panel, due to some missing values in several variables. The advantage of having a panel is that it often contains far more information than cross-section data. Thus it allows for an increased precision in estimated results. However, it is worth underlining the relatively small dimension of our sample due to the characteristics of the market and to the aim of our research.

Most of the research databases are plagued by the problem of missing values. While this may not be a significant problem in univariate analyses, the concerns increase in multivariate analyses, as it is our case, making it difficult to analyse the data.

When we want to estimate an econometric model with missing values, we have two options. On the one hand, we can use appropriate estimation methods (Baltagi, 1985), which are in general quite complex or, on the other hand, the alternative option is to use appropriate methods to deal with missing data. We use the second approach on this research.

Much has been written regarding missing values in statistical literature. Three types of consequences are usually associated with this problem: loss of information, efficiency or power due to loss of data and complications in handling and analysing the data due to irregularities in the data pattern and non-applicability of standard software.

Two important factors should be considered when selecting a technique for analysing missing data. First, the amount of data missing, and second, the specific type (or mechanism) of missingness. The greater the percentage of missing data, the more important missing data approaches are for minimising bias. As the portion of data missing reaches 20% or more, the

choice of a missing estimation technique can have substantial implications for the parameter estimates. Table 3.6 presents the percentage of missing data for each of the variables included in the analysis.

Table 3.6

Missing data in the dataset

Variable	Nr. Missing	Missing/Total
Costs_1Lag	23	0.08
%gas*price of gas	112	0.41
%coal*price of coal	67	0.25
%oil*price of oil	122	0.45
Nucleageneration	1	0.004
LabourCosts	30	0.11

Note: Only contains variables with missing values.

We can see a very different pattern in the missing data, from around 1% for nuclear generation to above 20% on weighted generation costs. Some variables seem to be especially problematic, namely the ones in the price of fuels, as we can see in additional information in each component of weighted average cost and labour costs. Most of the data were missing by design: IAEE reports are based on surveys fulfilled by each country and some countries do not report data for all years to IAEE.

Data is complete for several variables: Hydrogeneration, Disposable Income, the existence of the merger, TPA and %natgas and all the instruments. The variable Nuclear is almost complete. Most countries with missing data have only one or two missing variables and few have three missing values. From the 273 observations around 80% are complete.

Little and Rubin (1987) report a well known classification on the mechanism of missingness. If all individuals in the population have an equal probability of being missing, then we have

Missing Completely at Random (MCAR). When the probability of missing is variable but the difference in probability depend solely on data that is not missing, the data is said to be Missing at Random (MAR). When the probability of missingness is variable but, this variability depends upon factors other than covariates or observed values of the response variable, then the missingness mechanism is described as informative or non-ignorable. Our data is assumed to be MAR, according to the definitions above. As it was stressed before, from this classification it also depends the choice of the best method to solve the missingness problem.

A number of different methods to deal with missings have been reported in the literature. These methods can be divided into two main categories: traditional approaches and missing data imputation. The first solution is more frequently used in the literature. However, even if it has some intuitive logic, it lacks a proper formal basis and can be quite misleading. These approaches include listwise deletion, pairwise deletion, mean substitution and inclusion of an indicator variable.

The default method in all statistical software is simply deleting cases with any missing data on the variables of interest (listwise deletion or complete case analysis). A large part of the empirical literature takes the option of using listwise deletion and eliminates entire observations. Though, in multivariate problems, case deletion often results in a large portion of the data being deleted and an unacceptable loss of power. In our case, the use of listwise deletion will represent losing around one-fourth of our data. The first estimation results presented in section 3.5 are based on this solution. However, our database is already relatively small and so, the listwise approach does not seem to be the most suitable.

All shortcomings of deletion strategies have been well documented (Little & Rubin, 1987). If the deleted cases form a relatively small portion of the entire dataset, then this method may

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indeed be a reasonable approach. Nevertheless, the consequence is a loss of valuable information at best and a severe selection bias at worst. Inferences from analysis using listwise deletion are relatively inefficient, no matter which assumption characterises the missingness.

When there is a relatively large amount of data missing, imputation is pointed out as an assumed popular method to handle incomplete data problems. This popularity is due mainly to the fact that once the missing values are filled in, it is possible to apply standard complete data methods to produce the desirable results.

To be effective the imputation method should fulfill two requirements: (i) it must reasonably capture the actual distributional relationship between unobserved and the observed; (ii) the analysis must take into account the uncertainty in the imputed values, because no matter how much effort one makes, the imputed values are simply not the real ones.

Multiple imputation methods[10] have been around for about three decades and are now a choice to avoid the problems of traditional practices presented (Rubin, 1977). The difference between the latter and the standard single imputation is that the last approach underestimates the true variability in the data as it does not account for the fact that the imputed values are not in fact the true, observed data. Multiple imputation addresses this problem by generating multiple imputations for each missing value.

Among some alternatives we have used Rubin's multiple imputation (Rubin, 1987; Schaffer, 1997). This is a three-step method to meet the two requirements referred to above. The first step is to build a sensible imputation model and then to impute the unobserved values for m independent draws from the model. As the second step we simply construct a complete data

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[10] The textbooks by Little and Rubin (2002), Schafer (1997) provide a comprehensive overview of methods in this setting, focused on multiple imputation.

analysis using each of the imputed data sets in the same way as we would use a real complete data. Finally, as the third step we combine these multiple results to obtain the so-called repeated imputation inference.

Even if the available literature does not identify clearly the best method to solve missingness for all data, according to all the reasons stated above, multiple imputation is identified as one good alternative with very good statistical properties when compared to the other approaches.

3.4.4 Econometric method

If we could assume stability on price function and the presence of no contemporaneous shocks on price over the period, it would be simple to identify the effects of mergers by just comparing the post-merger and pre-merger price for the affected country. However, prices of electricity have changed over time and there were several factors that caused those variations.

The parameter of interest when estimating the effect a merger between a natural gas supplier and electricity generator has on electricity final prices for the market where it occurred is $\beta_1 and \beta_2$, the coefficients of the merger dummy variables. Therefore, the estimation of β_1 and β_2 is the main issue of this chapter. A value of the coefficients that is statistically different from zero would indicate that the merger has a significant effect on final prices. The sign of the coefficients show whether this effect is positive or negative: a positive coefficient means that the existence of a merger increases final prices for consumers and a negative coefficient allows to conclude that the merger decreases final prices.

