

**EVALUATING THE REGULATOR: WINNERS AND  
LOSERS IN THE REGULATION OF SPANISH  
ELECTRICITY DISTRIBUTION (1988-2002)**

Autores: *Leticia Blázquez Gómez*<sup>(1)</sup>

*Emili Grifell-Tatjé*<sup>(2)</sup>

P. T. N.º 7/08

(1) Department of Spanish and International Economics, Econometry and Economic History and Institutions, Toledo Faculty of Law and Social Sciences, University of Castile-La Mancha, Cobertizo de San Pedro Mártir, s/n, 45071, Toledo (Spain). [Leticia.Blazquez@uclm.es](mailto:Leticia.Blazquez@uclm.es)

(2) Department of Business Economics, Faculty of Economic and Business Studies, Universitat Autònoma de Barcelona, Campus de la UAB, 08193, Bellaterra (Cerdanyola del Vallès), Barcelona (Spain). [emili.grifell@uab.cat](mailto:emili.grifell@uab.cat)

N.B.: Las opiniones expresadas en este trabajo son de la exclusiva responsabilidad de los autores, pudiendo no coincidir con las del Instituto de Estudios Fiscales.

Desde el año 1998, la colección de Papeles de Trabajo del Instituto de Estudios Fiscales está disponible en versión electrónica, en la dirección: ><http://www.minhac.es/ief/principal.htm>.

Edita: Instituto de Estudios Fiscales

N.I.P.O.: 602-08-004-3

I.S.S.N.: 1578-0252

Depósito Legal: M-23772-2001

## INDEX

1. INTRODUCTION
  2. REGULATION OF THE SPANISH ELECTRICITY DISTRIBUTION
  3. AN INCENTIVES MODEL FOR ELECTRICITY DISTRIBUTION ACTIVITY
    - 3.1. Regulation of electricity distribution
      - 3.1.1. The regulation model
      - 3.1.2. Rewarding electricity distribution
    - 3.2. Decisions made by the regulator about  $\rho$  factor
      - 3.2.1. About the setting of  $\rho$
      - 3.2.2. Classification of the regulator's behavior
  4. IMPLEMENTATION OF THE INCENTIVES MODEL
    - 4.1. Definition of the base years
    - 4.2. The costs of electricity distribution
    - 4.3. Renegotiation incomes
    - 4.4. A calculation of  $c^{\text{DEA-}i}(y_i, w_i)$
  5. DEFINITION OF THE DATA AND VARIABLES
  6. RESULTS
  7. CONCLUSIONS
- REFERENCES
- SÍNTESIS. Principales implicaciones



## **ABSTRACT**

The main aim of this article is to evaluate the actions of the Spanish regulator as far as the activity of electricity distribution is concerned. In contrast to other European Union countries, in Spain this activity has historically been in the hands of the private sector. To this end, we shall firstly analyze whether the legislative changes introduced by the regulator have led to the distribution companies improving their efficiency levels; secondly, whether the benefits they have obtained have been linked to these levels; and lastly, whether the consumer has shared in these improvements. The analysis was carried out by comparing the income obtained by the companies as reward for their electricity distribution activity during the 1988-2002 period with those they would have received had the regulation model proposed by Bogetoft (1997) been applied to them. The results show that the Spanish electricity regulator has not linked the reward given to the companies with their efficiency, and in addition, they have benefited at the expense of the interests of the consumer.

**JEL classification:** D24, D82, L12, L51, L94.

**Keywords:** efficiency analysis, regulation by incentives, Spanish electricity distribution, yardstick competition.



## I. INTRODUCTION

In recent decades, the countries of the European Union (EU) have introduced significant reforms in the electricity sector, promoted in the framework of the various European initiatives aimed at creating a common energy market in Europe. From the point of view of regulation, the reforms have meant introducing competition into the generating and service activities, while transport and distribution have continued to be considered as natural monopolies under regulation. In the case of electricity distribution, the regulatory models based on the cost of the service or on the maximum profitability allowed, in which prices reflected the level of cost which firms had incurred, have been gradually abandoned, and incentive based regulation systems have been adopted instead. Spain, where unlike other EU countries electricity distribution has historically been in the hands of the private sector, has been a pioneer in adopting these models.

The main advantage of incentive-based models is that they encourage and induce the companies to increase their productive efficiency, so that companies' operating costs are reduced. In order for these models to function correctly, the optimum solution is to establish a clear legislation that sets out the parameters that will determine the rewards to companies and establish the period of time during which these criteria will remain unaltered. However, their practical implementation tends to be accompanied by a high degree of complexity. Usually, the regulating authority publishes a set of main laws fixing the goals and the compensation mechanisms for the companies. However, after some time, frequently a really brief period, the regulator, often under pressures that are both political and business in nature, introduces modifications to these laws, or even decides to change the previously set incentive mechanisms. In this context it is not always easy to assess whether the regulator has got it right.

