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European Energy Market Integration: Efficiency Improvements in Electricity Producing Firms

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Abstract: In this paper, we review and use different methods to measure and compare efficiency scores in energy producing plants. In particular, we use non-parametric and parametric techniques. We focus our attention in electricity producing power plants on eighteen European countries, as well as in thirty energy systems as a whole. This paper also state some results such as that efficiency has widely improved in the period studied, but these positive results are not homogeneous among energy systems or firms. We present some evidence that the greatest part of energy improvement is the consequence of the technological shift and is not necessarily due to alternative factors, such as market integration, increasing competition, or other firm-level decisions.

JEL Codes: Q40, G14, Q41, Q48.

Keywords: Market integration, Efficiency, Data Envelopment Analysis, Energy Market, Europe, Industrial Organization.

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1. INTRODUCTION

Over the last few decades, the energy sector in nearly all countries, and particularly in Europe, has experienced a group of reforms; these reforms attempt to cope with three main aspects of the energy-producing firms: security of the supply of raw materials, the control of shocks in prices, and efficiency improvements of firms in the energy sector. In this paper, we explore the latter aspect, and in particular weather market integration has exerted a relevant effect on the efficiency improvement of the energy producing firms and power plants. We review different methods of measurement that have been proposed in the literature, discuss the differences in the results obtained when applied in different studies and, finally address improvements in efficiency that might be directly related with the integration of energy markets in Europe or alternative phenomena. While efficiency improvements have been pointed out as one of the main objectives in the design, development and deployment of European reforms in this sector, we think that the greatest part of improvements can be better identified with other causes such as technological shift or new energy generation methods. Better identification of factors and their consequences is crucial to cope better with further reforms and policy design.

In particular the European Union began this process of energy markets reform in 1988 with the publication of the "White Paper of the European Commission on Interior Market Construction". The idea behind this white paper was that any European citizen might purchase energy from any European provider, regardless of who owns the transport grid. However, it was not until 1992, with the Treaty of Lisbon that the entire process started with the setting of four basic goals: 1) improve assurance of the supply; 2) achieve lower prices for final consumers; 3) improve environment-friendly practices and; 4) improve efficiency of firms through energy savings. From the very beginning, the process was designed in different stages, with the third stage bargained among European Union (EU) members along the 2007-2009 period; from that juncture, a compliance period was also designated until 2011 (Eikeland, 2008).

As stated previously, in this paper we focus mainly in the fourth of these goals, that is, the efficiency improvement of the energy-producing firms. In order to do this, we propose a two-fold research question: Under what conditions do the efficiency of electricity-producing firms improve? And to which factors may we attribute the greater part of this improvement?

We discuss briefly the methods used to assess efficiency, its advantages and flaws but most importantly, we conduct a two-step empirical analysis, first with a data set at country level and secondly, with a different data set at firm level. In this manner we first sought the most efficient countries within the European countries and afterward we were also able to look for the progression of energy producing firms in Europe.

Our general hypothesis is that efficiency has improved greatly in the last fifteen years, but that there are important observations to conduct with regard the main factors of this improvement. We present such concerns in the form of three particular hypotheses: first, with respect to what concerns overall improvements (at the country level), the improvements are the consequence of a more diverse energy mix; second, a large proportion of the inefficiency detected in the less efficient countries is caused by installed but unused capacity and not only by technical inefficiency; and third, in terms of what particularly concerns energy producing firms, we think that a greater part of their improvement is due to technological change (use of better technologies) and not only to increasing competition due to energy market integration, either at the regional or the European level.

For the development of our work we set four objectives clearly differentiated: We first describe the most frequently employed measures of efficiency evolution in different companies and, in particular, energy-producing firms. After this, we introduce the type of methods that are currently utilized to assess efficiency, and secondly we discuss some advantages and drawbacks of the different measures and indicate two of the best methods that we will use on the empirical part of our work.

The third objective of this paper is to focus in the empirical data that will allow us to compare different methods, rank the different countries and energy-producing firms and assess the more likely cause of energy improvements.

As a fourth objective we will contrast our results with the expectations at the beginning of the reform of the energy sector and the electricity-producing firms in particular.

The rest of the paper is organized as follows: in section two we will describe and set up the subject of the paper, stressing the relationship between the construction of a single energy market and efficiency changes in Europe. In section three we will talk about the methods regularly used to disentangle the kind of problems we present and we will point out a couple of those (Data Envelopment Analysis and Stochastic Frontier Analysis) that we will use in the applied section. Section four is devoted to explicit our plan, how we will proceed and what data we will use, at country and power plant level. The fifth section of this paper is the summary of the results we obtained at both levels of analysis and with all the tools we used. Finally, the sixth and last section is devoted to state our conclusions.

2. SINGLE MARKETS AND EFFICIENCY

In economics it is a well-known result that openness and integration of markets can lead to a series of results among which we can find the increasing efficiency of the firms operating in the area to be integrated (countries, regions, etc.). Improvement in efficiency is not the sole result, it is clear that there are some additional positive results as well as negative ones. In this section of the paper, we will mention all of these, but we will extend some more in the efficiency effect.

When European policy-makers first conceived the creation of a single market, they were thinking mainly of this tool as a trade enhancer among European Union members. But as expected, while constructing this single market, they had to assess other positive outcomes and all negative ones. In addition to efficiency improvements, we have also mentioned gains in trade volume, increasing competition (thanks to what we can expect in terms of prices cuts, technical improvements, and efficiency gains), the exchange of ideas and production methods, due to increasing commercial exchange, can also be an innovation enhancer, and finally, there can be policy making synergies thanks to sector spill-overs. With respect to energy policies, these spill-overs can affect environmental policy or higher education.

In what concerns the negative outcomes that can occur, we can first point out trade diversion losses from third parties of the new (more) integrated area as trade increases among partners, third parties may lose terrain. Synchronizing policies with one's partners and tightening the scope of your possible decisions with those of the group might be observed as sovereign cost and cause controversy within countries. A different type of cost is that described as subsidiary costs, which are those created due to the obligation of complying with some policies not well fitted to local needs

(wearing a uniform can be useful, but it does not fit all bodies or situations). Finally there are the costs of the process, while there might be some that are paid for only once (new energy lines, costs of adaptation, etc.), there are some costs that, once created, must be paid regularly (costs of new authorities, new maintenance costs, etc). All these costs and benefit evolve in different ways as integration towards a single market advances, but in the following paragraphs we will focus solely in how efficiency improves and the tools employed by European countries to construct the single energy market.
The basic tool-kit of European single market construction might be easily simplified, but is extremely more complex than what we describe here. The first type of tools are those of the construction of any free-trade or custom area, which comprise eliminating internal tariffs and imposing tariffs on third parties, and of course, depending on the degree of integration, tariffs can be blurred or completely eliminated and third parties tariffs can apply to all or a group of country members. The signing of and compliance with different European Treaties comprise one of the main tools; nearly all, if not all, EU treaties contain some new rules to intensify the integration of European countries, mainly with respect to free movement of goods, services and production factors (capital and labour). Compliance with European treaties and directives often requires mutual recognition of other member states laws and norms, in addition to pronounced coordination and harmonization of rules and institutional structures such as unbundling of vertical integrated energy firms or re-structuration of member state energy markets. It is quite common that the EU directives contain some suggestions for adapting member states ways to the best practices, but it is also true that the Nation-State has proven to be way more resilient than what is usually thought.
Because there is a positive and a negative side of the integration of markets, there is a trade-off; thus there must be an optimal outcome, where there is no possibility of improving without becoming worse in at least one aspect. While it is good to know that there might be an optimal point and that it is possible to reach it, for our purposes it is primarily important to asses such optimal point in what concerns to efficiency as well as it is important to know whether we are heading toward it, that is, whether efficiency has really been improving and if such an improvement can be attributed to the creation of the European single energy market.

3. METHODS AND PROCEDURES

3.1 Overview of current methods

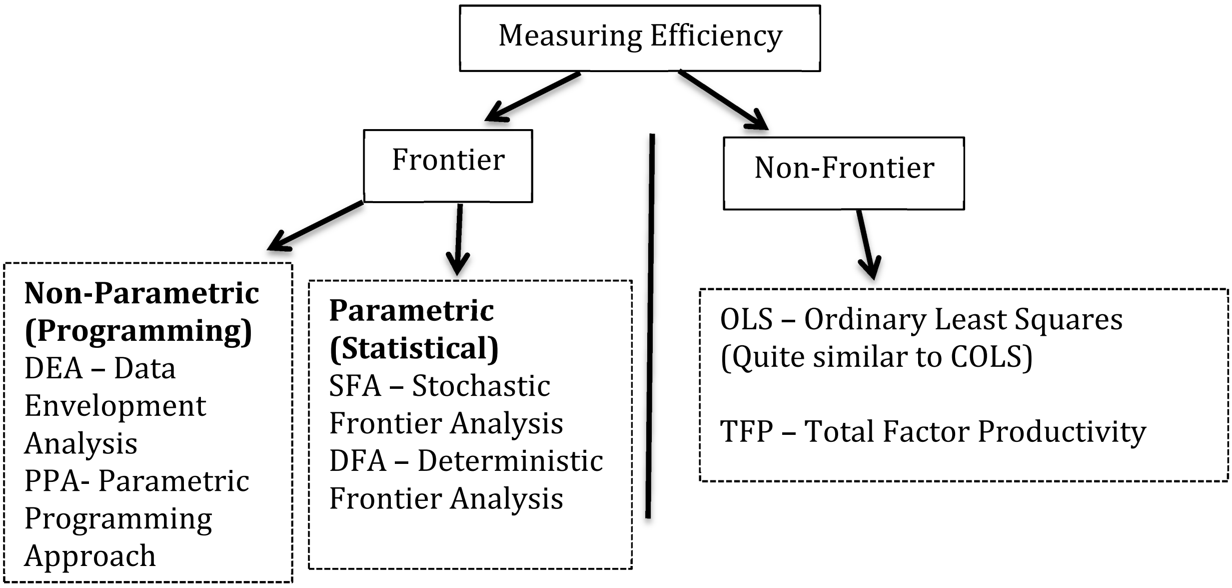
The literature in what concerns to measuring the efficiency of firms is abundant, and it can divided it in two main groups; first the so called non-frontier approach, that basically consist in estimate a cost function without a stochastic component for inefficiency and thus it is assumed that all firms operate in the cost frontier. Once the cost functions have been estimated it is possible to calculate the inefficiency of scale and scope of the companies (Mehdi & Filippini, 2009; Jamasb & Pollit, 2001; Jamasb & Pollitt, 2003). The most common methods of estimation of these cost functions are Ordinary Least Squares or Total Factor Productivity techniques. Both of these techniques use a mean or an average performance of companies to compare all firms and that is why this group is also known as the average performance approach.
The second part of the literature is the Frontier approach, which assumes that the full cost efficiency is limited to those companies that are identified as the best-practice producers (Mehdi & Filippini, 2009). It is also assumed that the rest of companies in

the sector produce at higher costs and thus the inefficiency is higher than zero. In this case, it is possible to measure not just the scope and scale inefficiency but also the cost inefficiency. In what concerns to the estimation methods, this second group can be also divided in two different categories that are the non-parametric and the parametric methods. In the first one we can find the Data Envelopment Analysis, which is a linear programming method; while in the second category we can find the Deterministic Statistical Frontier Analysis method or the Stochastic Frontier Analysis that both are statistical approaches (Jamasb & Pollitt, 2003; Pollitt, 1995). In the figure 1 we present a scheme of the literature and below we describe the most relevant ones.

All these methods of measuring efficiency of different firms or DMUs (Decision Making Units) have been developed with a main objective, that is, help regulators to promote efficiency improvement by rewarding good performance relative to some pre-defined benchmark (either a frontier or a mean).

It is also true that several scholars trying to acknowledge the efficiency of different firms have used all these methods. In particular we would like to call the attention over two particularly relevant studies.

Fig. 1



The first one of these studies was conducted by Pollitt (1995), and it analyses the technical productive efficiency of an international sample of electric power plants. The data Pollitt uses in this study is an international sample of power plants (rather than firms) and it uses different methodologies, like Stochastic Frontier Analysis, Data Envelopment Analysis and other, to acknowledge for what is called a "methodological cross-checking". Nonetheless, one of the main objectives of this study is to identify differences in efficiency of public and private owned power plants and this constitutes one of his main results (he actually finds that there are no significant differences in the performance of plants regarding if it's publicly or private owned). Other significant results are the comparison of alternative methods like DEA and Parametric Programming Approach, where the former gives a better approximation of the actual frontier; regarding non programming techniques, the Stochastic Frontier Analysis results more efficient while estimating the frontier

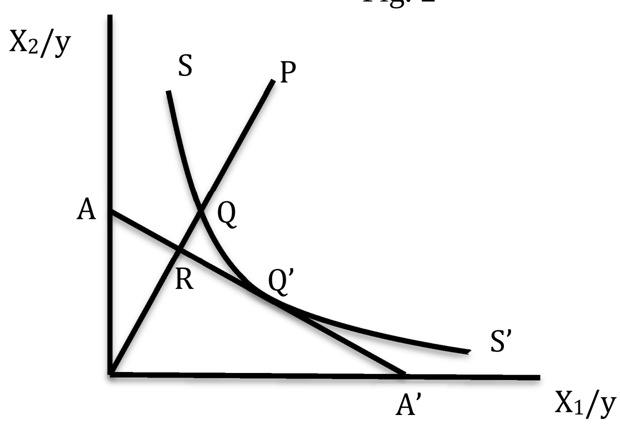
function while the DSA Deterministic Statistical Frontier Analysis (DSA) performed worst with Pollitt's sample.
The second one, is that conducted by Førsund and Kittelsen (1998), they use a Malmquist index to study shifts in frontier technology and change in efficiency for Norwegian electricity distribution utilities. They found a positive productivity growth, averaging 2% per year, but also that this change is mainly due to the shift in technology frontier. Even when they offer quite interesting and relevant results, they use data for only few years and they account the increase for distribution firms while we plan to do so for electricity producing plants.