A potential problem with the overall regression model is the endogeneity of the vertical cross-sectorial merger. The central question is, then, whether market structure can be treated as exogenous, as in some previous research (Owen, 1970; Landon, 1973). However, the creation

of a vertically integrated firm is not randomly determined across countries, but rather is the result of a strategic choice. In fact, mergers do not arise by chance. Factors that trigger mergers are likely to also concomitantly affect market outcomes, such as final prices. Whether firms in a country respond by vertically integrating depends, in part, on unobservable factors and these unobserved characteristics are probably correlated with electricity final price.

One solution to solve the endogeneity of explanatory variables is to implement Instrumental Variable (IV) estimators. Adding to the economic arguments above, we use the Durbin-Wu-Hausman test for endogeneity of M^j. The null hypothesis (H_0) is that OLS and IV are both consistent but OLS is efficient. If we reject H_0 then the endogenous regressors' effect on the estimators is meaningful and OLS is not the appropriate technique due to biased and inconsistent estimators. In all estimated models endogeneity tests confirm the economic reasoning that justify the endogeneity of M^j.

The instrument variable should identify the exogenous variation in final price of electricity attributable to a merger, recognising that the participation (having a merger or not) is not random. There are two requirements that need to be fulfilled, in this case, for an instrument to be valid. First, the existence of a merger should be highly correlated with the instruments and second, the instrumental variable should not be correlated with the final price, other than through the merger variable. The first condition can be tested through the correlation between the instruments and the endogenous variables (or the coefficient in the instrument on the first stage of a two stage least squares regression). The exogeneity condition, on the other hand, cannot generally be directly tested, and an intuitive argument may be made.

Therefore, the reasoning is to find an instrument correlated with the existence of mergers of this type, but not correlated with prices. The instruments chosen are relative measures of

strenght/toughness of competition regulation. The existence or not of a merger is likely to depend on the effectiveness of competition policy. Effectiveness of competition policy is likely to depend on the toughness of the regulator. Neoclassical explanations of merger waves argue that these events depend on an industry's economic and regulatory environment. We use three variables in order to measure the relative effectiveness/ toughness of competition authorities in each country.

The set of instruments is based on the fact that the effectiveness of competition regulation may be related with the average quality of a country's regulators. The general quality of regulators in a country creates an environment that affects the effectiveness of all public policies. In a context where all regulators, in average, are effective and efficient, the authority that presides over the enforcement of competition law also tends to be effective and efficient. The idea behind the instruments is that comparing the quality of electricity sectorial regulator with the average quality of regulators in a country may be a good indicator of quality of the competition authority. On the one hand, there will be less attempts from the parts involved in mergers because they know that, by reputation, the authorities will be very rigorous. On the other hand, the rigorous scanning from a tough/effective authority will increase the probability of a merger to be blocked. In any of these cases, a competition authority with higher quality (more tough/ more effective) is related with a lower probability for the existence of mergers.

To determine our relative measure, we use an index based on a set of regulatory reforms indicators (REGREF), an OECD regulatory database which collects some indicators of privatisation, desintegration and liberalisation of several services of general interest across some OECD countries. These indicators have been used extensively in various empirical studies linking regulation to economic performance and to measure the strength of policies aimed at

preserving and promoting market competition.

We use the relative features of electricity regulators (compared to the average of the country) as a proxy for the same feature on competition authority according to the explanation above and recognising that the sector regulator has also some intervention on merger cases assessment in its sector. The description of each instrument is presented in Table 3.7.

Table 3.7

Definition of instruments for IV

Instruments	description
Auth1	the distance of the electricity sectorial regulator index to the average of the country
	benchmark: <u>average of the indicator for all sectorial regulator for each country</u>
Auth2	the distance of the electricity sectorial regulator index to the average of the country
	benchmark: <u>aggregate indicator of regulatory reforms indicator (REGREF) of each country</u>
Auth3	compare with the indicator for electricity regulator and assumes 0 if it is less or equal to the anual average amd 1 otherwise
	benchmark: <u>average of the indicator for all sectorial regulator for each year for all countries</u>

The choice of the set of instruments above was based on economic reasoning and also based on verifying the conditions for a good instrument, using appropriate statistics. The results and conclusions are shown in section 3.5.

3.5 Empirical results and discussion

In order to answer our research question on the impact of vertical integration between natural gas suppliers and electricity generators on household consumers, we will be concerned about the coefficients of the dummy variables defined for each of the chosen merger. A fixed effects

approach (within group estimation) is used to control for the unobserved country specific effects that cannot be captured by the explained control variables through all the results on this section. The aim of applying fixed effects estimators is to look at the effect on price within each country and removing the pernicious effect of omitted variable bias.

As most of empirical papers in economics, we start from using listwise deletion to solve the data missingness problem, by deleting any observation having at least one missing value. In table 3.8 we present the estimation results for the linear specification of the reduced form of final price for household consumers using Ordinary Least Squares (OLS). In our case, if we restrict ourselves to observations where data is available for all regressors, we lose around one - fourth (20%) of our data.

Table 3.8

Estimation results (OLS estimation): *listwise deletion*

Dependent variable: P_H	
	listwise deletion
M_{DE}	.019***
	(.005)
M_{FI}	-.0001**
	(.005)
Costs1_L1	2.5***
	(.399)
Hydrogeneration	.031**
	(.013)
Nucleageneration	.194**
	(.034)
LabourCosts	.0005***
	(.0002)
Income	1.30e-09***
	(2.18e-10)
Time	.00005
	(.0002)
%natgas	-.066***
	(.0114)
TPA	-.004
	(.003)
constant	.075***
	(.014)
Nr. obser	222
Durbin-Wu-Hausman test	chi-sq(2) = 19.878 (0.000)

Notes:The dependent variable is the real prices for household consumers, D^{c};Standard errors in parenthesis;

***, ** and * denote significance at the levels of 1%, 5% and 10%, respectively.

The coefficients of most of the independent variables are statistically significant. The exception are TPA and also the Time, which are not statistically significant. The majority of explanatory variables show the expected sign.

Concerning the merger coefficients, the values are also statistically significant and therefore

it allows us to conclude that there are effects of the mergers on the final price for household consumers. This effect is different according to the merger: from the German vertical integration we obtain as a result a detrimental effect and from the Finish merger the impact is positive, even if it is very small. This means that the merger between Ruhrgas and EOn seems to have increased household prices and the merger between IVO and Neste seems to have reduced prices for household consumers, if we compare pre-merger with post-merger prices for Germany and Finland, *ceteris paribus*, respectively.

We check for multicollinearity between explanatory variables, using a correlation table and the tolerance and variance inflation factors (VIF). Cumulatively, the highest correlation was less than 0.60 and the VIF are not greater than 10 while the tolerance values are not lower than 0.1. Therefore, multicollinearity between the explanatory variables is not an issue to be addressed.