A second aspect to be considered is who the regulation should benefit. The response is well-known: regulation is justified when the correct functioning of the market is not possible. In a market, competition provides companies with the motivation to improve their productive efficiency and pressure so that cost reductions can be translated into lower selling prices. Thus the consumer is the one who benefits the most. Regulation, which replaces the market, should have the same goal. Yet a large majority of consumers' associations consider that the regulator legislates mainly in favor of the companies and their shareholders, and is in the hands of the companies. This is due to the "vertigo" experienced when faced with the enormous political cost represented by a failure in the electricity distribution system. There are very recent examples both in the EU and the US of the economic and media impact of this type of situation.

The main aim of this article is to evaluate the actions of the Spanish regulator in the activity of electricity distribution during the 1988-2002 period. To do so,

we shall analyze three questions: i) Whether the legislative changes introduced by the Spanish regulator implied that higher levels of efficiency in electricity distribution companies were achieved; ii) Whether the reimbursements received by companies corresponded with the levels of efficiency attained by them. In the case of the regulation of Spanish electricity distribution it can be said that, at the beginning of the study period, the reimbursements were the result of combining various incentive systems which have been modified over time through successive legislative reforms (Blázquez and Grifell-Tatjé, 2004). In these models, increases in efficiency are normally shared between consumers and the companies, to ensure that the latter have an incentive to improve, and; iii) Whether or not regulation has allowed both consumers and companies to receive the benefits of the new model applied, or whether any of the groups has been favored by the regulation to the detriment of the interests of the other.

In the literature concerning the energy sector, there are studies examining these three aspects separately, for example Knittel (2002) in the case of regulation by incentives and efficiency, or Doyle (1998), McKerron and Pearson (2000) and Arocena, Cotín and Huerta (2002) for the analysis of the conflict of interests between companies and consumers. However, in this study we shall deal with them jointly, using for this the incentive based regulation model proposed by Bogetoft (1997). This model is based on the idea of “yardstick competition”, i.e. that a company should not be compensated in line with its costs, but rather depending on the costs of other (comparable) companies. By allowing the companies to recover only the costs thus estimated instead of those really incurred, the regulator gives them incentives to minimize their costs, minimizing the effects of the asymmetries of information existing between the regulator and the said companies.

The simulation of this model will reveal that the Spanish regulator, in designing its scheme of compensating electricity distribution, has not linked the efficiency of the companies with the reimbursements that these have obtained, and this has led the companies that were inefficient at the beginning of the period under consideration continuing to be so throughout this period, without achieving any improvement.

In addition it can be seen how, during the whole period, with some rare exceptions, the Spanish regulator has behaved in a beneficial way to the companies and at the expense of the interests of the consumer, since companies have obtained reimbursements far beyond what an incentive based system would recommend. Therefore, we have detected a transfer of rents, as a result of overpayment by consumers.

The outline of the paper is as follows. In the next section we will describe schematically the legislation applied to Spanish electricity distribution between 1988 and 2002 and examine it from the incentives point of view. In section 3



will describe the incentive based regulation model with which the Spanish regulation will be compared. In Section 4 we will explain how the comparison has been made operative. In this sense, one of the main difficulties encountered has been the Spanish electricity companies' vertical integration. In Section 5 we will define the data and variables, and discuss the reason why we have not considered quality of the service as a variable. In section 6 we will present the main results, and section 7 concludes.

## 2. REGULATION OF THE SPANISH ELECTRICITY DISTRIBUTION

Throughout the period of time analyzed in this study, from 1988 to 2002, we can distinguish two main stages from the regulation point of view. The first stage covers the period from 1988 to 1997. The companies were submitted to the regulation generically known as Stable Legal Framework (*Marco Legal Estable - MLE*), enacted by means of Royal Decree 1538/1987 of December 11<sup>th</sup>, which came into force in 1988 and which was applicable to all electricity activities. The fundamental element of this regulating framework was the concept of *standard cost*, i.e. the setting by the Administration of objective costs for the system that would eliminate superfluous expenses, and on which the companies' reimbursements would be based. The MLE regulation was also structured into two levels: i) the determination of the electricity tariff, which is calculated as an average, by the simple quotient between the sum of the standard costs of the system –among these, those of distribution– and the expected number of kW/h demanded every year, and ii) a system of reimbursements based on the average sector incomes and the average sector standard costs.

In this way, the MLE proposed an incentive based regime combining elements of price cap regulation with others characteristic of the yardstick competition models, which would subsequently be applied in a great number of countries<sup>1</sup>.

For electricity distribution activity, the MLE defines and rules the four *outputs* that make up this activity differently: i) electricity supplied at high voltage; ii) electricity supplied at medium voltage; iii) electricity supplied at low voltage; and iv) the retailing costs. In addition, a differentiated regulation is applied for fixed costs and operating costs in each of the voltages considered<sup>2</sup>.

---

<sup>1</sup> For a more extensive analysis of what type of regulation the MLE is, see for example Lafont and Tirole (1993:86), Rodríguez and Castro(1994), Crampes and Laffont (1995) and Blázquez and Grifell-Tatjé (2004).

<sup>2</sup> Blázquez and Grifell-Tatjé (2004) give a full description of this regulatory framework, analyzing empirically the consequences that applying this regulation has had on electricity distribution from the efficiency point of view.