3.2 Selected methods

Our toolkit consists of three basic applications; we decided to keep these instead of other available ones because of a number of reasons, among which we might mention simplicity of calculation, alternative experiences of implementation with which we could compare to and finally, our opinion about the flaws of some of those methods. This way, we are sure that we will use the best methods and the best fitted to get the answers we are looking for. In the following sections then we will detail how the methods we selected works, mainly Data Envelopment Analysis (DEA) and Stochastic Frontier Analysis (SFA) put the focus on the performance of firms and the evolution of the best performers and the firms that follow the lead, whereas we decided to include the Malmquist index in order to assess the factors to which we should attribute the changes in efficiency.

3.2.1 DEA - The first of all methods we would like to comment is the Data Envelopment Analysis (DEA). This method was first developed by Farrell (1957) and somehow retaken and further developed by Coelli (2005). With their examples we will illustrate how it functions assuming a set of firms that use two inputs x_1 and x_2, and produce a single output *y* (we use here the single output example only to simplify the explanation, but one capital feature to select DEA as a methodological approach is that it can be implemented with multiple outputs); we will sustain the assumption of constant returns to scale.

Fig. 2



The isoquant SS' represents the full efficient firm in figure 2 and knowing this line we can measure the technical efficiency of a given firm. If such firm uses quantities of inputs in the point P, to produce a unit of input, the distance QP can represent the technical inefficiency of that firm, which is the amount by which all inputs could be proportionally reduced without a reduction in output. We can also present that in percentages with the ratio QP/0P, which represents the percentage by which all inputs can be reduced. Finally we can define the Technical Efficiency (TE) of a firm like;

TE=0Q/0P

This measure takes values between zero and one and provides an indicator of the degree of technical inefficiency of the firm. If the firm is efficient it might obtain a value of one and it would be placed in the isoquant, like the point Q.

If we also know the input price ratio, here represented by line AA' it is possible to calculate the allocative efficiency (also referred sometimes as price efficiency). The allocative efficiency (AE) of the firm operating at P is defined to be the ratio

AE=0R/0Q

Since the distance RQ might be taken as the reduction in production costs that might occur if production takes place in the in the allocativelly and technically efficient Q', instead of produce at the technically efficient but allocativelly inefficient point Q.

The efficiency measures we have presented so far assume that the production function is known (or the cost function if such approach is preferred), but in practice this is not the case, and thus, the efficient isoquant must be estimated from the available data. Two alternatives have been suggested to calculate the isoquant, either a picewise-linear convex isoquant, or using a Cob-Douglas function fitted to the data.

3.2.2 SFA – The second method considered here is the Stochastic Frontier Analysis that is a parametrical method. We prepared this explanation based mainly in Coelli et al. (2005). We might say that one of the most important differences with the previously exposed method is that the envelopment of data is done by choosing an arbitrary function. The most common function used in applications is the Cobb-Douglas of the form:

$$\ln q_i = \mathbf{x}_i{}'\beta - u_i \qquad\qquad i = 1, \dots, I$$

where q_i is the output of the firm i; $\mathbf{x}_i$ is a K x 1 vector with the logarithm of inputs; β is a vector of unknown parameters and ; u_i is a non-negative random variable associated with technical inefficiency. For the estimation of these parameters different studies have used different methods like linear programming, maximum likelihood, least squares or a variation of this last one, modified least squares.

The problem with the frontiers like the one we have just described is that it does not take in account (like DEA neither) measurement errors or other sources of statistical noise and thus, all deviations of the frontier are assumed to be the result of technical inefficiency unless we introduce some modifications.

We can find in the literature stochastic frontier production functions like the following:

$$\ln q_i = \mathbf{x}_i{}'\beta + v_i - u_i$$

That is, more or less the same described above but with a symmetric random error v_i, to acknowledge for statistical noise.

In order to illustrate graphically how the stochastic frontier model works, we will use the transformation and simplification by Coelli (2005) in which it is used only one input x_i. The Cobb-Douglas stochastic frontier model takes thus the following form:

$$\ln q_i = \beta_0 + \beta_1 ln\, x_i + v_i + u_i$$

or
$$q_i = \exp(\beta_0 + \beta_1 ln\, x_i + v_i + u_i)$$

or
$$q_i = \exp(\beta_0 + \beta_1 ln\, x_i) \times \exp(v_i) \times \exp(u_i)$$

where:

$\exp(\beta_0 + \beta_1 ln\, x_i)$ is the deterministic component

$\exp(v_i)$ is noise

and $\exp(u_i)$ is the inefficiency

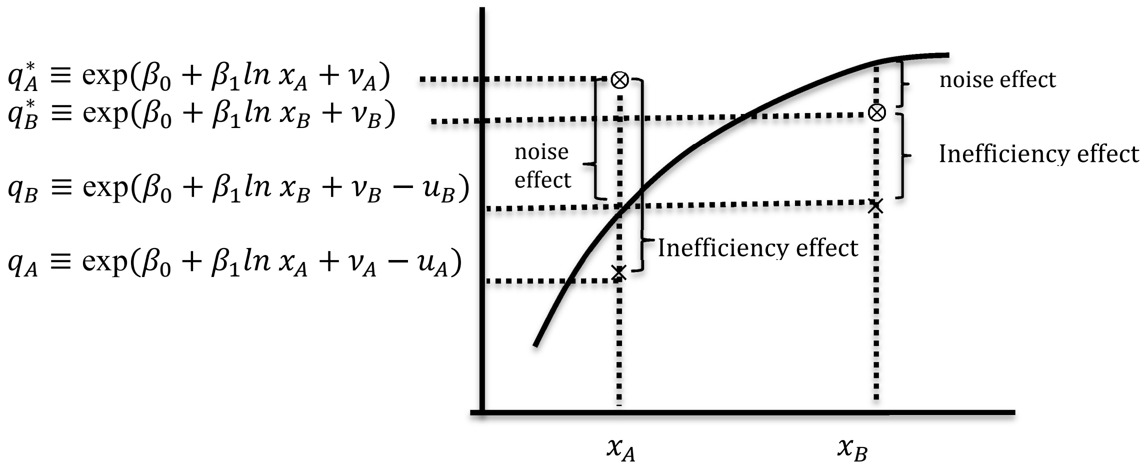
Still following the example by Coelli (2005) we present below a graph where two firms are plotted, A and B, and where diminishing returns of scale are assumed. The horizontal axis corresponds to inputs and the vertical axis measures the outputs. x_A and q_A are the input level and output used and obtained by firm A, and thus x_B and q_B are the input level and the output of firm B. With no inefficiency effect, that is u_A=0 and u_B=0, the frontier outputs for firms A and B respectively will be

$$q_A^* \equiv \exp(\beta_0 + \beta_1 ln\, x_A + v_A) \quad \text{and} \quad q_B^* \equiv \exp(\beta_0 + \beta_1 ln\, x_B + v_B)$$

Observed values are indicated in the graph below by × while frontier values are indicated by ⊗. Frontier output for firm A lies above the deterministic part of the production frontier only because the noise effect is positive ($v_A > 0$), while the frontier output of the firm B lies below the deterministic part of the frontier because the noise effect is negative ($v_B < 0$). In the graph it is also represented that the observed output of firm A lies below the deterministic part of the frontier because noise and inefficiency summed up ($v_A - u_A < 0$) are negative.

If we generalize this example to cases with firms using several inputs, observed outputs tend to lie below the deterministic part of the frontier. Indeed they can only lie above the deterministic part of the frontier when noise effect is positive and greater than the inefficiency effect ($q_i^* > \exp(\mathbf{x}_i'\beta)$ if $\epsilon_i \equiv v_i - u_i$).

Fig. 3



3.2.3 Malmquist Productivity Index – Using this index we can decompose the productivity improvements into technological change and other productivity improvements (Førsund & Kittelsen, 1998)

The Malmquist efficiency index was first defined after Sten Malmquist (1953) and gained a big deal of popularity to measure not just productivity but also how this changes over time. Nonetheless this index has been also criticized and reviewed by many scholars that have shed some light on its drawbacks, specially, in some systematic bias and its dependence on the magnitude of scale economies (Grifell-Tatjé & Lovell, 1995); (Bjurek, 1996); also see (Halkos & Tzeremes, 2006). Still, if we proceed carefully, it is a great tool that may help us to test our main hypothesis; first we calculate productivity development, relative to the best practice production frontier and; secondly we can split into change in efficiency and technical change, acknowledging changes in individual performance relative to the frontier, but also changes in the best practice, that is, the frontier.

As Førsund (1998) and Farrell (1957) defined previously, the production possibility set that faces an operation unit can be expressed as follows:

$$P^t = \{(y, x) | y \text{ can be produced by } x \text{ at time } t\}$$

where $\boldsymbol{y}$ is the vector of N outputs and $\boldsymbol{x}$ the vector of S inputs, given that we assume a multi-input, multi-output scenario. As with other examples, we also assume here constant returns to scale. The Farrell efficiency measure for an input-output combination (y_t^τ, x_t^τ) for observation j at time τ, with technology P^t from the year t can be expressed as

$$E_{j\tau}^t = E^t\left(y_j^\tau, x_j^\tau\right) = Min_\theta\left\{\theta | \left(y_j^\tau, \theta x_j^\tau\right) \in P^t\right\}$$

Minimizing θ we minimize the use of output x with the available technology P at time t. When an efficiency score is less than one, the observation is inefficient compared to the technology in period t. Since our goal is acknowledge sifts in efficiency over time, we will base our index in binary comparisons for each production unit between two time periods. In this example we denote those time periods with 1 and 2. Expressions involving period 2 observations will be in the numerator and expressions involving period 1 observations will be in the denominator. Thus, the Malmquist productivity index, $M_{j1,2}$, that compares the performance of unit j with a frontier technology from period *1* as reference is

$$M_{j1,2} = M\left(y_j^1, x_j^1, y_j^2, x_j^2\right) = \frac{E_{j2}^1}{E_{j1}^1} = \frac{Min_{\theta 2}\left\{\theta_2 | (y_j^2, \theta_2, x_j^2) \in P^1\right\}}{Min_{\theta 1}\left\{\theta_1 | (y_j^1, \theta_1, x_j^1) \in P^1\right\}}, 1, 2 \in T$$

T represents the time periods. If $M_{j1,2} > 1$, the observation in period 2 is more productive than the observation in period 1. A change in productivity might be caused by either a change in efficiency or a shift in the frontier production. Färe (1994) showed how these indexes can be decomposed with data for at least two time periods; the Malmquist productivity index $M_{j1,2}$ can be decomposed into two parts: the catching up $M_{Cj1,2}$, and the pure technology shift, $M_{Fj}^{1,2}$ as follows

$$M_{j1,2} = \frac{E_{j2}^1}{E_{j1}^1} = \frac{E_{j2}^2}{E_{j1}^1} \cdot \frac{E_{j2}^1}{E_{j2}^2} = M_{Cj1,2} \cdot M_{Fj}^{1,2}, 1,2 \in T$$

This way we can know the catching-up effect $M_{Cj1,2}$, that is the relative movement of the observed unit to the frontier. The frontier technology change, on the other hand, it is expressed by the ratio of the efficiency scores for the second period observation relative to the two technologies.

4. OUR PLAN

We split our analysis in two stages clearly differentiated; first we will compare the overall efficiency of a group of countries; this group includes almost all European Union member states and some non EU members like Switzerland, Norway or Turkey, we consider the inclusion of this non EU members might be useful not just as a control group but also for further country grouping. A complete homogeneous change in all countries, including those non-EU members, would give us the idea that the change is due to factors affecting equally those two groups (EU and non-EU members) and not just one of these groups of countries (for our interest it is good to find some evidence that such homogeneous results is due to the technological change to which all countries have access regardless of the membership or association status with the EU). This stage of the analysis consist mainly in conducting a multi-output, multi-input analysis adapting linear programming tools to set a point of comparison for different methods. We use the Data Envelopment Analysis to get a first rank of countries from the more efficient ones and those following the lead. Since the first set of data (at countries level) has a wider range of inputs and outputs this will allow us to assess the energy efficiency improvements. This first stage of analysis give us a first hint of the effects that will also appear in the second stage of analysis, since we aim to assess the main factors and conditions that face electricity producing firms.

In the second part of the analysis, on the other hand, we will use micro-data related to a sample of power plants, to conduct our analysis at power plant level. At this point, we will compare different scores obtained with different methods, like the mentioned Data Envelopment Analysis and Stochastic Frontier Analysis. Our aim at this point of our work is to be also capable to discuss the performance of the most used techniques used to measure efficiency, not just by scholars but also by some regulators. With the micro data we also calculate the Malmquist-Indexes for the 2004-2009 and 2009-2013 pairs of years, this way we will be available to comment not just the evolution of efficiency but we will be also capable to split the results into technical efficiency and improvements due to other factors, that is, the movements of the power plant's scores towards the frontier of production (catch-up effect) and the movement of the same frontier (technology shift).

4.2 Data

The data we use as we mentioned above consist basically in two datasets, each for one of the two levels of analysis we are willing to conduct. First dataset refers to countries (energy systems) while the second dataset refers to electricity generation power plants.