Further econometric tests seemed essential in this panel data context. These are tests of serial correlation and heteroskedasticity. The Wooldridge test for autocorrelation in panel data assumes the value $F(1, 12) = 42.506$ what means that fails to reject H0: no serial correlation. Concerning heteroskedasticity, the null hypothesis is rejected according to the modified Wald test for groupwise heteroskedasticity in FE regression model [chi2 $(13) = 830.70$].

In order to ensure valid statistical inference in the presence of heteroskedasticity, serial correlation and cross-sectional dependence we use Driscoll-Kraay standard errors (Driscoll and Krayy, 1998). After assessing the violation of the remaining assumptions we have decided to assume also cross-sectional dependence between disturbances in the panel. Several studies show that microeconomic panels, such as ours, are likely to exhibit mutual dependence between cross-sectional units. In table 3.9 are displayed the estimation results for the FE model with

Driscoll-Kraay standard errors.

<div align="center">

Table 3.9

Estimation results (OLS estimation): *listwise deletion*

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Dependent variable: P_H	
	listwise deletion
M_{DE}	.019***
	(.004)
M_{FI}	-.0001
	(.003)
Costs1_L1	2.5***
	(.508)
Hydrogeneration	.031**
	(.013)
Nucleageneration	.194***
	(.035)
LabourCosts	.0005
	(.0003)
Income	1.30e-09***
	(1.78e-10)
Time	.00005
	(.0002)
%natgas	-.066***
	(.015)
TPA	-.004***
	(.004)
constant	.075***
	(.011)

Notes:The dependent variable is the real prices for household consumers, D^c; Driscoll-Kraay standard errors in parenthesis; ***, ** and * denote significance at the levels of 1%, 5% and 10%, respectively.

However, these results still reflect the data issues mentioned before. Namely, the endogeneity of the existence of the mergers is not solved. In fact, one may imagine that a merger is more likely on markets where prices are high. If this interaction between the existence of a merger and final price is not considered in the econometric analysis, it must be expected that the

effect of the merger on final price will be at least partly offset by the effect of the price on the existence of a merger. Therefore, the true impact may be underestimated. This economic argument may be confirmed by econometric tests such as the Durbin-Wu-Hausman test (DWH) for endogeneity. This test compares the parameters estimated by OLS with the parameters estimated by Instrumental Variables (IV) method. If there is no significant difference in the parameters, then the null hypothesis of exogeneity can be accepted and OLS can be used for estimation.

As it can be concluded from table 3.8, the null hypothesis of exogeneity was strongly rejected. Thus, consistent with the arguments previously explained, there is evidence that the endogeneity significantly affects estimates of the relationship analysed. Therefore, the coefficients on this estimation are biased and we should apply IV estimators to solve endogeneity and multiple imputation to solve the existence of missingness on data.

3.5.1 Results 1: Solving endogeneity

In this section the aim is (on a first stage) to solve one of the problems presented in the estimation results above. Given the endogeneity of two explanatory variables, M^{DE} and M^{FI}, the dummy variables for the existence of mergers, the solution is to use Instrumental Variable methods for the estimation. The instruments chosen are the three measures of toughness and effectiveness of competition authorities, as defined in section 3.4.4. We are still using the listwise deletion as the solution for the missingness of data, thus we lose 20% of our database.

We assume homoskedasticity, no serial correlation and independence across cross-sectional units in this section and in the next one. We need to mention that we acknowledge the limitations of these assumptions, but the main aim was to solve, at this stage, the endogeneity

problem, in this section, and cumulatively, the missingness problem in the next section.

In order to infer the quality of the chosen instruments it is displayed in Appendix C the first stage regressions (FE estimation) and the summary of some statistical tests for robustness of instruments. The first stage estimations, displayed in table C1 depict the significant relationship between the endogenous variables (M^{DE} and M^{FI}) and the three chosen instruments (Auth1, Auth2, Auth3). Each of the three measures of toughness of competition authorities used as instruments in our IV estimation appear as statistically significant in the first stage regressions.

Recalling the two conditions for a valid instrument we know that for an instrumental variable to be valid it must satisfy two conditions: i) instrument relevance and (ii) instrument exogeneity. Some tests have been proposed to detect the relevance of the instruments. The usual test, when we have one endogenous variable, is the F-test in the first stage. Staiger and Stock (1997) proposed a "rule of thumb" in these cases: if the F-statistic is greater than ten, the instruments are strong; otherwise, they are weak. However, when we have more than one endogenous variable on the right-hand side, as is our case, the F test and the "rule of thumb" are not good tests of relevance. An alternative test to be applied is the Anderson canonical correlations test. It was developed based on the idea that the relevance of the instruments and identification of the model are closely related. In our case, according to this test, we reject the H_0 and therefore, the instruments are relevant and are not considered weak.

The second condition (exogeneity of the instruments) for good instruments says that these variables must not be correlated with the error term in the main equation, or in other words, they have been correctly excluded from the main equation. If they have any effect on the endogenous variables on the left-hand side, that effect should occur through the effect on the endogenous variables on the right-hand side. The Sargan statistic is used to test this condition:

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if instruments are correlated or not with the error term. The null hypothesis is that instruments are exogenous. The results of the Sargan test (displayed in table C1) allows to conclude that we cannot reject the null hypothesis of exogeneity in our model. Therefore, the instruments are exogenous.

To conclude, we can reasonably verify that the variables assumed as instruments are consistent in producing robust instruments for the endogenous variables. Table 3.10 presents the fixed effect estimation of the impact of each vertical merger on final prices.

Table 3.10

Estimation results (IV estimation)

Dependent variable: P_H	
	Listwise deletion
M_{GE}	.036*
	(.0192)
M_{FI}	.072***
	(.019)
Costs1_L1	2.62***
	(.398)
Hydrogeneration	.035***
	(.013)
Nucleageneration	.229***
	(.036)
LabourCosts	.0004
	(.0003)
Income	1.56e-09***
	(2.25e-10)
Time	-.0007*
	(.0004)
%natgas	-.048***
	(.012)
TPA	.0016
	(.003)
constant	.054***
	(.019)
Nr. obser	222

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The parameter estimates with respect to the explanatory variables are consistent with the economic intuition described before. The majority of the coefficients are statistically significant, except the cost of labour and the existence of TPA. Both variables are not significant in explaining the final price of electricity for household consumers. The low labour intensity of this industry may be an explanation for the first conclusion. As it was pointed out before, the relation of the existence of TPA with the household price is related with the decreasing on the cross-subsidiarisation presented in European electricity markets: price of industrial consumers were higher in order to have lower prices for household consumers, before liberalisation. The introduction of competition may lead to a decrease on prices for industrial consumers and thus to an increase in the price for household consumers. Even if it is not significant, the coefficient assumes the expected positive sign.