Two periods can be distinguished in the application of the MLE to the activity of distribution: from 1988 to 1993, and from 1994 to 1997. The reason for this distinction is twofold. On the one hand, in 1993 the Ministerial Orders December 3<sup>rd</sup> and 17<sup>th</sup> were published, introducing important modifications to the distribution reimbursement system. These Orders changed the criteria for remunerating investments in high voltage, the mechanism for calculating the standard fixed costs of medium and low voltage facilities was modified, new commercial management standard costs were established, and the parameters involved in their calculation were changed. In addition, until 1993 the so-called *structural* costs were considered as a further element to include in the tariff, without distinguishing which part of these corresponded to generation and which to distribution. These costs were differentiated in 1993 according to the activity which caused them. It should be stressed that the period between 1994 and 1997 was characterized by frequent changes in the criteria applied to the reimbursement mechanism for distribution.

On the other hand, in 1993 a market orientated reform of the regulation was debated for the first time, and this gave rise to legislation in the form of Law 40/1994 of december 30<sup>th</sup>, concerning the regulation of the national electricity system (LOSEN). The idea of this law was for it to be a compiling, ordering and systemizing rule for all the regulatory aspects of the electricity system. Yet beyond its regulatory achievements, it meant the start of a gradual introduction of competition into the system, based on establishing the separation of activities and the defining of what was known as the Independent System<sup>3</sup>.

From the regulation of electricity distribution point of view, we should underline two important contributions of the LOSEN. In the first place, the creation of the National Electricity System Commission (Comisión del Sistema Eléctrico Nacional - CSEN) as a body for regulating the system, independent from the Ministry of Industry and Energy<sup>4</sup>. Its objective was to safeguard the objectivity and transparency of the electricity sector, with its functions being consultative in terms of the development of electricity regulations. However, the Ministry retained the power of final decision in terms of regulatory aspects, and following the Spanish tradition, no *de facto* separation occurred between the political power and the regulating body. Secondly, we should highlight the detailed reference to aspects connected with the quality of the supply, referred to under Heading VIII, a topic that had not been given the importance that it deserved as one of the fundamental dimensions of the service, and therefore of

---

<sup>3</sup> For a more detailed analysis of this Law see Rodríguez Romero (1995).

<sup>4</sup> From the time the LSE came into effect, the CSEN became known as Comisión Nacional del Sistema Eléctrico Nacional. Later Law 34/1998, concerning Hydrocarbons created the National Energy Commission.

its regulation (Rodríguez Romero, 2006). In fact, only from 1994 onwards was quality introduced as a specific element to be rewarded<sup>5</sup>.

The problems arising from the development of the system implicit in the LOSEN, and the coming to power in 1996 of a new Government pledged to giving an important impulse to liberalization meant that this law would be shelved, and the *Protocol for the establishment of a new regulation of the national electricity system of December 11<sup>th</sup> 1996* drawn up, negotiated between the Ministry of Industry and Energy and the electricity companies. The principles of this Protocol formed the basis of Law 54/1997 of november 27<sup>th</sup>, or the Electricity Sector Law (Ley del Sector Eléctrico-LSE), that designed a new electricity industry model.

The LSE introduced competition into the generating and retailing activities, and established the right to choose a supplier, which would be progressively introduced. With regard to electricity transport and distribution, in the new legal framework they continued to be regulated activities, although they were liberalized by extending third-party access to the networks. The entering into force of the LSE thus meant that the electricity market was divided into two types of consumer: those who decided to keep on paying the official tariff fixed by the government; and qualified consumers who exercised their option to turn to the production market. These consumers paid either a price determined on the spot market or a price agreed with his chosen retailer: In addition, they must pay a regulated price by the use of the transport and distribution networks: an access toll.

As regards the tariff framework, according to the LSE, the average electricity tariff will be re-established as a relationship between the sum of the expected costs, defined again as objective and necessary to carry out all electricity activities in a proper way- among them the activity of distribution - and the expected final demand, determined by the government. The calculation methodology for setting this tariff is a dynamic one, in the sense that it determines the evolution of both the final consumption tariffs and the access charges to networks throughout a (non-defined) period of time, and so does for their corresponding costs. Besides, this regime establishes that the variation in the average tariff approved every year must not exceed 2%.

Regarding the economic framework used in the distribution activity, according with the LSE, the basis for rewarding it will be determined by taking the following elements into account<sup>6</sup>: (i) *Investment costs*, taking in account the distribution facilities needed to meet supply according to a reference network model of the

---

<sup>5</sup> It was really by means of the Order of december 3rd, 1993 that the parameter of quality was introduced into distribution reimbursement, but it did not come into effect until the following year.