The first dataset we will use is a combination of five input variables and five output variables and each of these is observed for sixteen years, from 1995 until 2010; this period of time covers almost all the process of integration of European energy markets, taking in account that the first package of liberalization measures were adopted in 1996. This is a completely balanced dataset as it is needed for conducting DEA and SFA, all series are homogeneous since all of them have been published by Eurostat.

Table 1

Input variables	**Output variables**
Primary energy consumed*	Solar Photovoltaic Produced
Energy Intensity	Nuclear Power Produced
Nuclear Power Capacity	Hydro Power Produced
Combustible Fuel Capacity	Wind Power Produced
Hydro Power Capacity	Solar Power Consumed
*It accounts for hydro, wind and solar power	

The second dataset we use to do the empirical part of this paper consist in a sample of 130 power plants in eighteen countries (sixteen EU members and two non-EU countries): Italy, Romania, Bulgaria, Spain, France, Sweden, Czech Republic, Germany, Slovenia, Switzerland, Finland, Croatia, Hungary, Slovakia, Belgium, Norway, Portugal, Estonia. All the current EU members were part of the EU at the starting point of the dataset and thus were compelled to follow the same rules regarding the liberalization of energy markets, and regarding the two non-EU countries we include them for control and comparison purposes. We don't need data for all the industry in all countries, since our main objective is to know if there have been changes in European firms in the last few years and to which particular factors we may attribute those changes. In the case of our second database it has been extracted from the AMADEUS database that publishes the data collected from the financial statements of all European countries, this is the main reason why this second set of data is mainly financial data. In order to have a better understanding of the efficiency improvements, we construct the variable "output" as a proxy of the real output of the firms dividing the total sales by the price of the energies, even when this proxy is just an indicator of the real output it is also measured in kw/h, like the real output.

Table 2

Input variables	**Output variables**
Labour (number of workers)	Operating Income
Total Assets	Yearly Results
Size	Results before Taxes
Cost of materials	Sales
Independence of stakeholders	Output
Labour costs	

Data accuracy is of capital importance in order to minimize further problems; frontier approaches are susceptible to shocks and data errors. This is specially the case when cross sectional data is used and there is no allowance for errors as in DEA (Jamasb & Pollit, 2001), this is the main reason why we prefer to stick with a carefully selected group of variables instead of trying a larger group but with other flaws, consequence of the collection or the sources (unbalance of the panel, multiplicity of sources, etc.).

5. RESULTS

In this section we present the results we have obtained with the treatment of the first and second dataset, we also speak of some additional results of the first and second stage of the analysis, in the next section we will present our conclusions related with the results presented in this section.

5.1.1 Results

As a starting point for our analysis we first construct a simple index based in the energy intensity of each of the countries included in our first set of data. The goal is to have a first approximation to the scores we might find in the more sophisticated analysis and, on the other hand, we might also be able to critically overview the standard measures (energy intensity) and other scores like those resulting from the Data Envelopment Analysis and other methods.

If we only take in account the standard measure of efficiency which is energy intensity, we might expect a quite inefficient general environment, and we take these first results as a comparison point to start explaining our first results.

Different countries have faced different resources endowments and may rely solely in a particular source of energy generation, particularly expensive or that account in a high proportion against the energy intensity of those countries; that, for example might be the case of the Czech Republic, Romania, Estonia and Bulgaria, some of the most energy inefficient countries if we only rely on the energy intensity as an indicator. Energy mixes are quite diverse throughout the European continent and it is also the case for general economic performance. The other side of the energy intensity measure is GDP or the size of the economies in the set. Our first results then, the position in the ranking (see Table 3) and the belonging to one group or another might be highly dependent on GDP during the period of study and to the deployment of certain generation methods in further proves we will be able to test these results but so far there seems to be a correlation between GDP growth rates, the size of the economies and energy efficiency improvements. Some countries, because of their climate conditions for example, exhibit higher needs for energy than others, when it is the case that such countries are among the less favored countries in the EU (have small GDP's), their energy intensity is way much higher than others. That affects directly their scores in this first index dependent on the energy intensity indicator.

Table 3

Efficient Group	The follower Group	The non-Efficient	The less Efficient
(0.85-1)	(0.50-0.85)	(0.20-0.49)	(0.07-0,19)
Switzerland	Italy	Malta*	Lithuania
Ireland	Norway	Sweden	Poland
Denmark	United Kingdom	Belgium	Latvia
	Austria	Cyprus	Slovakia
	Spain	Turkey	Czech Republic
	Luxemburg	Finland	Romania
	Germany	Iceland*	Estonia
	Greece	Croatia	Bulgaria
	France	Slovenia	
	Portugal	Hungary	
	Netherlands		

* Missing data may alter the result

We can clearly distinguish four groups of countries regarding the position that each of them occupies in the ranking; in the table below we present the groups regarding the score obtained in our first analysis. These groups have been labeled as Efficient, Follower, non-Efficient and less Efficient. Even when a small GDP can drag you to the bottom of the rank, it is also true that a high GDP level do not grant a good performance in the exercise, since it is also known that with higher GDP's there are

also more need for energy, not just because there are more appliances in use but also because consumption of all kind of products is higher and there is more need of energy to produce them.
An additional result that is worth reporting is that there is some convergence in what concerns to efficiency, that is, a group of countries, particularly the less efficient ones move towards the frontier (even when at the end of the analyzed period are still far from the frontier); we must take in account, though, that some countries start from quite inefficient scenarios, which might be five times less efficient than the best performers.
A result that we were expecting and that has been partially proved is that energy efficiency has improved in the last fifteen years. This improvement has been of about two or three percent each year, depending of the year but also of the country. We have already talked about the existence of a catch-up effect, and that such effect is stronger in the less efficient countries, then, it is clear that more efficient countries exhibit smaller rates of improvements in their energy efficiency scores. Nonetheless, at the present rates of improvement and “all things been equal” it might take decades to the less efficient countries to catch the more efficient scores. For the full table see the appendix one at the end of the paper.

5.1.3 DEA by country

When we use more sophisticated techniques to account for the efficiency of the group of countries we have included in our set, a very different reality awakens. The first results that we would like to stress is that countries perform much better than what we expected. There are more countries in the frontier than what we could expect from the first approximation with the energy intensity indicator. Around half of the countries in the set perform fairly well and are in the frontier at least once, even when some of them lose this position at least once. Some countries start a little below the frontier but end up catching it, like Belgium, Hungary, Netherlands, Slovenia or Finland, some others even when they are in the frontier at least once, lose this position in the year 2010, like Austria or the United Kingdom; particularly these two countries lose some ground since it seems that the frontier moves away from them (detailed results are reported in the Annex 2). After comparing all scores and looking for certain correlations, it is also true that the more production methods are used in the different countries, the more likely is that such country will end up been in the frontier and the higher the score in energy intensity the less likely such country will be in the frontier. Both observations might be quite intuitive, the more diverse the country’s energy mix is, the more efficient might be and the more inputs it takes to produce an extra unit of GDP the less efficient it is also in overall terms.
What is really interesting about the use of non-parametric techniques such as DEA is that this methodology let us know not just the scores of every country and assess different technologies, that is, the combination of certain inputs to produce one or more outputs, but also how much technology improves.

5.1.3.1 Frontier moves and catch-up effects

Given these results it is also worth to mention the changes in the frontier of production, acknowledged by the Malmquist index calculated and also available at detail in the Annex 2. Between 1995 and 2000 the total productivity increased a 2% in average, but the technical change effect was a little less important than the efficiency change (catch-up effect), 0.9% and 1% respectively. This changes slightly for the rest of the years coupled, where technical change is a little better than the catch-up effect, like in the 2005/2010, when the technical change accounts for a 0.96% and efficiency change for a 0.93.

5.1.4 DEA by production firms

As it was expected, the efficiency scores at the production plant levels are way more diverse that the results at country levels. Only a small portion of the complete set of producing firms (11%) reach and maintain the position in the frontier for the whole period of study. As often happens in these sort of studies, many firms or DMU score differently in every year, even when they maintain a certain level of efficiency. In average, the distance from the typical producing firm to the frontier is of about 30%, but again, some firms are way more inefficient than others. Size of the firm is one of the factors that can be directly correlated with the less efficient scores, that is, the bigger the firm, the less likely that it will get to the production frontier; it is harder for bigger firms to achieve full efficiency. On the other hand, and non-surprisingly, the higher the volume of assets the firm holds, the more likely is for it to reach the production frontier.

Finally, if we account by country of origin of the firms, there are no strong correlation with been a given country and perform better than the rest of countries. It is clear that there are stronger factors, micro factors (like firm size, assets available or cost of factors) rather than national states context or regulation.

5.1.4.1 Frontier moves and catch-up effects in production firms

Since technology is an important factor in production, the use and ageing of certain production method can account relevant changes both in the frontier (how much electricity is produced in the whole sector) and how much can a given firm produce (catch-up effect). In the set of firms we study, it seems that there is a correlation between the source used to produce electricity and the final efficiency score; firms using traditional sources of energy, like coal or other fossil fuel lose ground through time more easily than others.

A very relevant result and that we would like to stress again is that the frontier moves accounting for a higher production of the firms in the sample, the increase is of 12% within 2004 and 2009 (2.4% each year), 12% again between the year 2009 and 2013 (2.4% again). On the other hand, those firms that better improve their scores are those that account for a higher technical change than the rest of the firms in the set; that is, technical change is the more important driver of efficiency improvement at the firm level also.

5.1.5 SFA by production firms

Finally, we report some results from the Stochastic Frontier Analysis estimation. First thing that we should say is that this method has an important flow relative to other methods used here and in other related studies, that is, you can only estimate the stochastic frontier using only one output, other multi-output approaches using stochastic frontier methodology are under development and we couldn’t warranty the comparability of the results. We decided then to make a second calculation of DEA frontiers taking only one output for sake of comparability.

Scores estimated with the SFA method are consistently lower, as expected, the difference is a full 10% in average. This difference is partially explained by the fact that since SFA estimations also accounts an estimation error while DEA calculation of inefficiency attributes all the distance from the observed inefficient units to pure inefficiency.

When we compare different SFA scores for 2004 and 2009 we can say that productivity has increase, but not for all firms nor in equal quantities. Somehow the results are equivalent to those of the DEA, but quite different in its size and nature.

6. CONCLUSIONS

Efficiency measures are useful, not just for benchmarking of firms, power plants or countries as part of the energy sector (or any other sector where you want to apply these techniques), but also for policy makers and entrepreneurs. While the second group must be aware of the major causes that deliver results after the energy market reform and the slow pace that some results have been exhibiting, the entrepreneurs can be interested in their position in the market and the factors that might help them to improve their performance relative to their direct competitors.

Even when different regulators use different measures, it is important to know other possibilities and the drawbacks of all of them, in what concern to simplicity, reliability and the information that every technique provides. Sometimes it might be not enough with just a ranking of firms or countries but also to assess the main factors of change, in this respect, the inclusion of the Malmquist index is quite illustrative, but also other techniques that enrich the results.

Asses the different components or factors of the efficiency improvements are also important for further policy deployments and to know better where to put more effort, either in the group of policies that help companies to move towards the frontier of production or in the group of policies that promote technological change and thus an overall improvement in the sector (It is important how we use different scores to different phenomena).

An important and shared drawback of all the measures is the relevance of accurate data. There is an important margin for improvement not just from the development of different methods (parametric and non-parametric) point of view but also from the collection and availability of data, particularly at firm level. Even when there is information available at country level, the availability of information decrease when we look for micro data.

We were able to prove the relevance of the technological progress in the improvement in the volume of output, even if we were expecting higher shares relative to the catch-up effect, if we differentiate by production sources, the effect can be more clearly seen. The increasing participation of renewable sources of energy is a clear improvement in the overall sector, besides of other decisions that firms can make at the micro level, like the amount of labor, the effort they put in sales or the output produced.