The positive and significant value of the coefficient of lagged weighted generation costs confirm the expectation: an increase on thermal cost of generation is split into two parts but both have a positive impact on price. The share of hydrogeneration and of nuclear generation have a significant positive coefficient. The increase in the share of hydrogeneration in drought years (as in the period studied) may increase household prices. The same seems to happen with increases in nuclear generation share in total generation of the country.

Time has a very small negative impact on final prices, ceteris paribus, which means a decreasing time trend for household prices. This conclusion seems appropriate to support the

positive effects in the last years after liberalisation in Europe for consumers, even if the decrease in prices, *ceteris paribus*, is not very large (it amounts to less that 1cent€).

With respect to the effect of the existence of a merger between a natural gas supplier and an electricity generator, the main aim of our research, the estimated coefficients (of M^{DE} and M^{FI}), seem to show that these events increase the final price for household consumers. The coefficients suggest that the final price of electricity for households in Germany after the merger is nearly 4cent€ higher than the price before the merger, holding the other independent variables constant. In what concerns Finland, the results seem to allow to conclude that the vertical integration increased the household prices around 8cent€. Therefore, the existence of the cross-sectorial integration, as defined for our study, has a detrimental effect on household consumers, ceteris paribus. So far, consumers should be concerned if the wave of mergers of this type are not reduced by competition authorities.

For the estimated results above we still apply listwise deletion to solve the data missingness. The significant lost of data may result in ignoring useful information from nonmissing regressors and may produce biased inferences. The estimators obtained with such a method have been proved to be biased if the data remaining after deletion is not a random sample of the overall database and may lead to serious biases in variances and covariances and therefore to biased conclusions.

3.5.2 Results 2: Solving endogeneity and existence of data missingness

In order to avoid the above mentioned consequences it is essential, at this point to solve the problem with a more efficient solution. Consequently, we implement a two-step multiple imputation algorithm developed by Rubin (1987) and Schafer (1997). Multiple imputation has been

shown to reduce bias and increase efficiency compared to listwise deletion.

The choice of number of imputations is the first important choice in this method, and we have used several alternative number of imputations (m). The results allowed to conclude that the appropriate number of imputations (m) for our database is 5. In the first stage of this method, multiple imputation for each missing value is created, resulting in multiple data sets, each with 273 observations and different imputations for the missing data. Then the 5 imputed datasets are integrated into a final result using Rubin's rule.

Amelia II (Honaker et al, 2011) was used on R to perform the multiple imputations and draw imputations of the missing values using a novel bootstrapping approach, the Expectation-maximisation with bootstrapping algorithm. The EM algorithm (Dempster, Laird, and Rubin 1977) is a simple computational approach to find the mode of the posterior. This method combines the classic EM algorithm with a bootstrap approach to take draws from this posterior, which gives fundamental uncertainty too. The algorithm draws imputed values from each set of boostrapped parameters, replacing the missing values with these draws.

After having the five imputed datasets, we use IV estimation method in order to solve also the endogeneity problem found. The first stage results of IV in appendix C, on table C2, support the relevance of our instruments. The coefficient of the three instruments are statistically significant in almost all estimated equations in the first stage. This allows to generalise the conclusion on the relevance of the instruments. The results seem to show the significant relationship between the endogenous variables and the three chosen instruments.

In order to evaluate the quality of the instruments, we search for two answers. First, can we be reasonably satisfied that the instruments have adequately identified the reduced form equation? Both Anderson and Cragg-Donald Wald statistics suggest that we can comfortably

reject the null hypothesis of underindentification of the model. The reduced form price equation is identified in that the excluded instruments are correlated with the endogenous regressors. Under the null hypothesis, the instrument is valid, thus uncorrelated with the error term. Since the Sargan statistics amount to more than 1 for all imputed datasets with higher p-values, the null hypothesis that the instruments are valid is not rejected.

The second question to be answered is if we can reject the null hypothesis of weak instruments. Once again, since we have more than one endogenous variable, the F-statistic of the first stage for both variables do not verify the "rule of thumb". Using the alternative, the Anderson canonical correlations test, we may conclude that we reject the H_0 and therefore, the instruments are relevant. Therefore, after conducting all these tests we are confident to apply IV setting to our specification of price equation and conclude from the estimation results.

Table 3.11 reports the fixed effect estimated coefficients for the reduced form of the final price equation for household consumers. The results presented consider the endogeneity of the merger dummy variables and after using multiple imputation to solve the missingness of data problem.

Table 3.11

Estimation results (IV estimation)

Dependent variable: P_H	
	Multiple Imputation
M$_{GE}$	.072**
	(.025)
M$_{FI}$	.050*
	(.020)
Costs1_L1	.872*
	(.400)
Hydrogeneration	.052***
	(.0147)
Nucleageneration	.177**
	(.055)
LabourCosts	.001***
	(.0003)
Income	1.5e-09***
	(2.6e-10)
Time	-.001*
	(.0004)
%natgas	-.077***
	(.012)
TPA	.0087*
	(.004)
constant	.036
	(.020)
Nr. obser	273

Notes:The dependent variable is the real prices for household consumers, D^c;Corrected standard errors in parenthesis; ***, ** and * denote significance at the levels of 1%, 5% and 10%, respectively.

All explanatory variables are statistically significant and confirm the economic reasoning. The values presented are similar to the estimation of the section before. The main difference of solving the missingness of data are the dimension of the coefficients as they keep the same signal as before with listwise deletion. The coefficients that were before negative are still negative in the new estimation and the ones that were positive are still positive. In conclusion, the direction

of the effect of those explanatory variables on final prices did not change with this estimation refinement, thus, the explanation of the effect of each variable on final prices for household is similar to the one exposed in the section before.

In what concerns to the main objective of our research, to answer the question whether European households should be concerned, our focus goes, once more to the coefficients of the merger dummies. The evidence suggests that both mergers have a positive and statistically significant effect on final price for households consumers in each country, meaning that the vertical integration seem to cause an increase in final prices and represent, ceteris paribus, a detrimental event for German and Finish household consumers. The coefficients suggest that the final price of electricity in Germany is 1.8% higher than the price that would be if there were no cross-sectorial merger, and in Finland the price seems to be around 2% higher due to the merger. These values are evaluated at the mean price.

In conclusion, the approval of these events, even if some of them were controversial (namely the Eon-Ruhrgas merger), seem to be non beneficial for household consumers, due to an increase of prices. In fact, it seems that it would be better for them if the events had been blocked by the competition authorities.