<sup>6</sup> Royal Decree 2819/1998 of December 23rd.

distribution activity covering the whole national territory,<sup>7</sup> and the real investments; (ii) *Operating and maintenance costs* of the facilities, both those deriving from the reference network and the real facilities; (iii) *Energy circulated* in the different voltage levels, using this parameter to determine the costs of operation and maintenance; (i) *Retailing costs*<sup>8</sup>; (v) *Incentives for the supply quality and reduction of losses*. The 1998 and 1999 electricity tariffs incorporated these incentives. In contrast, in the Royal Decrees which fix the tariffs for 2000 to 2003 inclusively, they were excluded; and (vi) *Costs to promote the efficient use of electricity*.

The overall reimbursement for distributors as a whole is established in terms of the previous parameters. This reimbursement will be updated annually by the expected CPI minus a productivity improvement rate of 1%. In addition the demand increase will be taken into account, affected by a correcting parameter known as the “efficiency factor”, which cannot exceed the value of 0.4. In this sense, as Crampes and Fabra (2004) point out, the reimbursement scheme has the incentive that a rise in demand does not imply a proportional rise in the income. This is because an increase in the demand does not create the need to increase the distribution costs by the same amount, since the majority of these costs are fixed. Therefore a greater demand has correspondingly lower unit costs. According to this reasoning the regulator will consider the increase in demand in an arbitrary way, with the only limit being that it is below 40%. Moreover, these authors maintain that the rewarding mechanism does not explicitly encourage investment, in such a way that distributors have incentives to adapt to a greater demand without developing their facilities. This factor means a very significant change regarding the MLE, with investments being compensated at the moment that they were acknowledged by the regulator. The new situation can make distributors more efficient in the short term, when facilities are oversized, but can be harmful in the long term if it leads to structural congestion.

It should also be pointed out that the rules do not specify the period after which the basis for rewarding, the formula for updating this reward, or the CPI correcting parameter, have to be revised. Nor are the criteria that justify the value of neither this parameter nor the corresponding efficiency factor in each year, known.

The Order of June 14<sup>th</sup> 1999 established for the first time the reimbursement for electricity power distribution in line with the new LSE, and established how

---

<sup>7</sup> The reference network is understood as meaning the network needed to link up the transport network with all the customers, for high, medium and low voltage. It is calculated by following the criteria for planning, minimizing the investment -losses binomial, and for supply quality orders represented by the drop in voltage and the number of power cuts per customer. Grifell-Tatjé and Lovell (2003) analyze the application of this reference network in the framework of the LSE.

<sup>8</sup> Royal Decree 2819/1998, of December 23rd, sets out the formula with which the overall commercial management costs will be updated. These costs will be updated annually in the same way as the overall distribution reimbursement.

the total overall sum of the reimbursement was to be distributed. For those distributors carrying out their activity under the MLE, the reimbursement existing up to 1997 was taken as a base. The Order's Appendix set out the allocation percentages applicable in 1998 and 1999 and established a methodology for calculating those corresponding to the successive years<sup>9</sup>. However, this methodology has been thwarted in practically all the periods<sup>10</sup>. As a result it seems reasonable to assume that the share-out percentages have been agreed upon between the companies and the Ministry, as the criteria what they have been based on have not been revealed.

Following this schematic analysis, we can say that, during the whole period examined, the regulation of the Spanish electricity distribution suffers from a fundamental problem: uncertainty, and the regulatory risk implicit in this. The MLE introduced numerous changes throughout the period it was in effect, and this tendency has continued with the current LSE, or has even increased. At present, the justification for the recognized reimbursement base to distribution activity continues to be necessary, as the National Energy Commission (Comisión Nacional de Energía-CNE) has pointed out on numerous occasions<sup>11</sup>. Moreover, a great deal of opacity exists in the procedures used to determine the regulated prices, which do not correspond to a allocation costs methodology, but are rather fixed in an *ad hoc* manner, in such a way that they remain within limits set by the government in order to maintain its macroeconomic objectives for inflation.

### **3. AN INCENTIVES MODEL FOR ELECTRICITY DISTRIBUTION ACTIVITY**

As we have pointed out earlier, the Spanish regulator, in establishing its price control policies, has two-fold objective. On the one hand to ensure the financial

---

<sup>9</sup> For distributors exercising their activity in accordance with the MLE, the share-out between the system's different companies will be carried out initially in line with the total system reimbursement percentages corresponding to each company in accordance with the previous reimbursement framework, with these percentages tending to be adapted progressively (over 16 years and at a rate of 6.22% annually) to those provided by the reference network model.

<sup>10</sup> It was shelved by virtue of Royal Decree 3490/2000, concerning the tariffs for 2001, in Appendix VIII of Royal Decree 1483/2001, concerning the tariffs for 2002, in Appendix VIII of Royal Decree 1436/2002, concerning the tariffs for 2003, in Appendix VIII of Royal Decree 1802/2003, concerning the tariffs for 2004, and was once again shelved in the proposal of the Royal Decree on tariffs for 2005. In addition, Section 2 of Article 8 of Royal Decree 3490/2000, it was established that during 2001 the criteria for compensating distribution established in the OM of June 14<sup>th</sup> 1999 would be revised.