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Annexes

Annex 1. Index of efficiency constructed with energy intensity of each country

GEO/TIME	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Switzerland	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00
Ireland	0,70	0,75	0,79	0,79	0,82	0,82	0,85	0,86	0,91	0,92	0,94	0,98	0,92	0,91	0,93	0,86
Denmark	0,80	0,74	0,82	0,84	0,88	0,90	0,92	0,91	0,87	0,90	0,92	0,89	0,85	0,92	0,87	0,85
Italy	0,73	0,75	0,76	0,74	0,73	0,71	0,75	0,73	0,70	0,69	0,67	0,69	0,65	0,67	0,69	0,65
Norway	0,75	0,81	0,81	0,79	0,76	0,76	0,78	0,83	0,77	0,80	0,78	0,79	0,74	0,70	0,74	0,61
United Kingdom	0,58	0,58	0,62	0,63	0,64	0,63	0,67	0,68	0,70	0,70	0,69	0,72	0,72	0,73	0,76	0,72
Austria	0,68	0,66	0,68	0,69	0,71	0,71	0,71	0,69	0,66	0,65	0,62	0,65	0,63	0,64	0,67	0,61
Spain	0,60	0,63	0,61	0,60	0,60	0,57	0,60	0,58	0,58	0,56	0,55	0,58	0,54	0,57	0,62	0,58
Luxembourg	0,55	0,55	0,59	0,64	0,65	0,64	0,65	0,62	0,60	0,55	0,55	0,59	0,59	0,61	0,63	0,57
Germany	0,55	0,55	0,56	0,57	0,59	0,57	0,59	0,58	0,58	0,57	0,56	0,58	0,57	0,58	0,59	0,56
Greece	0,54	0,55	0,55	0,53	0,54	0,51	0,54	0,53	0,55	0,55	0,54	0,57	0,54	0,54	0,56	0,54
France	0,55	0,54	0,57	0,56	0,57	0,56	0,58	0,56	0,56	0,55	0,54	0,57	0,54	0,55	0,57	0,53
Portugal	0,56	0,59	0,59	0,57	0,54	0,54	0,57	0,53	0,54	0,52	0,49	0,54	0,49	0,52	0,53	0,52
Netherlands	0,52	0,52	0,56	0,57	0,59	0,57	0,59	0,57	0,56	0,55	0,54	0,58	0,52	0,55	0,56	0,51
Malta	n	n	n	n	n	0,53	0,49	0,52	0,47	0,45	0,43	0,48	0,43	0,46	0,49	0,47
Sweden	0,42	0,42	0,45	0,45	0,48	0,50	0,50	0,48	0,50	0,49	0,50	0,54	0,52	0,53	0,56	0,50
Belgium	0,43	0,42	0,44	0,43	0,44	0,43	0,46	0,47	0,45	0,45	0,45	0,47	0,46	0,45	0,46	0,42
Cyprus	0,46	0,44	0,46	0,46	0,47	0,44	0,48	0,47	0,44	0,47	0,47	0,48	0,44	0,44	0,46	0,45
Turkey	0,39	0,39	0,40	0,40	0,39	0,37	0,40	0,38	0,38	0,40	0,40	0,39	0,35	0,36	0,36	0,34
Finland	0,36	0,35	0,36	0,37	0,38	0,38	0,40	0,37	0,36	0,36	0,39	0,38	0,37	0,39	0,39	0,36
Iceland	0,35	0,35	0,36	0,35	0,32	0,30	0,31	0,30	0,31	0,32	0,32	0,28	n	n	n	n
Croatia	0,33	0,35	0,34	0,34	0,33	0,34	0,36	0,35	0,34	0,35	0,35	0,37	0,34	0,37	0,37	0,35
Slovenia	0,31	0,31	0,31	0,33	0,34	0,34	0,35	0,35	0,35	0,35	0,34	0,37	0,36	0,36	0,37	0,35
Hungary	0,23	0,23	0,24	0,25	0,26	0,26	0,28	0,28	0,28	0,29	0,28	0,30	0,28	0,29	0,29	0,27
Lithuania	0,12	0,12	0,13	0,13	0,16	0,18	0,18	0,17	0,18	0,19	0,21	0,23	0,22	0,23	0,22	0,26
Poland	0,16	0,16	0,18	0,19	0,21	0,21	0,22	0,22	0,22	0,23	0,23	0,23	0,23	0,24	0,26	0,24
Latvia	0,14	0,15	0,17	0,18	0,20	0,21	0,22	0,23	0,23	0,24	0,25	0,27	0,27	0,27	0,24	0,22
Slovakia	0,14	0,15	0,15	0,16	0,16	0,15	0,16	0,16	0,17	0,17	0,18	0,19	0,21	0,22	0,23	0,22
Czech Republic	0,18	0,19	0,18	0,19	0,20	0,19	0,20	0,19	0,19	0,19	0,20	0,21	0,21	0,22	0,23	0,21
Romania	n	0,13	0,13	0,14	0,15	0,15	0,16	0,16	0,16	0,17	0,18	0,19	0,18	0,20	0,22	0,20
Estonia	0,10	0,10	0,11	0,13	0,14	0,15	0,15	0,17	0,16	0,16	0,18	0,20	0,18	0,18	0,17	0,15
Bulgaria	0,07	0,07	0,07	0,08	0,09	0,09	0,09	0,09	0,10	0,10	0,10	0,11	0,11	0,11	0,13	0,12

Annex 2. DEA scores by country and Malmquist indexes for different pairs of years

	Efficiency scores with DEA				1995/2000			2000/2005			2005/2010			1995/2010		
	1995	2000	2005	2010	Tech change	Eff Change	$M_{1995,2000}$	Tech change	Eff Change	$M_{2000,2005}$	Tech Change	Eff Change	$M_{2005,2010}$	Tech Change	Eff Change	$M_{1995,2010}$
Belgium	0,9472	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000
Bulgaria	1,0000	1,0000	0,8616	0,9960	1,0000	1,0000	1,0000	1,0773	1,1606	1,2504	0,9301	0,8651	0,8046	1,0020	1,0040	1,0060
Czech Republic	0,6170	0,6682	0,7831	0,9149	1,0086	1,0174	1,0262	0,9237	0,8533	0,7882	0,9252	0,8559	0,7919	0,8620	0,7430	0,6405
Denmark	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000
Germany	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000
Estonia	0,3752	0,4827	0,9096	1,0000	0,8821	0,7781	0,6864	0,7285	0,5307	0,3866	0,9537	0,9096	0,8675	0,6129	0,3756	0,2302
Ireland	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000
Greece	0,6653	0,6180	0,5852	0,9066	1,0376	1,0765	1,1170	1,0276	1,0560	1,0852	0,8034	0,6455	0,5186	0,8566	0,7338	0,6286
Spain	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000
France	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000
Croatia	1,0000	1,0000	0,7033	0,9550	1,0000	1,0000	1,0000	1,1924	1,4219	1,6955	0,8582	0,7364	0,6320	1,0233	1,0471	1,0715
Italy	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000
Cyprus	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000
Latvia	0,5262	0,9166	1,0000	0,9919	0,7577	0,5741	0,4350	0,9574	0,9166	0,8775	1,0041	1,0082	1,0123	0,7284	0,5305	0,3864
Lithuania	0,2512	0,3943	0,4211	0,5740	0,7982	0,6371	0,5085	0,9677	0,9364	0,9061	0,8565	0,7336	0,6284	0,6615	0,4376	0,2895
Luxembourg	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000
Hungary	0,7481	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000
Netherlands	0,7087	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000
Austria	0,9531	1,0000	1,0000	0,9456	0,9763	0,9531	0,9305	1,0000	1,0000	1,0000	1,0284	1,0575	1,0875	1,0040	1,0079	1,0119
Poland	0,1788	0,2530	0,2587	0,3074	0,8458	0,7154	0,6051	0,9889	0,9780	0,9671	0,9174	0,8416	0,7720	0,7673	0,5888	0,4518
Portugal	0,9362	0,7672	0,6860	1,0000	1,1047	1,2203	1,3480	1,0575	1,1184	1,1827	0,8283	0,6860	0,5682	0,9676	0,9362	0,9058
Romania	1,0000	0,4750	0,8785	0,9741	1,4510	2,1053	3,0546	0,7353	0,5407	0,3976	0,9497	0,9019	0,8565	1,0132	1,0266	1,0401
Slovenia	0,9050	1,0000	1,0000	1,0000	0,9984	0,9968	0,9952	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	0,9984	0,9968	0,9952
Slovakia	0,6613	0,6584	0,4065	0,5338	1,0022	1,0044	1,0066	1,2727	1,6197	2,0613	0,8727	0,7615	0,6645	1,1130	1,2389	1,3789
Finland	0,9249	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000
Sweden	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000
United Kingdom	0,9613	1,0000	1,0000	0,9319	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0359	1,0731	1,1116	1,0359	1,0731	1,1116
Norway	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000
Switzerland	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000	1,0000
Turkey	0,3949	0,5078	0,6553	0,8311	1,0398	1,0811	1,1241	0,8803	0,7749	0,6821	0,8880	0,7885	0,7001	0,8128	0,6606	0,5369

Annex 3. Efficiency scores of the set of firms by years DEA (part 1)

No	Name of the company	e2004	e2009	e2013
1	ELECTRICITE DE FRANCE	0,4886	0,4874	0,5524
2	IBERDROLA GENERACION SAU	1,0000	0,5114	0,6072
3	ENEL ENERGIA S.P.A.	1,0000	1,0000	1,0000
4	ENEL PRODUZIONE S.P.A.	1,0000	0,4887	0,4716
5	ČEZ, A. S.	0,5536	0,5096	0,5116
6	A2A S.P.A.	0,5973	0,4682	0,4262
7	ENDESA GENERACION SA	0,6628	0,6408	0,4687
8	MVV ENERGIE AG	0,5274	0,5862	0,5703
9	HIDROELECTRICA DEL CANTABRICO SA	0,4614	0,4873	0,4715
10	STADTWERKE LEIPZIG GMBH	0,5816	0,5917	1,0000
11	SLOVENSKÉ ELEKTRÁRNE, A.S.	1,0000	0,4838	0,4689
12	STADTWERKE HANNOVER AKTIENGESELLSCHAF	0,6454	0,5632	0,5012
13	MAINOVA AKTIENGESELLSCHAFT	0,5390	0,5125	0,5291
14	REPOWER AG	0,5927	0,5122	0,4716
15	UNION ELECTRICA DE CANARIAS GENERACION S	0,5616	0,6234	0,5751
16	FORTUM POWER AND HEAT OY	1,0000	0,7040	0,9478
17	HIDROCANTABRICO ENERGIA SA	1,0000	1,0000	1,0000
18	COMPAGNIA VALDOSTANA DELLE ACQUE	0,8701	0,7665	0,7254
19	REPOWER ITALIA S.P.A.	1,0000	0,9344	1,0000
20	EON GENERACION SL	0,3264	0,4417	0,5535
21	E.ON KÄRNKRAFT SVERIGE AB	1,0000	1,0000	1,0000
22	AZIENDA ENERGETICA S.P.A. - ETSCHWERKE	1,0000	1,0000	1,0000
23	STADTWERKE KIEL AKTIENGESELLSCHAFT	0,7480	1,0000	0,6544
24	RHÖNENERGIE FULDA GMBH	0,4397	0,5445	0,4921
25	HEP-PROIZVODNJA D.O.O.	0,3395	0,4157	0,4700
26	MVM PAKSI ATOMERŐMŰ ZÁRTKÖ	0,5404	0,9283	1,0000
27	ELECTROCENTRALE BUCURESTI SA	0,7097	0,6254	0,4686
28	OKG AKTIEBOLAG	0,2911	0,3031	0,2690
29	GAS Y ELECTRICIDAD GENERACION SA	0,7270	0,5334	0,3782
30	GROSSKRAFTWERK MANNHEIM AK	0,4098	0,4289	0,2756
31	JÄMTKRAFT AKTIEBOLAG	1,0000	0,4709	0,4118
32	EESTI ENERGIA NARVA ELEKTRIJAAMAD AS	1,0000	1,0000	1,0000
33	GETEC ENERGIE AG	1,0000	0,7966	1,0000
34	SOCIETATEA NATIONALA -NUCLEARELECTRICA-	0,2494	0,3240	0,3628
35	ELIA ASSET	0,4727	0,4285	0,3614
36	TEOLLISUUDEN VOIMA OYJ	0,8013	0,8273	1,0000
37	АЕЦ КОЗЛОДУЙ ЕАД	1,0000	1,0000	1,0000
38	ROSEN - ROSIGNANO ENERGIA SPA	1,0000	1,0000	1,0000
39	MÁTRAI ERŐMŰ ZÁRTKÖRŰEN MŰKÖDŐ RÉSZV	0,8280	0,7111	0,6268
40	KERNKRAFTWERK GÖSGEN-DÄNIKEN AG	1,0000	1,0000	1,0000
41	EWV ENERGIE- UND WASSER-VERSORGUNG GN	0,5965	0,8313	0,8089
42	KERNKRAFTWERK GUNDREMMINGEN GMBH	0,2896	0,8381	1,0000
43	E-CO ENERGI AS	1,0000	1,0000	0,9508
44	ТЕЦ МАРИЦА ИЗТОК 2 ЕАД	0,9081	0,8840	0,8198
45	AGDER ENERGI VANNKRAFT AS	1,0000	0,7739	1,0000
46	ENEL GREEN POWER ESPAÑA S L	0,6270	1,0000	0,3372
47	SWE ENERGIE GMBH	0,5550	0,7554	0,9422
48	LYSE PRODUKSJON AS	0,8748	1,0000	1,0000
49	TERMOELEKTRARNA ŠOŠTANJ D.O.O.	0,7781	0,8358	0,5485
50	BKK PRODUKSJON AS	1,0000	1,0000	1,0000
51	ITAL GREEN ENERGY S.R.L.	1,0000	1,0000	1,0000
52	STADTWERKE TÜBINGEN GMBH	0,4739	0,6420	0,5159
53	КОНТУРГЛОБАЛ МАРИЦА ИЗТОК 3 АД	0,9495	1,0000	1,0000
54	TEJO ENERGIA - PRODUÇÃO E DISTRIBUIÇ	1,0000	1,0000	1,0000
55	JYVÄSKYLÄN ENERGIA OY	0,8088	0,5112	0,6787
56	ZEAG ENERGIE AG	0,9561	0,4855	0,4165
57	INFRASERV GMBH & CO. WIESBADEN KG	0,6645	1,0000	1,0000
58	LAHTI ENERGIA OY	0,5908	1,0000	0,7349
59	STADTWERKE REMSCHEID GESELLSCHAFT MIT I	0,3252	0,5374	0,4694
60	G.O.R.I. S.P.A. - GESTIONE OTTIMALE RISORSE I	1,0000	0,9394	1,0000
61	FMV SA	0,8801	1,0000	0,7341
62	ENERGOTRANS, A.S.	0,8423	1,0000	1,0000
63	UNTERFRÄNKISCHE ÜBERLANDZENTRALE EG	0,5102	0,5296	0,5390
64	KRAFTWERKE OBERHASLI AG	1,0000	0,7120	0,6198
65	ELCOGAS SOCIEDAD ANONIMA	0,4573	0,5723	0,5642

Annex 3. DEA of the set of firms (part 2)