3.6 Conclusions

The path of the EU towards a single, competitive European Energy market is being followed closely by a wave of mergers in electricity and gas sectors. The ones involving either firms in the electricity and gas sectors had particular (mediatic) attention and regulation concerns.

This chapter contributes to the existing empirical literature on the effects of vertical integra-

tion on economic outcomes, by providing evidence on how some behaviour of firms may affect final consumers, namely on energy sectors. The main objective of this chapter is to assess the effect of vertical integration between electricity generators and natural gas suppliers on final prices of electricity for household consumer. To study this issue, we formulate and estimate a reduced model of the determinants of final price of electricity in several European countries. This question was answered based on panel data from 13 European countries for 21 semesters, from the beginning of the liberalisation process between 1997 and 2007.

We encounter two main issues to be addressed: data missing and endogeneity of our explanatory variables of interest. An additional aim of this chapter was to apply solutions for these problems that are proposed in other empirical research. Due to the sparse data and missing observations that do not match up across our various variables, we have used multiple imputation techniques developed by Rubin (1987) and Schafer (1997) to estimate the effects of the cross-sectorial mergers on household consumers through the impact on final prices of electricity.

From the results and conclusions of this chapter we can summarise three main findings. First, we found that the existence of a vertical merger between an electricity generator and a natural gas supplier seems to increase in average the final price of electricity on markets where it occurs. The comparison of prices before and after the merger for each country where it occurs allows to conclude for the negative impact of these events on market outcome. Second, we found evidence that any household consumer in Germany pays a price for their electricity 1.8% higher because there was the merger between EOn and Ruhrgas. It is worth mentioning that German competition regulators found, during their assessment, reasons to block this merger. However, it was authorised by the Government based on the interest to create a national champion. Third,

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even in Finland, where the merger was not controversial, because it involved public firms, the effect on prices was equally detrimental to consumers. Household prices after the merger are around 2% higher than they would be without the merger between IVO and NESTE.

The values found are very similar, even if we recognise the fact that the impact of vertical integration may differ across countries due to the features of the country and the features of the merger itself. It may be true that these values are not very high, but it may be a reason of concern for European household consumers or association of consumers and to call the attention of competition authorities to this type of vertical integration and their effects on consumer welfare. The idea that the approval of a merger of this type, by a national or European regulator, may affect negatively their prices may be a warning for consumers to be more aware of these events in the future. The main concern of competition authorities should be consumers welfare and, in energy sectors, it should be a priority to act in favour of achieving all benefits from liberalisation and integration of European markets. This is a working process and all the actions should be made to improve it.

The research does, however, have a number of limitations which we acknowledge. To begin with, the small size of our sample may have been determinant on some of the results. The energy data available for all European countries is still very scarce. In the future, perhaps it will be possible to infer more clearly these effects and others, due to more availability of comparable data. Nevertheless, our results and conclusions could be valid to help the awareness on this subject.

Some of the assumptions made may be relaxed on future research, as for example how the results would change if we assume that the impact of vertical integration on market outcomes may have different effects depending on time from the event. We do not consider also in

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our analysis the long-run perspective, leaving out of the research some efficiency effects on the operation of the merged firms that may represent benefits for consumers that are not considered in our conclusions.

Our research and its results lead also to other questions that would be interesting to analyse. Among possible directions for further research is the assessment of the features of cross-sectorial mergers that increase the probability of detrimental impact on market prices. The research may also be extended to the approach to other aspects of electricity markets such as, available quantities or prices for other customer groups which may also be affected by the change in

market structure. From these answers it could be easier to assess merger events in energy markets based on known features more prone to create negative effects, not only for consumers, but also for all market participants.

Chapter 4

Conclusions

The aim of the thesis was to assess the effects of some identified obstacles concerning the reestructuring (liberalisation and integration) of the EU electricity market.

First, we present and analyse the progress on the liberalisation and integration of electricity markets in the EU with an overview of the assessement made by the the economic literature in the achievements (effects) and obstacles of the process.

We use this perspective to identify some important obstacles and concerns on European electricity markets, namely the exercise of market power and concentration, vertical integration and unbundling and finally, the lack of interconnection capacity and congestions. All the obstacles mentioned in the first chapter are connected. The common factor to all of them is the impact on the exercise of market power. The consequence of not overcoming these obstacles is to increase, or at least not decrease the exercise of market power.

The solutions presented are mainly proposals for improvement of the European market design in order to find the best framework that guarantees competition, efficiency and integration in electricity markets. The example of the Nordic integrated market should be used as a guide

for European choice due to the success achieved with the restructuring process.

Despite all the solutions proposed by economic experts and implemented, we can conclude, from our review, that liberalisation and integration of European markets are still far from the end. The several obstacles are not only impeding the creation of an efficient, competitive and transparent Single market for electricity, but also and mostly, are impeding that market players may take all benefits from the introduction of competition and integration.

In the last two chapters the focal point was to assess empirically the effect of two identified obstacles on market players. The first was the exercise of market power and to verify if the integration may change this main feature of electricity markets or it is not enough to prevail over it. The last chapter was about a recent barrier that is a result of the evolution of energy markets: the cross-sectorial mergers. These events may delay free competition in electricity and natural gas markets and impede that benefits of reestructuring may be passed on to final consumers. A merger between a natural gas supplier and a generator of electricity can also be seen as an attempt to exercise market power or to improve this capacity.

In what concerns the presence of market power, from all the results, it seems that it decreases after the integration. We found evidence from the simulation of one of the European regional markets, the MIBEL. Nevertheless, the existence of market power would keep being a feature of the market after the integration. Consequently, the benefits from market integration would not be fully achieved due to this obstacle.

The assessment on MIBEL follows the growing importance of these sub-markets on the regional approach to the achievement of the SEM, implemented by the EC. On the assessment of who benefits and who does not with the integration the conclusions are as expected. Both countries benefit from it, but Portugal is the country that would take more advantages, both

by their consumers if the effect on wholesale prices will be passed on to final prices, and by the main incumbent generator. These results are partially in line with previous findings where the .country whose prices are higher before the integration sees the prices decrease and will have more benefits with full integration. The conclusions on the increase of market share from the Portuguese incumbent are, however, more unexpected, since marginal cost of generation are, in reality, higher in Portugal. This evidence is due to the assumption of zero marginal cost for hydro resources taken in our model.

A cross-sectorial merger, when not associated with cross border acquisition, may be understood as an obstacle for the achievement of the full benefits of liberalisation and integration if it has a detrimental impact on prices. Our results support this argument by showing evidence that household consumers in countries where these mergers occur pay a higher price than they would otherwise. This was the case for Germany with the merger between EOn and Ruhrgas and for Finland, as a consequence of the merger between Neste and IVO.