<sup>11</sup> Reports 16/2002 and Report 7/2004 of the CNE.

viability of the companies at the same time as encouraging them to be efficient; and on the other hand, to protect the interests of the consumer, preventing the companies from exercising the market power arising from a situation of monopoly. Bogetoft (1997, 2000) and Agrell, Bogetoft and Tind (2005) propose an incentives model applicable to companies that seeks to satisfy this double goal. This model is based on the fundamentals of *yardstick competition* (Shleifer, 1985), consisting essentially in the regulator being able to use the information about the realized costs by other comparable companies to infer the costs that might be attained by the company being evaluated. By allowing the companies to recover only the estimated costs instead of the real ones, the regulator provides incentives to companies to minimize their costs and enables them to extract the least possible informational rents (Holmstrom 1982, Shleifer 1985, Strasser y Kohler 1989). Throughout the following sections, we shall discuss the application of this model to the case of Spanish electricity distribution companies.

### 3.1. Regulation of electricity distribution

#### 3.1.1. *The Regulation model*

The scheme proposed stems from the idea that there are significant asymmetries of information between the regulator and the companies with regard to the technology used by the electricity distribution companies: it is assumed that the companies know this technology and the regulator does not. The companies will try to take advantage of this asymmetry generating *informational rents*, claiming for example that their activity involves costs to them that are greater than they really are. The regulator for its part will try to undermine the extraction of these informational rents while assuring a satisfactory service.

Thus we start from principal-agent approach, in which a regulator (principal) delegates to each of the  $I$  electricity distribution companies (agents  $i$ ), where  $i \in k = (1, 2, \dots, I)$ , the transformation of an *inputs* vector  $x = \{x_1, \dots, x_N\} \geq 0$  into a vector of *outputs*  $y = \{y_1, \dots, y_M\} \geq 0$ , with  $w = \{w_1, \dots, w_N\} > 0$  as the *input* prices vector. We can define  $S$  as the set of feasible *input-output* combination with the available technology

$$S = \{(x, y): x \text{ can produce } y\}. \quad (1)$$

It is assumed that  $S$  satisfies the usual conditions of strong disposability of *inputs* and *outputs* and convexity. The associated underlying cost frontier defined by the minimum costs incurred in the production of  $y$ , when the prices of the *inputs* are  $w$ , is given by

$$c(y, w) = \min_x \{w^T x \mid (x, y) \in S\}, \quad (2)$$

where  $x^* = \{x^*_1, \dots, x^*_N\}$  is the *inputs* vector that minimizes (2). The regulator does not know the optimum vector of  $x^*$  *inputs* although he may speculate about a finite set of possibilities and assign a subjective probability  $p(\cdot)$  to each of these. The company may have a strategic behavior in the choice of the set of *inputs*  $x(x^*)$ , in such a way that the level of costs incurred  $w^T x(x^*)$  would be higher than the optimum one:  $w^T x(x^*) \geq c(y, w)$ . Additionally, we have that the utility function of an electricity distribution company is given by

$$U = (R - w^T x(x^*)) + \rho(w^T x(x^*) - c(y, w)) \text{ being } \rho \in [0, 1], \quad (3)$$

which indicates that the utility of the companies depends on the profits defined by the difference between the reimbursement ( $R$ ) and its actual costs ( $w^T x$ ), and also that the company will try to avoid making the efforts involved in being efficient, i.e. producing at the minimum cost, which is set out in the second term of the right side. Thus the utility of each of the companies is given by the sum of the profits and a consideration of the difference between their costs and their minimum costs. The parameter  $\rho$  is the value that company gives to the difference:  $w^T x(x^*) - c(y, w)$ , relative to profits:  $R - w^T x(x^*)$ . By setting the value of the parameter  $\rho$  between zero and one, it is assumed that the company values profits more than the saving in efforts that it achieves by being inefficient. It is also considered that the company's reserve utility is zero.

For his part, the objectives of the regulator will be to minimize the costs of inducing the companies to accept a contract to produce  $y$  in order to satisfy the electricity demand and, at the same time, to encourage them to be efficient. We consider that these demands  $y$ , as well as the companies costs  $w^T x(x^*)$ , and the *input* prices  $w$ , can be observed by the regulator *ex post*. On this point, it is important to stress the fact that Spanish electricity companies were vertically integrated. This introduces a certain difficulty in direct observation by the regulator of the actual costs, specifically in the activity of electricity distribution. We shall discuss this aspect in the following section, where we propose a mechanism for estimating these costs in a context of vertical integration. In order to evaluate and compensate the companies, the regulator has the aforementioned data available, and can thus establish a reimbursement plan  $R$ , with which to compensate the electricity distribution companies for their activity. Thus the process occurs in the following way: the companies know their cost structures and the demands. The regulator proposes a reimbursement plan, and the companies decide whether to accept or reject the plan. Let us assume that the companies accept the scheme offered, and decide what their production plans are to be. Finally, the costs are observed, the demands are made public, and the reimbursements are paid to the companies.