66	FLYENERGIA SOCIETA' PER AZIONI	1,0000	1,0000	1,0000
67	ŠKO-ENERGO, S.R.O.	1,0000	1,0000	0,6678
68	EDISON ENERGIE SPECIALI S.P.A.	1,0000	0,5858	1,0000
69	GEMEINSCHAFTSKRAFTWERK VELTHEIM GESEL	0,6374	0,6296	0,7334
70	SCHLUCHSEEWERK AKTIENGESELLSCHAFT	0,2756	0,5186	0,3769
71	ASTEA S.P.A.	0,6735	0,6267	0,8383
72	HYDRO EXPLOITATION SA	1,0000	1,0000	1,0000
73	GUDBRANDSDAL ENERGI AS	1,0000	0,7194	0,7894
74	OTTANA ENERGIA SOCIETA' PER AZIONI - S.P.A. (	1,0000	0,9615	0,8539
75	ENGADINER KRAFTWERKE AG	1,0000	0,3927	0,5470
76	ITALGEN S.P.A.	1,0000	0,8280	0,8746
77	BIOMASSE ITALIA S.P.A.	0,7092	1,0000	0,7735
78	ČEZ OBNOVITELNÉ ZDROJE, S.R.O.	1,0000	1,0000	1,0000
79	DRAVSKE ELEKTRARNE MARIBOR D.O.O.	1,0000	0,8706	0,7942
80	ELEKTRIZITÄTSWERK ALTDORF AG	0,8500	1,0000	1,0000
81	HÄRJEÅNS KRAFT AKTIEBOLAG	1,0000	0,6933	0,7383
82	TAFJORD KRAFTPRODUKSJON AS	0,7962	1,0000	1,0000
83	ENERGIEVERSORGUNG SYLT GMBH	1,0000	0,7233	0,7627
84	SEA ENERGIA S.P.A.	0,6924	0,7673	0,7878
85	LOMELLINA ENERGIA S.R.L.	0,5846	0,8191	0,9789
86	KEMIJOKI OY	0,3089	0,2888	0,3859
87	PORVOON ENERGIA OY - BORGÅ ENERGI AB	0,5798	0,6437	0,5523
88	ETELÄ-SAVON ENERGIA OY	0,4941	0,5684	0,5540
89	ASM TERNI S.P.A.	0,6419	0,5836	0,7631
90	ONDA COGENERACION SL	0,7935	0,6727	1,0000
91	GREEN GAS DPB, A.S.	0,8257	0,8560	0,9214
92	SOŠKE ELEKTRARNE NOVA GORICA D.O.O.	0,7006	0,3049	0,4215
93	ТОПЛОФИКАЦИЯ ПЛЕВЕН ЕАД	0,7382	0,8668	0,6224
94	ISTAD KRAFT AS	1,0000	0,9705	0,8994
95	ELEKTRIZITÄTSWERK OBWALDEN	0,4820	0,7557	0,6613
96	COGENERACION DEL NOROESTE SL	0,9325	1,0000	1,0000
97	TAMPIERI ENERGIE S.R.L.	0,8277	1,0000	1,0000
98	KANTONALES ELEKTRIZITÄTSWERK NIDWALDEI	0,7355	0,3827	0,5825
99	VULKAN ENERGIEWIRTSCHAFT ODERBRÜCKE G	0,8016	1,0000	0,5485
100	TUSSA ENERGI AS	0,6435	0,6631	0,6203
101	ASPIRAVI	1,0000	1,0000	0,5897
102	SWL ENERGIE AG	0,6257	0,6361	0,9534
103	HAMINAN ENERGIA OY	0,7315	0,6504	0,6401
104	SEL EDISON SPA % SEL EDISON A.G.	1,0000	1,0000	1,0000
105	ТОПЛОФИКАЦИЯ РУСЕ ЕАД	0,4004	0,6590	0,6106
106	VOGHERA ENERGIA S.P.A.	1,0000	0,5406	0,5314
107	TECHNISCHE BETRIEBE GLARUS SÜD	0,9742	1,0000	0,7561
108	SAN MARCO BIOENERGIE S.P.A. IN FORMA ABB	0,7284	1,0000	0,6939
109	VATAJANKOSKEN SÄHKÖ OY	0,4123	0,5053	0,5464
110	BALTEAU IE	1,0000	1,0000	0,9261
111	ТЕЦ СВИЛОЗА АД	1,0000	0,7154	0,7031
112	GKS-GEMEINSCHAFTSKRAFTWERK SCHWEINFU	0,4250	0,8330	0,7386
113	KAINUUN VOIMA OY	0,4396	0,5373	0,6478
114	TARANIS DU ROUVRAY	1,0000	0,8701	0,8635
115	MJÖLBY- SVARTÅDALEN ENERGI AB	0,7797	0,5147	0,4366
116	MASTROPASQUA INTERNATIONAL - S.P.A.	1,0000	1,0000	0,9996
117	PRIMIERO ENERGIA S.P.A.	1,0000	1,0000	1,0000
118	EDA RENOVÁVEIS, S.A.	1,0000	0,7756	1,0000
119	ECOSESTO S.P.A.	0,6648	0,6820	0,5766
120	AKTIEBOLAGET EDSBYNS ELVERK	0,5349	0,7659	0,6908
121	E.T.A. - ENERGIE TECNOLOGIE AMBIENTE SOCIE	0,5515	0,5995	0,3966
122	SOCIETA' ELETTRICA IN MORBEGNO SOCIETA' C(	0,6676	0,6946	0,6402
123	CENTRALA ELECTRICĂ DE TERMOFICARE ARAD S	0,2997	0,6766	0,3202
124	VARESE RISORSE S.P.A.	1,0000	0,9937	0,7288
125	VOSS ENERGI AS	0,6393	0,5074	0,5838
126	GRANADA VAPOR Y ELECTRICIDAD SL	0,6169	0,9889	1,0000
127	AZIENDA SPECIALIZZATA SETTORE MULTISERVIZ	0,4507	0,4594	0,3960
128	LINEA ENERGIA S.P.A.	0,3934	0,6296	0,5712
129	VERSORGUNGSBETRIEBE BORDESHOLM GMBH	1,0000	1,0000	1,0000
130	VEST - ENERGO SA	1,0000	0,7533	1,0000

Annex 4. Production Firms Malmquist indexed 2004-2009, decomposed (part 1)

		2004/2009		
No	Name of the company	Tech change	Eff Change	$M_{2004,2009}$
1	ELECTRICITE DE FRANCE	1,0012	1,0025	1,0037
2	IBERDROLA GENERACION SAU	1,3984	1,9554	2,7344
3	ENEL ENERGIA S.P.A.	1,0000	1,0000	1,0000
4	ENEL PRODUZIONE S.P.A.	1,4305	2,0462	2,9271
5	ČEZ, A. S.	1,0423	1,0863	1,1323
6	A2A S.P.A.	1,1295	1,2757	1,4409
7	ENDESA GENERACION SA	1,0170	1,0343	1,0519
8	MVV ENERGIE AG	0,9485	0,8997	0,8534
9	HIDROELECTRICA DEL CANTABRICO SA	0,9731	0,9468	0,9213
10	STADTWERKE LEIPZIG GMBH	0,9914	0,9829	0,9745
11	SLOVENSKÉ ELEKTRÁRNE, A.S.	1,4377	2,0670	2,9717
12	STADTWERKE HANNOVER AKTIENGESELLSCHAF	1,0705	1,1460	1,2267
13	MAINOVA AKTIENGESELLSCHAFT	1,0255	1,0517	1,0786
14	REPOWER AG	1,0757	1,1572	1,2448
15	UNION ELECTRICA DE CANARIAS GENERACION S	0,9491	0,9009	0,8550
16	FORTUM POWER AND HEAT OY	1,1918	1,4205	1,6929
17	HIDROCANTABRICO ENERGIA SA	1,0000	1,0000	1,0000
18	COMPAGNIA VALDOSTANA DELLE ACQUE	1,0654	1,1352	1,2094
19	REPOWER ITALIA S.P.A.	1,0345	1,0702	1,1071
20	EON GENERACION SL	0,8596	0,7390	0,6352
21	E.ON KÄRNKRAFT SVERIGE AB	1,0000	1,0000	1,0000
22	AZIENDA ENERGETICA S.P.A. - ETSCHWERKE	1,0000	1,0000	1,0000
23	STADTWERKE KIEL AKTIENGESELLSCHAFT	0,8649	0,7480	0,6469
24	RHÖNENERGIE FULDA GMBH	0,8986	0,8075	0,7257
25	HEP-PROIZVODNJA D.O.O.	0,9037	0,8167	0,7381
26	MVM PAKSI ATOMERŐMŰ ZÁRTKÖ	0,7630	0,5821	0,4442
27	ELECTROCENTRALE BUCURESTI SA	1,0653	1,1348	1,2089
28	OKG AKTIEBOLAG	0,9800	0,9604	0,9412
29	GAS Y ELECTRICIDAD GENERACION SA	1,1675	1,3630	1,5912
30	GROSSKRAFTWERK MANNHEIM AK	0,9775	0,9555	0,9340
31	JÄMTKRAFT AKTIEBOLAG	1,4573	2,1236	3,0946
32	EESTI ENERGIA NARVA ELEKTRIJAAMAD AS	1,0000	1,0000	1,0000
33	GETEC ENERGIE AG	1,1204	1,2553	1,4065
34	SOCIETATEA NATIONALA -NUCLEARELECTRICA-	0,8774	0,7698	0,6753
35	ELIA ASSET	1,0503	1,1032	1,1586
36	TEOLLISUUDEN VOIMA OYJ	0,9842	0,9686	0,9532
37	АЕЦ КОЗЛОДУЙ ЕАД	1,0000	1,0000	1,0000
38	ROSEN - ROSIGNANO ENERGIA SPA	1,0000	1,0000	1,0000
39	MÁTRAI ERŐMŰ ZÁRTKÖRŰEN MŰKÖDŐ RÉSZV	1,0791	1,1644	1,2565
40	KERNKRAFTWERK GÖSGEN-DÄNIKEN AG	1,0000	1,0000	1,0000
41	EWV ENERGIE- UND WASSER-VERSORGUNG GN	0,8471	0,7176	0,6078
42	KERNKRAFTWERK GUNDREMMINGEN GMBH	0,5878	0,3455	0,2031
43	E-CO ENERGI AS	1,0000	1,0000	1,0000
44	ТЕЦ МАРИЦА ИЗТОК 2 ЕАД	1,0135	1,0273	1,0412
45	AGDER ENERGI VANNKRAFT AS	1,1367	1,2922	1,4688
46	ENEL GREEN POWER ESPAÑA S L	0,7918	0,6270	0,4965
47	SWE ENERGIE GMBH	0,8572	0,7347	0,6298
48	LYSE PRODUKSJON AS	0,9353	0,8748	0,8182
49	TERMOELEKTRARNA ŠOŠTANJ D.O.O.	0,9649	0,9310	0,8983
50	BKK PRODUKSJON AS	1,0000	1,0000	1,0000
51	ITAL GREEN ENERGY S.R.L.	1,0000	1,0000	1,0000
52	STADTWERKE TÜBINGEN GMBH	0,8592	0,7382	0,6342
53	КОНТУРГЛОБАЛ МАРИЦА ИЗТОК 3 АД	0,9744	0,9495	0,9252
54	TEJO ENERGIA - PRODUÇÃO E DISTRIBUIÇ	1,0000	1,0000	1,0000
55	JYVÄSKYLÄN ENERGIA OY	1,2578	1,5822	1,9901
56	ZEAG ENERGIE AG	1,4033	1,9693	2,7636
57	INFRASERV GMBH & CO. WIESBADEN KG	0,8152	0,6645	0,5417
58	LAHTI ENERGIA OY	0,7686	0,5908	0,4541
59	STADTWERKE REMSCHEID GESELLSCHAFT MIT I	0,7779	0,6051	0,4707
60	G.O.R.I. S.P.A. - GESTIONE OTTIMALE RISORSE I	1,0318	1,0645	1,0983
61	FMV SA	0,9381	0,8801	0,8257
62	ENERGOTRANS, A.S.	0,9178	0,8423	0,7730
63	UNTERFRÄNKISCHE ÜBERLANDZENTRALE EG	0,9815	0,9634	0,9456
64	KRAFTWERKE OBERHASLI AG	1,1851	1,4045	1,6645
65	ELCOGAS SOCIEDAD ANONIMA	0,8939	0,7991	0,7143

Annex 4. Production Firms Malmquist indexed 2004-2009, decomposed (part 2)