The choice of this particular type of merger (cross-sectional) is justified by the importance of the effects of these events in both energy sectors. A vertical integration between a natural gas supplier and an electricity generator may expand the exercise of market power to both markets. The interventions of competition authorities (national or European) in these cases have been deeply criticized and our results may reinforce this criticism and call the attention for the essential investigation of merger events on energy markets and their effects.

The main conclusion from all chapters of this thesis is the support of the existence of several obstacles delaying the attainment of all benefits from liberalisation and integration in Europe, namely the persistence of the exercise of market power and the reality of some strategies from market players to increase it as the cross-sectorial mergers.

The exercise of market power in the European electricity markets has been a major concern since 1996 and mentioned in all EC reports. In all subsequent legislation on electricity markets there are several attempts to find new policies to overcome this problem. The main idea is not to have a European market without market power, because this is common to many other markets, it is just to decrease this power.

The expansion of interconnection capacities between European countries or regions is always the best policy suggestion to limit market power in a larger market as the EU. The increase in the degree of integration between neighbouring markets will enhance competition. However, in the EU, the expansion of interconnection capacity is slow, due to the wrong incentives for the investments.

A set of new European directives with common rules about expansion of interconnections and with effective implementation is the right way. Only with the increase of these capacities the IEM can be achieved and with it the EU may solve all the problems related with market power: lower competition, risk of market abuse and collusion.

The main drawback on our research was the availability of data. Our choice for the application on the Iberian market was motivated for the inexistence of research on this topic. However, the effective creation of the MIBEL was in 1997 and this caused some problems to collect the data. We found similar problems for the study of the cross-sectorial mergers, due to our aim of studying the effect on final consumers. The consequence in both cases was to have small databases. However, the main contribution of our research is not the quantitative results found but the qualitative suggestions on the effects of some obstacles on final consumers in the European integrated market. In both cases it was possible to find ways of ovecoming these difficulties, but the results and conclusions would be better, as happens with all empirical

applications, if there was more data available.

For further research it can be mentioned an extension of the model applied to the MIBEL, considering dynamic elements as the possibility of entry and exit of firms after integration, the changes on demand specification after integration and the change on production capacity through time. Moreover, the importance of cross-ownership between firms calls also for an extension of our model, considering interdependence between firms.

With respect to the impact of mergers on market outcomes, our future research should include assessing the effects on other consumers (for example industrial consumers) or the effects on electricity available in the market. The second extension would be to relax the assumption of isolated effects of the mergers on the country where the firm is incumbent. The increasing integration of the European market calls for the relaxation of this assumption in order to find more realistic conclusions.

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Appendix A

Data sources

The model was estimated using real demand and cost data and it was based on historical data on plant costs, capacities and technological characteristics of generating units.

Generation Firms Data

Plant status and capacities by source were obtained in firms reports and cross checked with Reports from national electricity regulators (ERSE and CNE). For the Portuguese generators we use data supplied by EDP and in Spain the data was collected from the Boletin estadistico released by REE.

Available capacities were derived using the total outage rate (planned and forced) assigned to each source of electricity generation for the two chosen months (June and December). We have used the outage rate of 2005 because it was the only one available. In case of unavailable data we consider the average outage rate for each type of source. The capacity of each source was re-rated using an availability factor that accounts for forced outages of power plants as follows:

$$\text{Plant availability factor} = \text{1-forced outage rate}$$
$$\text{Plant's available capacity} = \text{installed capacity} * \text{available factor}$$

Cost of thermal generation sources were derived using data on theoretical full capacity heat rate and fuel cost projections. Heat rate of a power plant is its design parameter and should not change significantly within a short period of time.

The data on fuels cost are collected from the annual reports of the electricity regulator and from the generation firm's reports. To these fuel costs we added variable operating and maintenance costs taken from Annual Reports released by the generators.

We will use the data released by the Foro de la Industria Nuclear Española. We use an estimation released by the Foro Nuclear for marginal cost for nuclear power plants. The data that was available is for the year 2003. What we did was to update these costs with the annual growth rate from 1999 to 2003. The method used by the *Foro Nuclear* to determine the marginal cost for nuclear is the same described above for the thermal generators plants.

Special generators are considered as base load due to the existence of law enforcement that obliges buying all the production from this kind of generators.

Demand Data

Monthly loads and load shapes were provided by EDP (for Portugal) and by OMEL (for Spain). For Spain we have access to all the data related with the wholesale market (spot and intra-daily market): prices and quantities bid for each firm, marginal price and total quantity traded in the market. For Portugal we have data on hourly demand and for the price we use average price of acquisition of energy through the energy acquisition contracts (EAC).

While there is a continuum of demand states that arise over time, the analysis is simplified by considering only 2004 demand figures for four periods, corresponding to different hydro conditions.Aall days chosen are Wednesday, a typical day to be studied due to the behaviour of load diagrams. In this study we use two hour time blocks for each typical day: peak, off peak 1. The time blocks were chosen according to the Spanish definition.