The regulation model is thus formulated as a principal-agent model in which, for a given costs function  $c(y, w)$ , for a demand vector to be satisfied  $y$ , and for given prices for the *inputs*  $w$ , we have that  $w^T x(x^*)$  is the level of costs incurred

by the company, i.e. the strategy used for it. Therefore, the regulator sets its reimbursement based on the decision taken by the company regarding its level of costs, which depends both on the demand and the *input* prices. In fact, the regulator has to solve the following problem:

$$\begin{aligned}
 & \text{Min}_{R, x^*} \sum_{i=1}^N R[w_i \cdot x(x^*)] p_i(x^*) \\
 \text{s.a. } & (R[w^T x(x^*)] - w^T x(x^*)) + \rho(w^T x(x^*) - c(y, w)) \geq 0 \\
 & (R[w^T x(x^*)] - w^T x(x^*)) + \rho(w^T x(x^*) - c(y, w)) \\
 & \geq (R[w^T x'] - w^T x') + \rho(w^T x' - c(y, w)) \quad \forall x': c(y, w) \leq w^T x' \leq R[w^T x'],
 \end{aligned} \tag{4}$$

where  $w^T x'$  describes any costs strategy other than  $w^T x^*$  that the company could carry out. The first constraint tells us that the company will only participate in the distribution activity and use the cost strategy  $w^T x^*$  if it has a utility of at least zero. Only in this case will the agents accept the reimbursement plan, taking into account their superior information. The second set of constraints indicates that the costs strategy chosen by the company is the best possible since it generates a higher utility than any other strategy. The regulator will attempt to minimize the resulting expected payments to the companies subject to these constraints.

### 3.1.2. Rewarding electricity distribution

From the regulator's point of view, the central question is how to make the aforementioned regulation model operational. If perfect information were available, the regulator would offer the companies directly a system of reimbursements equal to the minimum costs corresponding to the desired level of service. However, given that the regulator does not know this costs function, it has to estimate it in some way. One possibility is given by the mathematical programming models described in Färe, Grosskopf and Lovell (1985) based on the use of *Data Envelopment Analysis* (DEA) type technologies proposed by Charnes, Cooper and Rhodes (1978), which will be defined by:

$$T^t = \left\{ (x, y) : y \leq \sum_{s=1}^t \sum_{j \in I_s} \lambda_j^s y_j^s, \quad x \geq \sum_{s=1}^t \sum_{j \in I_s} \lambda_j^s x_j^s, \quad \lambda_j^s \geq 0 \right\}. \tag{5}$$

In this technology  $(y, x)$  is upper-bounded by a piecewise linear surface or frontier over the data, formed by the best observation in all the years running from year 1 to year  $t$  inclusive. We can see that the technology is defined in a *sequential* way. In this type of analysis technological regression is not possible, i.e. total or partial sinkings of the production possibilities frontier. Technological regression would be difficult to explain in an activity like electricity distribution, in which the technology does not undergo significant changes, at least in the short and medium term. In the year  $t$  the *output* quantity vector  $y$  cannot exceed the convex combination of the *output* vector of all the electricity distribution companies for all the years previous to  $t$ , including in the year  $t$  itself, expressed by  $y = \sum_s \sum_j \lambda_j^s y_j^s$ . Similarly, in the year  $t$  the *input* vector  $x$  cannot exceed the convex



combination of the *input* vectors of all the electricity distribution companies for all the years previous to  $t$ , including in the year  $t$  itself, expressed by  $x = \sum_s \sum_j \lambda_j^s x_j^s$ . This vector has a dimension  $l_1$  in year 1,  $l_1+l_2$  in year 2, and  $\sum_{s=1}^T l_s$ , in year  $T$ , where  $l_s$  is the number of distributing companies in the year  $s$ . The fact that we only consider a non-negativity restriction on  $\lambda$  involves defining a technology with constant returns to scale.

We define  $c^{\text{DEAt}}(y,w)$  as the cost frontier in  $t$ , the same as in the expression (2) however now the technology is defined by the expression (5) instead of (1). One of the problems confronted by the regulator when determining the reward to the companies on the basis of their past behavior is that it induces these companies to adopt a strategic behavior, since they are afraid that their improvements in efficiency will lead to penalization in the following periods. The company will anticipate this situation by increasing their costs in periods prior to the setting of the regulation so as to achieve a greater reward in the future. This is known as the “*ratchet effect*”. In order to correct this, the company being evaluated must be excluded from the analysis, so that the behavior of the evaluated company does not affect the reward that this receives (Andersen y Petersen, 1993). To do so we can redefine the technology given by the expression (5) as:

$$T^{-it} = \left\{ (y,x) : y \leq \sum_{s=1}^t \sum_{j \neq i} \lambda_j^s y_j^s, x \geq \sum_{s=1}^t \sum_{j \neq i} \lambda_j^s x_j^s, \lambda_j^s \geq 0, j \in I_s \right\} \quad (6)$$

In this way we can define  $c^{\text{DEA-it}}(y_i, w_i)$  as the minimum cost incurred by the company  $i$  in supplying the quantity  $y_i$ , with the *input* price vector  $w_i$ , in the period  $t$ , when the technology is defined by  $T^{-it}$ , i.e. when the distributor  $i$  is not included between the observations that define the best practice frontier. In this context it may occur that  $w_i^T x_i < c^{\text{DEA-it}}(y_i, w_i)$ , a situation called *superefficiency* for  $i$ . Additionally, we have that:

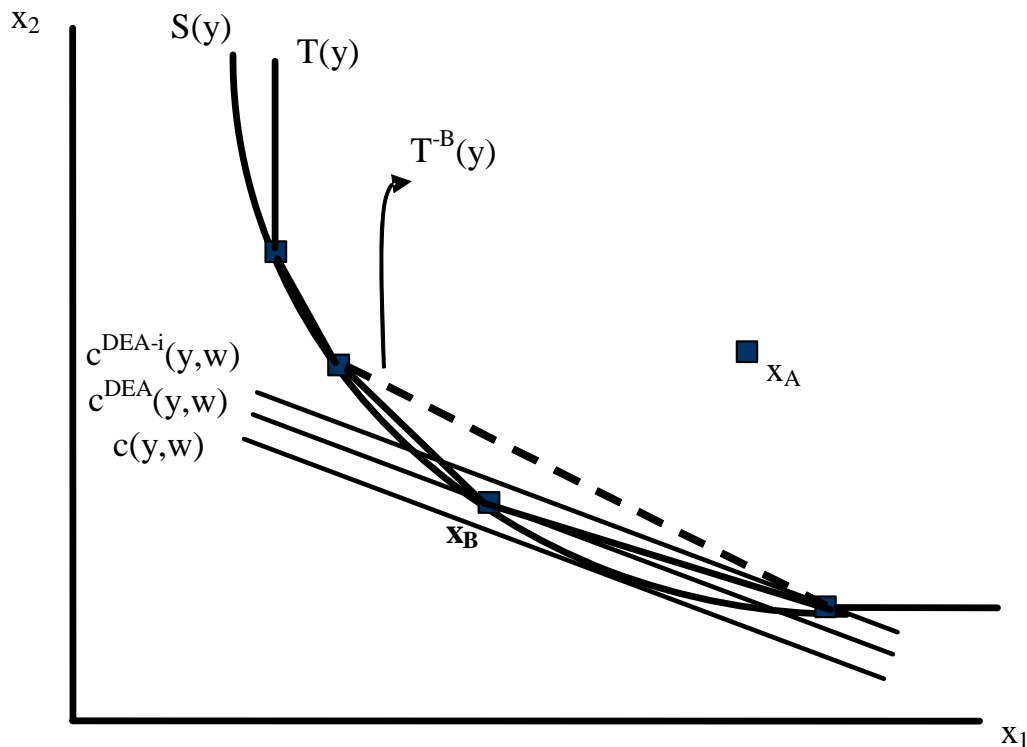
$$c^{\text{DEA-it}}(y_i, w_i) = c^{\text{DEAt}}(y_i, w_i) = c^t(y_i, w_i). \quad (7)$$

Graph I shows the situations described in expression (7). Bogetoft (1997, 2000) show that one (although not the only)<sup>12</sup> solution to the problem of optimization (4) for the case of the distributor  $i$ , in the period  $t$ , is given by:

$$R_i^t = w_i^T x_i^t + \rho_i^t [c^{\text{DEA-it}}(y_i, w_i) - w_i^T x_i^t], t = 1, \dots, T \quad (8)$$

<sup>12</sup> One disadvantage of the proposed model is that there are alternative equilibria which are preferred to the minimum cost equilibrium. This is due to the fact that with the reimbursement scheme proposed, the company obtains the same profit, regardless of what its real costs are. As Bogetoft points out (1997) in the proposed model this problem can be solved practically without additional costs for the regulator. It should simply modify the scheme in such a way that it is transformed into:  $R = w^T x + (\rho + \varepsilon) [c^{\text{DEA}}(y,w) - w^T x]$  where  $\varepsilon > 0$  means an additional reimbursement when it exceeds the frontier  $c^{\text{DEA}}(y,w)$ . In this way the minimum cost becomes the only optimum response. When  $\varepsilon \rightarrow 0$ , the cost for the regulator disappears.

**Graph I**  
**TECNOLOGY AND COSTS FUNCTION**



The basic idea of the expression (8) is to reimburse the company  $i$ , in  $t$ , its actual costs plus (or minus) an incentive bonus (or cost sharing) term, which is a portion of the difference between realized costs and the DEA-estimated costs, excluding the evaluated observation  $i$ . If a company beats the costs norm, it keeps a fraction  $\rho$  of the savings. Similarly, if the company incurs higher costs than the DEA estimated costs, the fraction  $\rho$  of these “extra” costs are borne by the company. In the first case the company’s profits would be negative, whereas in the second one they would be positive. We can thus see how the model introduces a cost reduction incentive. This can be achieved by eliminating inefficiency, or if the company is efficient, by displacing the costs frontier by means of productivity improvements. Expression (8) shows that the proposed reward model encourages the company to produce efficiently, which means to minimize the costs. We should note that a unit of actual costs above the optimum is less value than profit to the company, but equally expensive for the regulator to provide. The most important advantage for this scheme is that it shows how to link the company’s performance to its reimbursement and to its benefits. In this sense it should be pointed out that the effectiveness of the incentives scheme is given by the  $\rho$  factor.