66	FLYENERGIA SOCIETA' PER AZIONI	1,0000	1,0000	1,0000
67	ŠKO-ENERGO, S.R.O.	1,0000	1,0000	1,0000
68	EDISON ENERGIE SPECIALI S.P.A.	1,3065	1,7071	2,2304
69	GEMEINSCHAFTSKRAFTWERK VELTHEIM GESEL	1,0062	1,0124	1,0186
70	SCHLUCHSEEWERK AKTIENGESELLSCHAFT	0,7290	0,5314	0,3874
71	ASTEA S.P.A.	1,0367	1,0747	1,1141
72	HYDRO EXPLOITATION SA	1,0000	1,0000	1,0000
73	GUDBRANDSDAL ENERGI AS	1,1790	1,3900	1,6389
74	OTTANA ENERGIA SOCIETA' PER AZIONI - S.P.A. (	1,0198	1,0400	1,0607
75	ENGADINER KRAFTWERKE AG	1,5958	2,5465	4,0636
76	ITALGEN S.P.A.	1,0990	1,2077	1,3273
77	BIOMASSE ITALIA S.P.A.	0,8421	0,7092	0,5972
78	ČEZ OBNOVITELNÉ ZDROJE, S.R.O.	1,0000	1,0000	1,0000
79	DRAVSKE ELEKTRARNE MARIBOR D.O.O.	1,0717	1,1486	1,2310
80	ELEKTRIZITÄTSWERK ALTDORF AG	0,9220	0,8500	0,7837
81	HÄRJEÅNS KRAFT AKTIEBOLAG	1,2010	1,4424	1,7323
82	TAFJORD KRAFTPRODUKSJON AS	0,8923	0,7962	0,7104
83	ENERGIEVERSORGUNG SYLT GMBH	1,1758	1,3826	1,6256
84	SEA ENERGIA S.P.A.	0,9499	0,9024	0,8572
85	LOMELLINA ENERGIA S.R.L.	0,8448	0,7137	0,6030
86	KEMIJOKI OY	1,0342	1,0696	1,1062
87	PORVOON ENERGIA OY - BORGÅ ENERGI AB	0,9491	0,9007	0,8549
88	ETELÄ-SAVON ENERGIA OY	0,9324	0,8693	0,8105
89	ASM TERNI S.P.A.	1,0488	1,0999	1,1535
90	ONDA COGENERACION SL	1,0861	1,1796	1,2811
91	GREEN GAS DPB, A.S.	0,9821	0,9646	0,9474
92	SOŠKE ELEKTRARNE NOVA GORICA D.O.O.	1,5159	2,2978	3,4831
93	ТОПЛОФИКАЦИЯ ПЛЕВЕН ЕАД	0,9228	0,8516	0,7859
94	ISTAD KRAFT AS	1,0151	1,0304	1,0459
95	ELEKTRIZITÄTSWERK OBWALDEN	0,7986	0,6378	0,5094
96	COGENERACION DEL NOROESTE SL	0,9657	0,9325	0,9005
97	TAMPIERI ENERGIE S.R.L.	0,9098	0,8277	0,7530
98	KANTONALES ELEKTRIZITÄTSWERK NIDWALDEI	1,3863	1,9219	2,6643
99	VULKAN ENERGIEWIRTSCHAFT ODERBRÜCKE G	0,8953	0,8016	0,7177
100	TUSSA ENERGI AS	0,9851	0,9704	0,9560
101	ASPIRAVI	1,0000	1,0000	1,0000
102	SWL ENERGIE AG	0,9918	0,9837	0,9756
103	HAMINAN ENERGIA OY	1,0605	1,1247	1,1928
104	SEL EDISON SPA % SEL EDISON A.G.	1,0000	1,0000	1,0000
105	ТОПЛОФИКАЦИЯ РУСЕ ЕАД	0,7795	0,6076	0,4736
106	VOGHERA ENERGIA S.P.A.	1,3601	1,8498	2,5159
107	TECHNISCHE BETRIEBE GLARUS SÜD	0,9870	0,9742	0,9616
108	SAN MARCO BIOENERGIE S.P.A. IN FORMA ABB	0,8535	0,7284	0,6217
109	VATAJANKOSKEN SÄHKÖ OY	0,9033	0,8160	0,7370
110	BALTEAU IE	1,0000	1,0000	1,0000
111	ТЕЦ СВИЛОЗА АД	1,1823	1,3978	1,6526
112	GKS-GEMEINSCHAFTSKRAFTWERK SCHWEINFU	0,7143	0,5102	0,3644
113	KAINUUN VOIMA OY	0,9045	0,8182	0,7401
114	TARANIS DU ROUVRAY	1,0721	1,1493	1,2321
115	MJÖLBY- SVARTÅDALEN ENERGI AB	1,2308	1,5149	1,8645
116	MASTROPASQUA INTERNATIONAL - S.P.A.	1,0000	1,0000	1,0000
117	PRIMIERO ENERGIA S.P.A.	1,0000	1,0000	1,0000
118	EDA RENOVÁVEIS, S.A.	1,1355	1,2893	1,4640
119	ECOSESTO S.P.A.	0,9873	0,9748	0,9624
120	AKTIEBOLAGET EDSBYNS ELVERK	0,8357	0,6984	0,5836
121	E.T.A. - ENERGIE TECNOLOGIE AMBIENTE SOCIE	0,9591	0,9199	0,8823
122	SOCIETA' ELETTRICA IN MORBEGNO SOCIETA' C(	0,9804	0,9611	0,9423
123	CENTRALA ELECTRICĂ DE TERMOFICARE ARAD S	0,6655	0,4430	0,2948
124	VARESE RISORSE S.P.A.	1,0032	1,0063	1,0095
125	VOSS ENERGI AS	1,1225	1,2600	1,4143
126	GRANADA VAPOR Y ELECTRICIDAD SL	0,7898	0,6238	0,4927
127	AZIENDA SPECIALIZZATA SETTORE MULTISERVIZ	0,9905	0,9811	0,9717
128	LINEA ENERGIA S.P.A.	0,7905	0,6248	0,4939
129	VERSORGUNGSBETRIEBE BORDESHOLM GMBH	1,0000	1,0000	1,0000
130	VEST - ENERGO SA	1,1522	1,3275	1,5295

Annex 5. Production Firms Malmquist indexed 2009-2013, decomposed (part 1)

		2009/2013		
No	Name of the company	Tech change	Eff Change	$M_{2009,2013}$
1	ELECTRICITE DE FRANCE	0,9393	0,8823	0,8288
2	IBERDROLA GENERACION SAU	0,9177	0,8422	0,7729
3	ENEL ENERGIA S.P.A.	1,0000	1,0000	1,0000
4	ENEL PRODUZIONE S.P.A.	1,0180	1,0363	1,0549
5	ČEZ, A. S.	0,9980	0,9961	0,9941
6	A2A S.P.A.	1,0481	1,0985	1,1514
7	ENDESA GENERACION SA	1,1693	1,3672	1,5986
8	MVV ENERGIE AG	1,0138	1,0279	1,0421
9	HIDROELECTRICA DEL CANTABRICO SA	1,0166	1,0335	1,0507
10	STADTWERKE LEIPZIG GMBH	0,7692	0,5917	0,4551
11	SLOVENSKÉ ELEKTRÁRNE, A.S.	1,0158	1,0318	1,0480
12	STADTWERKE HANNOVER AKTIENGESELLSCHAF	1,0600	1,1237	1,1912
13	MAINOVA AKTIENGESELLSCHAFT	0,9842	0,9686	0,9533
14	REPOWER AG	1,0422	1,0861	1,1319
15	UNION ELECTRICA DE CANARIAS GENERACION S	1,0411	1,0840	1,1286
16	FORTUM POWER AND HEAT OY	0,8618	0,7428	0,6402
17	HIDROCANTABRICO ENERGIA SA	1,0000	1,0000	1,0000
18	COMPAGNIA VALDOSTANA DELLE ACQUE	1,0279	1,0567	1,0862
19	REPOWER ITALIA S.P.A.	0,9666	0,9344	0,9032
20	EON GENERACION SL	0,8933	0,7980	0,7129
21	E.ON KÄRNKRAFT SVERIGE AB	1,0000	1,0000	1,0000
22	AZIENDA ENERGETICA S.P.A. - ETSCHWERKE	1,0000	1,0000	1,0000
23	STADTWERKE KIEL AKTIENGESELLSCHAFT	1,2362	1,5281	1,8890
24	RHÖNENERGIE FULDA GMBH	1,0519	1,1065	1,1639
25	HEP-PROIZVODNJA D.O.O.	0,9405	0,8845	0,8318
26	MVM PAKSI ATOMERŐMŰ ZÁRTKÖ	0,9635	0,9283	0,8944
27	ELECTROCENTRALE BUCURESTI SA	1,1553	1,3346	1,5418
28	OKG AKTIEBOLAG	1,0615	1,1268	1,1961
29	GAS Y ELECTRICIDAD GENERACION SA	1,1876	1,4104	1,6749
30	GROSSKRAFTWERK MANNHEIM AK	1,2475	1,5562	1,9414
31	JÄMTKRAFT AKTIEBOLAG	1,0694	1,1435	1,2228
32	EESTI ENERGIA NARVA ELEKTRIJAAMAD AS	1,0000	1,0000	1,0000
33	GETEC ENERGIE AG	0,8925	0,7966	0,7110
34	SOCIETATEA NATIONALA -NUCLEARELECTRICA-	0,9450	0,8931	0,8439
35	ELIA ASSET	1,0889	1,1857	1,2911
36	TEOLLISUUDEN VOIMA OYJ	0,9096	0,8273	0,7525
37	АЕЦ КОЗЛОДУЙ ЕАД	1,0000	1,0000	1,0000
38	ROSEN - ROSIGNANO ENERGIA SPA	1,0000	1,0000	1,0000
39	MÁTRAI ERŐMŰ ZÁRTKÖRŰEN MŰKÖDŐ RÉSZV	1,0651	1,1345	1,2084
40	KERNKRAFTWERK GÖSGEN-DÄNIKEN AG	1,0000	1,0000	1,0000
41	EWV ENERGIE- UND WASSER-VERSORGUNG GN	1,0138	1,0277	1,0418
42	KERNKRAFTWERK GUNDREMMINGEN GMBH	0,9155	0,8381	0,7673
43	E-CO ENERGI AS	1,0255	1,0517	1,0786
44	ТЕЦ МАРИЦА ИЗТОК 2 ЕАД	1,0384	1,0783	1,1197
45	AGDER ENERGI VANNKRAFT AS	0,8797	0,7739	0,6808
46	ENEL GREEN POWER ESPAÑA S L	1,7221	2,9656	5,1070
47	SWE ENERGIE GMBH	0,8954	0,8017	0,7179
48	LYSE PRODUKSJON AS	1,0000	1,0000	1,0000
49	TERMOELEKTRARNA ŠOŠTANJ D.O.O.	1,2344	1,5238	1,8810
50	BKK PRODUKSJON AS	1,0000	1,0000	1,0000
51	ITAL GREEN ENERGY S.R.L.	1,0000	1,0000	1,0000
52	STADTWERKE TÜBINGEN GMBH	1,1155	1,2444	1,3882
53	КОНТУРГЛОБАЛ МАРИЦА ИЗТОК 3 АД	1,0000	1,0000	1,0000
54	TEJO ENERGIA - PRODUÇÃO E DISTRIBUIÇ	1,0000	1,0000	1,0000
55	JYVÄSKYLÄN ENERGIA OY	0,8679	0,7532	0,6537
56	ZEAG ENERGIE AG	1,0797	1,1657	1,2585
57	INFRASERV GMBH & CO. WIESBADEN KG	1,0000	1,0000	1,0000
58	LAHTI ENERGIA OY	1,1665	1,3607	1,5873
59	STADTWERKE REMSCHEID GESELLSCHAFT MIT I	1,0700	1,1449	1,2250
60	G.O.R.I. S.P.A. - GESTIONE OTTIMALE RISORSE I	0,9692	0,9394	0,9105
61	FMV SA	1,1671	1,3622	1,5899
62	ENERGOTRANS, A.S.	1,0000	1,0000	1,0000
63	UNTERFRÄNKISCHE ÜBERLANDZENTRALE EG	0,9912	0,9826	0,9740
64	KRAFTWERKE OBERHASLI AG	1,0718	1,1488	1,2312
65	ELCOGAS SOCIEDAD ANONIMA	1,0072	1,0144	1,0216

Annex 5. Production Firms Malmquist indexed 2009-2013, decomposed (part 2)