Appendix B

Marginal Cost Curves

Figure B1

Marginal Costs of fringe firms in Portugal, Spain and MIBEL, December 2004
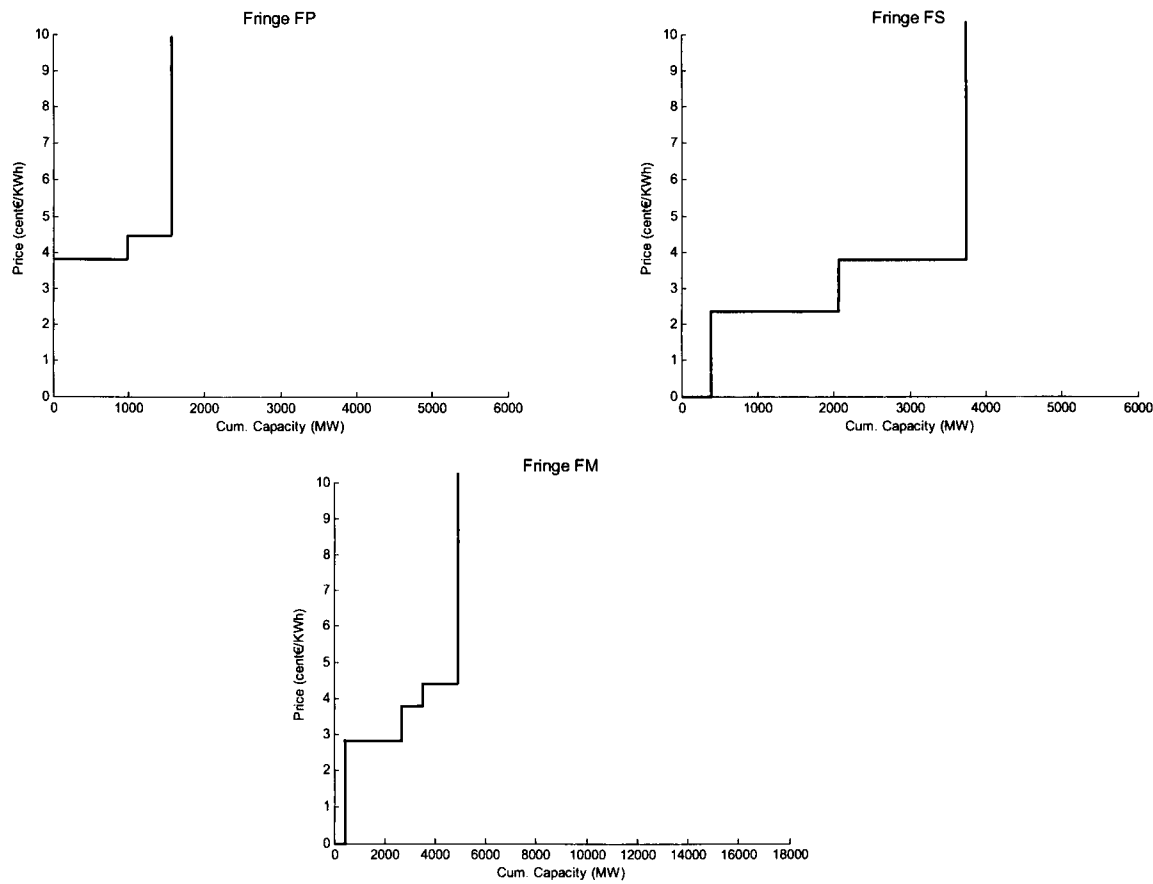
Marginal Cost Curves for P1 in Portugal, December 2004
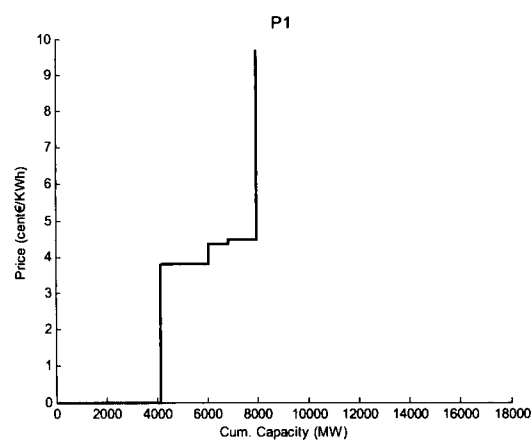
Marginal Cost Curves of Cournot generators (S1, S2, S3, S4) in Spain, December 2004

Appendix C

First stage estimation results and robustness tests

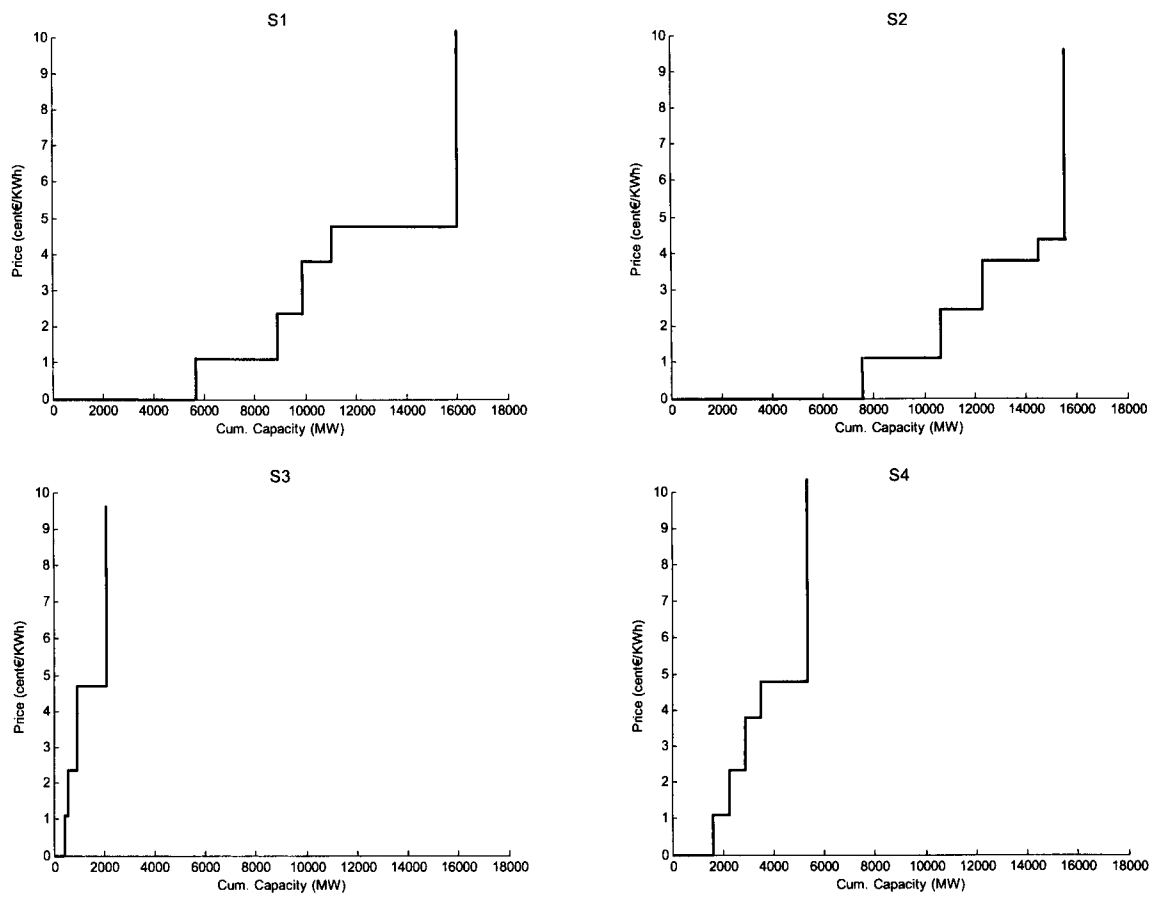This appendix reports the first stage regressions and the statistical tests for robustness of instruments for all models used.