66	FLYENERGIA SOCIETA' PER AZIONI	1,0000	1,0000	1,0000
67	ŠKO-ENERGO, S.R.O.	1,2237	1,4975	1,8324
68	EDISON ENERGIE SPECIALI S.P.A.	0,7654	0,5858	0,4484
69	GEMEINSCHAFTSKRAFTWERK VELTHEIM GESEL	0,9265	0,8585	0,7954
70	SCHLUCHSEEWERK AKTIENGESELLSCHAFT	1,1730	1,3760	1,6140
71	ASTEA S.P.A.	0,8646	0,7476	0,6464
72	HYDRO EXPLOITATION SA	1,0000	1,0000	1,0000
73	GUDBRANDSDAL ENERGI AS	0,9546	0,9113	0,8700
74	OTTANA ENERGIA SOCIETA' PER AZIONI- S.P.A. (	1,0611	1,1260	1,1949
75	ENGADINER KRAFTWERKE AG	0,8473	0,7179	0,6083
76	ITALGEN S.P.A.	0,9730	0,9467	0,9212
77	BIOMASSE ITALIA S.P.A.	1,1370	1,2928	1,4700
78	ČEZ OBNOVITELNÉ ZDROJE, S.R.O.	1,0000	1,0000	1,0000
79	DRAVSKE ELEKTRARNE MARIBOR D.O.O.	1,0470	1,0962	1,1477
80	ELEKTRIZITÄTSWERK ALTDORF AG	1,0000	1,0000	1,0000
81	HÄRJEÅNS KRAFT AKTIEBOLAG	0,9690	0,9390	0,9100
82	TAFJORD KRAFTPRODUKSJON AS	1,0000	1,0000	1,0000
83	ENERGIEVERSORGUNG SYLT GMBH	0,9738	0,9483	0,9235
84	SEA ENERGIA S.P.A.	0,9869	0,9740	0,9612
85	LOMELLINA ENERGIA S.R.L.	0,9147	0,8368	0,7654
86	KEMIJOKI OY	0,8651	0,7484	0,6474
87	PORVOON ENERGIA OY - BORGÅ ENERGI AB	1,0796	1,1655	1,2582
88	ETELÄ-SAVON ENERGIA OY	1,0129	1,0260	1,0392
89	ASM TERNI S.P.A.	0,8745	0,7648	0,6688
90	ONDA COGENERACION SL	0,8202	0,6727	0,5517
91	GREEN GAS DPB, A.S.	0,9639	0,9290	0,8954
92	SOŠKE ELEKTRARNE NOVA GORICA D.O.O.	0,8505	0,7234	0,6152
93	ТОПЛОФИКАЦИЯ ПЛЕВЕН ЕАД	1,1801	1,3927	1,6435
94	ISTAD KRAFT AS	1,0388	1,0791	1,1209
95	ELEKTRIZITÄTSWERK OBWALDEN	1,0690	1,1427	1,2216
96	COGENERACION DEL NOROESTE SL	1,0000	1,0000	1,0000
97	TAMPIERI ENERGIE S.R.L.	1,0000	1,0000	1,0000
98	KANTONALES ELEKTRIZITÄTSWERK NIDWALDEI	0,8106	0,6570	0,5325
99	VULKAN ENERGIEWIRTSCHAFT ODERBRÜCKE G	1,3502	1,8232	2,4617
100	TUSSA ENERGI AS	1,0339	1,0690	1,1053
101	ASPIRAVI	1,3022	1,6958	2,2083
102	SWL ENERGIE AG	0,8168	0,6672	0,5450
103	HAMINAN ENERGIA OY	1,0080	1,0161	1,0242
104	SEL EDISON SPA % SEL EDISON A.G.	1,0000	1,0000	1,0000
105	ТОПЛОФИКАЦИЯ РУСЕ ЕАД	1,0389	1,0793	1,1212
106	VOGHERA ENERGIA S.P.A.	1,0086	1,0173	1,0261
107	TECHNISCHE BETRIEBE GLARUS SÜD	1,1500	1,3226	1,5210
108	SAN MARCO BIOENERGIE S.P.A. IN FORMA ABB	1,2005	1,4411	1,7300
109	VATAJANKOSKEN SÄHKÖ OY	0,9617	0,9248	0,8893
110	BALTEAU IE	1,0391	1,0798	1,1221
111	ТЕЦ СВИЛОЗА АД	1,0087	1,0175	1,0264
112	GKS-GEMEINSCHAFTSKRAFTWERK SCHWEINFU	1,0620	1,1278	1,1977
113	KAINUUN VOIMA OY	0,9107	0,8294	0,7554
114	TARANIS DU ROUVRAY	1,0038	1,0076	1,0115
115	MJÖLBY- SVARTÅDALEN ENERGI AB	1,0858	1,1789	1,2800
116	MASTROPASQUA INTERNATIONAL - S.P.A.	1,0002	1,0004	1,0006
117	PRIMIERO ENERGIA S.P.A.	1,0000	1,0000	1,0000
118	EDA RENOVÁVEIS, S.A.	0,8807	0,7756	0,6831
119	ECOSESTO S.P.A.	1,0876	1,1828	1,2864
120	AKTIEBOLAGET EDSBYNS ELVERK	1,0530	1,1087	1,1674
121	E.T.A. - ENERGIE TECNOLOGIE AMBIENTE SOCIE	1,2295	1,5116	1,8585
122	SOCIETA' ELETTRICA IN MORBEGNO SOCIETA' C(	1,0416	1,0850	1,1301
123	CENTRALA ELECTRICĂ DE TERMOFICARE ARAD S	1,4536	2,1131	3,0716
124	VARESE RISORSE S.P.A.	1,1677	1,3635	1,5921
125	VOSS ENERGI AS	0,9323	0,8691	0,8103
126	GRANADA VAPOR Y ELECTRICIDAD SL	0,9944	0,9889	0,9834
127	AZIENDA SPECIALIZZATA SETTORE MULTISERVIZ	1,0771	1,1601	1,2495
128	LINEA ENERGIA S.P.A.	1,0499	1,1022	1,1572
129	VERSORGUNGSBETRIEBE BORDESHOLM GMBH	1,0000	1,0000	1,0000
130	VEST - ENERGO SA	0,8679	0,7533	0,6538

Annex 6. Production Firms Malmquist indexed 2004-2013, decomposed (part 1)

		2004/2013		
No	Name of the company	Tech Change	Eff Change	$M_{2004,2013}$
1	ELECTRICITE DE FRANCE	0,9405	0,8845	0,8319
2	IBERDROLA GENERACION SAU	1,2833	1,6469	2,1135
3	ENEL ENERGIA S.P.A.	1,0000	1,0000	1,0000
4	ENEL PRODUZIONE S.P.A.	1,4562	2,1204	3,0877
5	ČEZ, A. S.	1,0402	1,0821	1,1256
6	A2A S.P.A.	1,1838	1,4015	1,6591
7	ENDESA GENERACION SA	1,1892	1,4141	1,6816
8	MVV ENERGIE AG	0,9617	0,9248	0,8893
9	HIDROELECTRICA DEL CANTABRICO SA	0,9892	0,9786	0,9680
10	STADTWERKE LEIPZIG GMBH	0,7626	0,5816	0,4435
11	SLOVENSKÉ ELEKTRÁRNE, A.S.	1,4604	2,1327	3,1144
12	STADTWERKE HANNOVER AKTIENGESELLSCHAF	1,1348	1,2877	1,4613
13	MAINOVA AKTIENGESELLSCHAFT	1,0093	1,0187	1,0282
14	REPOWER AG	1,1211	1,2568	1,4089
15	UNION ELECTRICA DE CANARIAS GENERACION S	0,9882	0,9765	0,9650
16	FORTUM POWER AND HEAT OY	1,0272	1,0551	1,0837
17	HIDROCANTABRICO ENERGIA SA	1,0000	1,0000	1,0000
18	COMPAGNIA VALDOSTANA DELLE ACQUE	1,0952	1,1995	1,3137
19	REPOWER ITALIA S.P.A.	1,0000	1,0000	1,0000
20	EON GENERACION SL	0,7679	0,5897	0,4528
21	E.ON KÄRNKRAFT SVERIGE AB	1,0000	1,0000	1,0000
22	AZIENDA ENERGETICA S.P.A. - ETSCHWERKE	1,0000	1,0000	1,0000
23	STADTWERKE KIEL AKTIENGESELLSCHAFT	1,0691	1,1430	1,2220
24	RHÖNENERGIE FULDA GMBH	0,9453	0,8935	0,8446
25	HEP-PROIZVODNJA D.O.O.	0,8499	0,7223	0,6139
26	MVM PAKSI ATOMERŐMŰ ZÁRTKÖ	0,7351	0,5404	0,3973
27	ELECTROCENTRALE BUCURESTI SA	1,2307	1,5145	1,8638
28	OKG AKTIEBOLAG	1,0403	1,0822	1,1257
29	GAS Y ELECTRICIDAD GENERACION SA	1,3865	1,9223	2,6651
30	GROSSKRAFTWERK MANNHEIM AK	1,2194	1,4869	1,8132
31	JÄMTKRAFT AKTIEBOLAG	1,5583	2,4284	3,7842
32	EESTI ENERGIA NARVA ELEKTRIJAAMAD AS	1,0000	1,0000	1,0000
33	GETEC ENERGIE AG	1,0000	1,0000	1,0000
34	SOCIETATEA NATIONALA -NUCLEARELECTRICA-	0,8291	0,6874	0,5700
35	ELIA ASSET	1,1437	1,3080	1,4959
36	TEOLLISUUDEN VOIMA OYJ	0,8952	0,8013	0,7173
37	АЕЦ КОЗЛОДУЙ ЕАД	1,0000	1,0000	1,0000
38	ROSEN - ROSIGNANO ENERGIA SPA	1,0000	1,0000	1,0000
39	MÁTRAI ERŐMŰ ZÁRTKÖRŰEN MŰKÖDŐ RÉSZV	1,1493	1,3210	1,5183
40	KERNKRAFTWERK GÖSGEN-DÄNIKEN AG	1,0000	1,0000	1,0000
41	EWV ENERGIE- UND WASSER-VERSORGUNG GN	0,8587	0,7374	0,6332
42	KERNKRAFTWERK GUNDREMMINGEN GMBH	0,5381	0,2896	0,1558
43	E-CO ENERGI AS	1,0255	1,0517	1,0786
44	ТЕЦ МАРИЦА ИЗТОК 2 ЕАД	1,0525	1,1077	1,1658
45	AGDER ENERGI VANNKRAFT AS	1,0000	1,0000	1,0000
46	ENEL GREEN POWER ESPAÑA S L	1,3636	1,8594	2,5355
47	SWE ENERGIE GMBH	0,7675	0,5890	0,4521
48	LYSE PRODUKSJON AS	0,9353	0,8748	0,8182
49	TERMOELEKTRARNA ŠOŠTANJ D.O.O.	1,1910	1,4186	1,6896
50	BKK PRODUKSJON AS	1,0000	1,0000	1,0000
51	ITAL GREEN ENERGY S.R.L.	1,0000	1,0000	1,0000
52	STADTWERKE TÜBINGEN GMBH	0,9584	0,9186	0,8804
53	КОНТУРГЛОБАЛ МАРИЦА ИЗТОК 3 АД	0,9744	0,9495	0,9252
54	TEJO ENERGIA - PRODUÇÃO E DISTRIBUIÇ	1,0000	1,0000	1,0000
55	JYVÄSKYLÄN ENERGIA OY	1,0916	1,1917	1,3009
56	ZEAG ENERGIE AG	1,5151	2,2956	3,4780
57	INFRASERV GMBH & CO. WIESBADEN KG	0,8152	0,6645	0,5417
58	LAHTI ENERGIA OY	0,8966	0,8039	0,7208
59	STADTWERKE REMSCHEID GESELLSCHAFT MIT I	0,8323	0,6928	0,5766
60	G.O.R.I. S.P.A. - GESTIONE OTTIMALE RISORSE I	1,0000	1,0000	1,0000
61	FMV SA	1,0949	1,1989	1,3127
62	ENERGOTRANS, A.S.	0,9178	0,8423	0,7730
63	UNTERFRÄNKISCHE ÜBERLANDZENTRALE EG	0,9729	0,9466	0,9209
64	KRAFTWERKE OBERHASLI AG	1,2702	1,6134	2,0494
65	ELCOGAS SOCIEDAD ANONIMA	0,9003	0,8105	0,7297

Annex 6. Production Firms Malmquist indexed 2004-2013, decomposed (part 2)

66	FLYENERGIA SOCIETA' PER AZIONI	1,0000	1,0000	1,0000
67	ŠKO-ENERGO, S.R.O.	1,2237	1,4975	1,8324
68	EDISON ENERGIE SPECIALI S.P.A.	1,0000	1,0000	1,0000
69	GEMEINSCHAFTSKRAFTWERK VELTHEIM GESEL	0,9323	0,8691	0,8102
70	SCHLUCHSEEWERK AKTIENGESELLSCHAFT	0,8551	0,7312	0,6253
71	ASTEA S.P.A.	0,8963	0,8034	0,7201
72	HYDRO EXPLOITATION SA	1,0000	1,0000	1,0000
73	GUDBRANDSDAL ENERGI AS	1,1255	1,2668	1,4258
74	OTTANA ENERGIA SOCIETA' PER AZIONI - S.P.A. (	1,0822	1,1711	1,2673
75	ENGADINER KRAFTWERKE AG	1,3521	1,8282	2,4718
76	ITALGEN S.P.A.	1,0693	1,1434	1,2226
77	BIOMASSE ITALIA S.P.A.	0,9575	0,9169	0,8779
78	ČEZ OBNOVITELNÉ ZDROJE, S.R.O.	1,0000	1,0000	1,0000
79	DRAVSKE ELEKTRARNE MARIBOR D.O.O.	1,1221	1,2591	1,4129
80	ELEKTRIZITÄTSWERK ALTDORF AG	0,9220	0,8500	0,7837
81	HÄRJEÅNS KRAFT AKTIEBOLAG	1,1638	1,3545	1,5763
82	TAFJORD KRAFTPRODUKSJON AS	0,8923	0,7962	0,7104
83	ENERGIEVERSORGUNG SYLT GMBH	1,1450	1,3111	1,5013
84	SEA ENERGIA S.P.A.	0,9375	0,8789	0,8240
85	LOMELLINA ENERGIA S.R.L.	0,7728	0,5972	0,4615
86	KEMIJOKI OY	0,8947	0,8005	0,7162
87	PORVOON ENERGIA OY - BORGÅ ENERGI AB	1,0246	1,0498	1,0756
88	ETELÄ-SAVON ENERGIA OY	0,9444	0,8919	0,8423
89	ASM TERNI S.P.A.	0,9172	0,8412	0,7715
90	ONDA COGENERACION SL	0,8908	0,7935	0,7068
91	GREEN GAS DPB, A.S.	0,9466	0,8961	0,8483
92	SOŠKE ELEKTRARNE NOVA GORICA D.O.O.	1,2892	1,6622	2,1429
93	ТОПЛОФИКАЦИЯ ПЛЕВЕН ЕАД	1,0891	1,1861	1,2917
94	ISTAD KRAFT AS	1,0544	1,1119	1,1724
95	ELEKTRIZITÄTSWERK OBWALDEN	0,8537	0,7289	0,6223
96	COGENERACION DEL NOROESTE SL	0,9657	0,9325	0,9005
97	TAMPIERI ENERGIE S.R.L.	0,9098	0,8277	0,7530
98	KANTONALES ELEKTRIZITÄTSWERK NIDWALDE	1,1237	1,2627	1,4188
99	VULKAN ENERGIEWIRTSCHAFT ODERBRÜCKE G	1,2089	1,4614	1,7667
100	TUSSA ENERGI AS	1,0185	1,0374	1,0566
101	ASPIRAVI	1,3022	1,6958	2,2083
102	SWL ENERGIE AG	0,8101	0,6563	0,5317
103	HAMINAN ENERGIA OY	1,0690	1,1428	1,2217
104	SEL EDISON SPA % SEL EDISON A.G.	1,0000	1,0000	1,0000
105	ТОПЛОФИКАЦИЯ РУСЕ ЕАД	0,8098	0,6557	0,5310
106	VOGHERA ENERGIA S.P.A.	1,3718	1,8818	2,5815
107	TECHNISCHE BETRIEBE GLARUS SÜD	1,1351	1,2885	1,4625
108	SAN MARCO BIOENERGIE S.P.A. IN FORMA ABB	1,0246	1,0497	1,0755
109	VATAJANKOSKEN SÄHKÖ OY	0,8687	0,7546	0,6555
110	BALTEAU IE	1,0391	1,0798	1,1221
111	ТЕЦ СВИЛОЗА АД	1,1926	1,4223	1,6962
112	GKS-GEMEINSCHAFTSKRAFTWERK SCHWEINFU	0,7586	0,5754	0,4365
113	KAINUUN VOIMA OY	0,8238	0,6786	0,5590
114	TARANIS DU ROUVRAY	1,0761	1,1581	1,2463
115	MJÖLBY- SVARTÅDALEN ENERGI AB	1,3364	1,7858	2,3865
116	MASTROPASQUA INTERNATIONAL - S.P.A.	1,0002	1,0004	1,0006
117	PRIMIERO ENERGIA S.P.A.	1,0000	1,0000	1,0000
118	EDA RENOVÁVEIS, S.A.	1,0000	1,0000	1,0000
119	ECOSESTO S.P.A.	1,0738	1,1530	1,2380
120	AKTIEBOLAGET EDSBYNS ELVERK	0,8800	0,7743	0,6814
121	E.T.A. - ENERGIE TECNOLOGIE AMBIENTE SOCIE	1,1792	1,3906	1,6398
122	SOCIETA' ELETTRICA IN MORBEGNO SOCIETA' C(	1,0212	1,0428	1,0649
123	CENTRALA ELECTRICĂ DE TERMOFICARE ARAD S	0,9675	0,9360	0,9055
124	VARESE RISORSE S.P.A.	1,1714	1,3721	1,6073
125	VOSS ENERGI AS	1,0465	1,0951	1,1459
126	GRANADA VAPOR Y ELECTRICIDAD SL	0,7854	0,6169	0,4845
127	AZIENDA SPECIALIZZATA SETTORE MULTISERVIZ	1,0668	1,1381	1,2142
128	LINEA ENERGIA S.P.A.	0,8299	0,6887	0,5716
129	VERSORGUNGSBETRIEBE BORDESHOLM GMBH	1,0000	1,0000	1,0000
130	VEST - ENERGO SA	1,0000	1,0000	1,0000

Annex 7. SFA, 2004 and 2009 scores for producing firms (part 1)

No	Name of the company	sfa2004	sfa2009
1	ELECTRICITE DE FRANCE	0,5219	0,5230
2	IBERDROLA GENERACION SAU	0,5440	0,5084
3	ENEL ENERGIA S.P.A.	0,4799	0,5755
4	ENEL PRODUZIONE S.P.A.	0,5762	0,5506
5	ČEZ, A. S.	0,5733	0,5680
6	A2A S.P.A.	0,4939	0,5395
7	ENDESA GENERACION SA	0,5605	0,5173
8	MVV ENERGIE AG	0,4934	0,5067
9	HIDROELECTRICA DEL CANTABRICO SA	0,5271	0,5079
10	STADTWERKE LEIPZIG GMBH	0,4298	0,5029
11	SLOVENSKÉ ELEKTRÁRNE, A.S.	0,5059	0,4816
12	STADTWERKE HANNOVER AKTIENGESELLSC	0,4843	0,5000
13	MAINOVA AKTIENGESELLSCHAFT	0,4717	0,4659
14	REPOWER AG	0,3709	0,4497
15	UNION ELECTRICA DE CANARIAS GENERACI	0,4522	0,4522
16	FORTUM POWER AND HEAT OY	0,5169	0,4952
17	HIDROCANTABRICO ENERGIA SA	0,3953	0,4461
18	COMPAGNIA VALDOSTANA DELLE ACQUE	0,3888	0,3890
19	REPOWER ITALIA S.P.A.	0,3665	0,3834
20	EON GENERACION SL	0,4107	0,4275
21	E.ON KÄRNKRAFT SVERIGE AB	0,4401	0,3990
22	AZIENDA ENERGETICA S.P.A. - ETSCHWERKE	0,1865	0,1803
23	STADTWERKE KIEL AKTIENGESELLSCHAFT	0,3720	0,2762
24	RHÖNENERGIE FULDA GMBH	0,3247	0,3596
25	HEP-PROIZVODNJA D.O.O.	0,4255	0,4115
26	MVM PAKSI ATOMERŐMŰ ZÁRTKÖ	0,4258	0,3942
27	ELECTROCENTRALE BUCURESTI SA	0,4555	0,4069
28	OKG AKTIEBOLAG	0,4118	0,3625
29	GAS Y ELECTRICIDAD GENERACION SA	0,4207	0,4118
30	GROSSKRAFTWERK MANNHEIM AK	0,3818	0,3612
31	JÄMTKRAFT AKTIEBOLAG	0,3127	0,2979
32	EESTI ENERGIA NARVA ELEKTRIJAAMAD AS	0,4671	0,4751
33	GETEC ENERGIE AG	0,2638	0,3150
34	SOCIETATEA NATIONALA -NUCLEARELECTRI	0,3579	0,3926
35	ELIA ASSET	0,3798	0,3471
36	TEOLLISUUDEN VOIMA OYJ	0,2878	0,2901
37	АЕЦ КОЗЛОДУЙ ЕАД	0,3093	0,3152
38	ROSEN - ROSIGNANO ENERGIA SPA	0,4306	0,4750
39	MÁTRAI ERŐMŰ ZÁRTKÖRŰEN MŰKÖDŐ R	0,3733	0,3544
40	KERNKRAFTWERK GÖSGEN-DÄNIKEN AG	0,3245	0,5096
41	EWV ENERGIE- UND WASSER-VERSORGUNG	0,3412	0,3402
42	KERNKRAFTWERK GUNDREMMINGEN GMB	0,3134	0,3340
43	E-CO ENERGI AS	0,3763	0,3590
44	ТЕЦ МАРИЦА ИЗТОК 2 ЕАД	0,5255	0,4050
45	AGDER ENERGI VANNKRAFT AS	0,3588	0,3717
46	ENEL GREEN POWER ESPAÑA S L	0,2594	0,3192
47	SWE ENERGIE GMBH	0,3151	0,3537
48	LYSE PRODUKSJON AS	0,3542	0,3320
49	TERMOELEKTRARNA ŠOŠTANJ D.O.O.	0,6045	0,4379
50	BKK PRODUKSJON AS	0,3447	0,3466
51	ITAL GREEN ENERGY S.R.L.	0,6184	0,5736
52	STADTWERKE TÜBINGEN GMBH	0,2788	0,2823
53	КОНТУРГЛОБАЛ МАРИЦА ИЗТОК 3 АД	0,6720	0,7261
54	TEJO ENERGIA - PRODUÇÃO E DISTRIBUIÇ	0,5667	0,6029
55	JYVÄSKYLÄN ENERGIA OY	0,6255	0,5947
56	ZEAG ENERGIE AG	0,2729	0,2652
57	INFRASERV GMBH & CO. WIESBADEN KG	0,3071	0,2884
58	LAHTI ENERGIA OY	0,5855	0,5808
59	STADTWERKE REMSCHEID GESELLSCHAFT M	0,3053	0,2811
60	G.O.R.I. S.P.A. - GESTIONE OTTIMALE RISOR	0,6075	0,5849
61	FMV SA	0,6232	0,5907
62	ENERGOTRANS, A.S.	0,3209	0,3023
63	UNTERFRÄNKISCHE ÜBERLANDZENTRALE E	0,2221	0,2325
64	KRAFTWERKE OBERHASLI AG	0,6040	0,6008
65	ELCOGAS SOCIEDAD ANONIMA	0,3361	0,2843

Annex 7. SFA, 2004 and 2009 scores for producing firms (part 2)

66	FLYENERGIA SOCIETA' PER AZIONI	0,5939	0,5720
67	ŠKO-ENERGO, S.R.O.	0,2760	0,2444
68	EDISON ENERGIE SPECIALI S.P.A.	0,5656	0,6639
69	GEMEINSCHAFTSKRAFTWERK VELTHEIM GE	0,3067	0,2717
70	SCHLUCHSEEWERK AKTIENGESELLSCHAFT	0,2522	0,2412
71	ASTEA S.P.A.	0,5985	0,5948
72	HYDRO EXPLOITATION SA	0,5274	0,5174
73	GUDBRANDSDAL ENERGI AS	0,6358	0,6080
74	OTTANA ENERGIA SOCIETA' PER AZIONI- S.P	0,5905	0,5794
75	ENGADINER KRAFTWERKE AG	0,6474	0,6528
76	ITALGEN S.P.A.	0,6357	0,6159
77	BIOMASSE ITALIA S.P.A.	0,6130	0,6212
78	ČEZ OBNOVITELNÉ ZDROJE, S.R.O.	0,0841	0,1423
79	DRAVSKE ELEKTRARNE MARIBOR D.O.O.	0,6541	0,6579
80	ELEKTRIZITÄTSWERK ALTDORF AG	0,6090	0,6158
81	HÄRJEÅNS KRAFT AKTIEBOLAG	0,6630	0,6196
82	TAFJORD KRAFTPRODUKSJON AS	0,6470	0,6586
83	ENERGIEVERSORGUNG SYLT GMBH	0,2079	0,2013
84	SEA ENERGIA S.P.A.	0,6174	0,6141
85	LOMELLINA ENERGIA S.R.L.	0,6410	0,6538
86	KEMIJOKI OY	0,6144	0,6296
87	PORVOON ENERGIA OY - BORGÅ ENERGI AB	0,6297	0,6200
88	ETELÄ-SAVON ENERGIA OY	0,6334	0,6309
89	ASM TERNI S.P.A.	0,5641	0,5943
90	ONDA COGENERACION SL	0,6342	0,6142
91	GREEN GAS DPB, A.S.	0,1970	0,1988
92	SOŠKE ELEKTRARNE NOVA GORICA D.O.O.	0,6386	0,6329
93	ТОПЛОФИКАЦИЯ ПЛЕВЕН ЕАД	0,6394	0,6465
94	ISTAD KRAFT AS	0,6142	0,6077
95	ELEKTRIZITÄTSWERK OBWALDEN	0,6258	0,6183
96	COGENERACION DEL NOROESTE SL	0,6137	0,6042
97	TAMPIERI ENERGIE S.R.L.	0,6238	0,6259
98	KANTONALES ELEKTRIZITÄTSWERK NIDWAL	0,6071	0,5982
99	VULKAN ENERGIEWIRTSCHAFT ODERBRÜCK	0,2438	0,1587
100	TUSSA ENERGI AS	0,6335	0,6281
101	ASPIRAVI	0,5778	0,6060
102	SWL ENERGIE AG	0,6125	0,6014
103	HAMINAN ENERGIA OY	0,6324	0,6189
104	SEL EDISON SPA % SEL EDISON A.G.	0,6272	0,6429
105	ТОПЛОФИКАЦИЯ РУСЕ ЕАД	0,6439	0,6315
106	VOGHERA ENERGIA S.P.A.	0,4318	0,6397
107	TECHNISCHE BETRIEBE GLARUS SÜD	0,5290	0,5177
108	SAN MARCO BIOENERGIE S.P.A. IN FORMA A	0,6219	0,6213
109	VATAJANKOSKEN SÄHKÖ OY	0,6213	0,6152
110	BALTEAU IE	0,6112	0,5933
111	ТЕЦ СВИЛОЗА АД	0,6431	0,6282
112	GKS-GEMEINSCHAFTSKRAFTWERK SCHWEIN	0,1975	0,1684
113	KAINUUN VOIMA OY	0,6373	0,6240
114	TARANIS DU ROUVRAY	0,6765	0,6309
115	MJÖLBY- SVARTÅDALEN ENERGI AB	0,6290	0,6082
116	MASTROPASQUA INTERNATIONAL - S.P.A.	0,6004	0,5933
117	PRIMIERO ENERGIA S.P.A.	0,6163	0,6235
118	EDA RENOVÁVEIS, S.A.	0,5810	0,6044
119	ECOSESTO S.P.A.	0,6226	0,5940
120	AKTIEBOLAGET EDSBYNS ELVERK	0,6113	0,5942
121	E.T.A. - ENERGIE TECNOLOGIE AMBIENTE SO	0,6035	0,5980
122	SOCIETA' ELETTRICA IN MORBEGNO SOCIETA	0,5762	0,6085
123	CENTRALA ELECTRICĂ DE TERMOFICARE AR	0,6185	0,6045
124	VARESE RISORSE S.P.A.	0,5668	0,5833
125	VOSS ENERGI AS	0,6060	0,5531
126	GRANADA VAPOR Y ELECTRICIDAD SL	0,6054	0,5961
127	AZIENDA SPECIALIZZATA SETTORE MULTISE	0,5901	0,5866
128	LINEA ENERGIA S.P.A.	0,6069	0,6021
129	VERSORGUNGSBETRIEBE BORDESHOLM GM	0,1082	0,1098
130	VEST - ENERGO SA	0,5849	0,6048

Annex 8. Different Technologies Plots for producing firms, DEA method.