Table C1

First stage estimation

IV estimator, listwise deletion (within estimator) and robustness tests for IV

Dependent variable: M_{FI}	FE	Dependent variable: M_{DE}	FE
Costs1_1Lag	-2.931	Costs1_1Lag	-6.03
	-5.820		(6.59)
Hydrogeneration	-.015	Hydrogeneration	.014
	(.177)		(.201)
Nucleageneration	-.399	Nucleageneration	-1.03*
	(.491)		(.555)
LabourCosts	.002	LabourCosts	-.009***
	(.003)		(.004)
Income	-2.65e-09	Income	-4.80e-09
	(3.19e-09)		(3.61e-09)
Auth1	.007	Auth1	.273***
	(.075)		(.085)
Auth2	.024	Auth2	-.212**
	(.074)		(.083)
Auth3	-.104***	Auth3	-.022
	(.027)		(.031)
Time	.004	Time	.01351***
	(.004)		(.004)
%natgas	-1.62	%natgas	.0119719*
	(.175)		(.199)
TPA	-.056	TPA	-1.02*
	(.049)		(.055)
constant	.221	constant	.887***
	(.197)		(.223)
F	2.83	F	4.78
prob	(.002)	prob	(.000)

Robustness tests

Anderson canon. corr. N*CCEV LM statistic	Chi-sq (2) =8.80	
	p-value= .0123	
Sargan test	Chi-sq(1) = 0.909	
	p-value = .3405	

Notes:Standard errors in parenthesis; ***, ** and * denote significance at the levels of 1%, 5% and 10%, respectively. Include country dummies.

First stage estimation for the five imputed datasets
IV estimator, multiple imputation (within estimator)

Dependent variable: M_{DE}	FE				
	m=1	**m=2**	**m=3**	**m=4**	**m=5**
Costs1_1Lag	-3.295	-2.67	-2.527	-2.519	-1.86
	(4.799)	(4.702)	(4.74)	(4.59)	(4.572)
Hydrogeneration	.022	.059	.029	.031	.036
	(.175)	(.175)	(.175)	(.175)	(.175)
Nucleageneration	-.796*	-.480	-.622	-.930*	-.804*
	(.464)	(.404)	(.433)	(.485)	(.470)
LabourCosts	-.008***	-.007***	-.007***	-.006**	-.007***
	(.003)	(.0026)	(.003)	(.002)	(.003)
Income	-3.61e-09	-3.94e-09	-3.90e-09	-3.46e-09	-3.25e-09
	(3.01e-09)	(3.01e-09)	(3.01e-09)	(3.02e-09)	(3.02e-09)
Auth1	.244 ***	.234***	.23***	.246***	.236**
	.072	(.072)	(.072)	(.072)	(.072)
Auth2	-.206***	-.195***	-.193***	-.210***	-.202***
	.069	(.069)	(.069)	(.069)	(.07)
Auth3	-.022	-.023	-.0242	-.023	-.022***
	.026	(.026)	(.026)	(.026)	(.026)
Time	.01 ***	.010***	.010***	.009***	.009***
	(.003)	(.003)	(.003)	(.026)	(.003)
%natgas	.0616	.08	.039	.044	.032
	(.147)	(.148)	(.147)	(.147)	(.147)
TPA	-.096**	-.098 **	-.096**	-.089**	-.094**
	(.044)	(.044)	(.044)	(.003)	(.044)
constant	.708***	.589 ***	.640***	.677***	.678***
	(.177)	(.160)	(.169)	(.175)	.176
F	4.76	4.52	4.59	4.63	4.64
prob	.000	.000	.000	.000	.000

Notes:Standard errors in parenthesis; ***, ** and * denote significance at the levels of 1%, 5% and 10%, respectively.; Include country dummies on estimation.

Dependent variable: MFI			FE		
	m=1	m=2	m=3	m=4	m=5
Costs1_1Lag	-1.35	-1.27	-1.27	-.629	-1.51
	(4.43)	(4.322)	(4.372)	(4.222)	(4.211)
Hydrogeneration	-.029	-.025	-.026	-.028	-.030
	(.161)	(.161)	(.161)	(.161)	(.161)
Nucleageneration	-.248	-.172	-.226	-.249	-.253
	(.429)	(.371)	(.399)	(.447)	(.433)
LabourCosts	-.0005	-.001	.0004	-.001	-.0006
	(.0024)	(.002)	(.002)	.0023	.0025)
Income	-3.26e-09	-3.32e-09	-3.36e-09	-3.18e-09	-3.24e-09
	(2.78e-09)	(2.77e-09)	(2.77e-09)	(2.78e-09)	(2.78e-09)
Auth1	-.010	-.012	-.011	-.011	-.0114
	(.066)	(.066)	(.066)	(.067)	(.067)
Auth2	.049	.053	.048	.05	.050
	(.064)	(.063)	(.064)	(.064)	(.064)
Auth3	-.106***	-.106***	-.105***	-.106***	-.106***
	(.024)	(.024)	(.024)	(.024)	(.024)
Time	.007**	.007**	.006**	.007**	.007**
	(.003)	(.003)	(.003)	(.003)	(.003)
%natgas	-.15	-.145	-.151	-.148	-.153
	(.136)	(.137)	(.136)	(.135)	(.136)
TPA	-.047	-.048	-.048	-.046	-.047
	(.041)	(.041)	(.041)	(.041)	(.041)
constant	.249	.25*	.204	.28	.26
	(.163)	(.148)	(.156)	(.161)	(.162)
F	4.14	4.15	4.13	4.16	4.15
prob	.000	.000	.000	.000	.000

Notes:Standard errors in parenthesis; ***, ** and * denote significance at the levels of 1%, 5% and 10%, respectively. Includes country dummies.

Table C3
Summary of statistical tests for robustness of instruments
(IV estimators and multiple imputation)

Statistics		m=1	m=2	m=3	m=4	m=5
Test of excluded instruments						
M_{DE}	F(3,249)	4.18	3.88	3.79	4.22	3.91
	Partial R- Squared:	.048	.045	.044	.048	.045
M_{FI}	F(3,249)	6.73	6.77	6.55	6.79	6.75
	Partial R- Squared:	.075	.08	.073	.076	.075
Underidentification Test:						
	Anderson Chi-sq. (2)	9.86	9.4	9.2	9.69	9.61
	p-value	.007	.009	.01	.008	.008
	Cragg-Donald W chi-sq (3)	10.25	9.75	9.54	10.06	9.98
	p-value	.006	.008	.009	.007	.007
Weak Identification Test:						
	Cragg-Donald Wald test					
	F-stat	3.27	3.11	3.05	3.21	3.19
Weak-instr-robust inference						
	Anderson-Rubin Wald test					
	Chi-sq(3)	23.46	25.68	24.53	23.03	24.34
	p-value	.000	.000	.000	.000	.000
Overidentification test						
Sargan Statistic Chi-sq (2)		1.692	2.483	1.685	1.652	1.321
	p-value	.193	.115	.194	.199	.251