Moreover,  $R_i^\dagger$  is optimal in the sense that it minimizes the regulator’s (expected) payments of making the companies to accept employment, fulfill the demands and minimize costs, subject to the condition that all efficient firms can survive.

Another of the model's achievements is that it minimizes the company informational rents. This company can transmit to the regulator the idea that it is under an unfavorable situation regarding costs or demand, although this may not be true, with the intention of obtaining a greater amount of money. The regulator has significant asymmetries of information, however the information it has a priori, as well as the results from other companies, goes some way to restricting the claims that the company can make. Assuming the case that the company is efficient in costs, in the sense that  $w^T x = c^{DEA}(y,w)$ . By substituting in the expression (8), we can see that the reimbursement it receives will be equal to the efficient costs plus a positive quantity  $\rho[c^{DEA-i}(y,w) - c^{DEA}(y,w)]$ . When the company is not efficient  $c^{DEA-i}(y,w) = c^{DEA}(y,w)$ , since the observation does not form a part of the best practice technology  $T^{-it}$ , in (6). In this case the regulator will subtract from its actual costs the quantity  $\rho[c^{DEA}(y,w) - w^T x]$  which we can interpret in terms of *informational rents*. We can see that with the scheme proposed, the impact of the informational rents does not disappear but is minimized to  $\rho (c^{DEA-i}(y,w) - c(y,w))$  when the actual cost structure is  $c(\cdot)$ .

It is also interesting to note how the incentive system described “rewards” the best companies. To see this, let us assume the extreme case in which  $\rho = 1$ . According with expression (8) the reimbursement received by the company would be equal to  $c^{DEA-i}(y,w)$ . This quantity can change depending on whether the company is cost efficient or not, and the degree of efficiency reached. If the company is not cost efficient the reimbursement would be equal to  $c^{DEA}(y,w)$  which, as expressed by (7), may be less than  $c^{DEA-i}(y,w)$ , and in fact, describes the minimum DEA reimbursement possible. In the case of a cost efficient company, the amount of its reward will depend on its relative importance in the construction of the best practice frontier. We should expect that the greater its relative importance, the greater will be the displacement within the production frontier resulting from the elimination of the evaluated company. The reasoning presented is valid for any value of  $\rho \in [0,1]$ , which we will discuss in the next section. Graph I describes this situation for the case of a hypothetical observation  $x_B$ .

### 3.2. Decisions made by the regulator about the $\rho$ factor

#### 3.2.1. About the setting of $\rho$

The effectiveness of the aforementioned regulation model incentive scheme lies in the value given to the parameter  $\rho$ . The fundamental problem for the regulator will thus be how to set this parameter. In setting it, the regulator should have a priori clear idea about what the consequences of setting one parameter value or another are going to be from the point of view of the incentives given to the companies to minimize their costs. Companies will try to “negotiate” the value of the parameter with the regulator in such a way that the



more efficient companies will press for the setting of a high value and the less efficient companies will want this value to be as low as possible.

At this point, it should be remembered that the reimbursement received by the electricity companies for the distribution activity, although decided by the regulator, is paid for by the consumer. As we have seen in section 2, in the Spanish legislation the tariff is calculated as a quotient between the costs attributed to the different electricity activities and the estimated demand. Thus the reimbursement for the distribution activity is one more component of the final tariff charged to the consumer. In this sense, in a distribution reimbursement system like that presented here, the parameter  $\rho$  would determine the share-out of the efficiency improvements (or losses) achieved by the companies between the consumers and these companies. In this context, it is important to point out the anomalies that imply that the values of  $\rho$  remain outside the interval between zero and one. If  $\rho > 1$ , and the company is cost efficient, it would obtain as reward its actual costs plus a bonus higher than its efficiency improvements, according with expression (8). The consumers for their part, not only would not receive any portion of the company's savings, but they would be charge with a price higher than the company actual cost. In the same way, if the company is not cost efficient, it would receive a reimbursement lower than the minimum DEA costs, which could lead to it having financial difficulties. Consumers, in contrast, would see how the tariff would be reduced by an amount higher than the company efficiency improvements. In parallel with this, if  $\rho < 0$  and the company were cost efficient, the company would be penalized for its good performance by receiving a lower reimbursement than the DEA-estimated costs. In this case, the consumers would pay quantity lower than these efficient costs. In contrast, if the company were cost inefficient, it would be "rewarded" for its poor performance since it would receive a reimbursement higher than its actual costs, and the consumers would have to bear not only the company's inefficiency but also a greater quantity. Any of these situations is incompatible with a correctly designed incentive based regulation system.

### 3.2.2. *Classification of the regulator's behavior*

Considering only values  $\rho \in [0, 1]$ , table I presents a taxonomy of the decisions that the regulator might make faced with different company efficiency situations. In this way we have classified the regulator as "pro-industry" in the case where its decisions about parameter  $\rho$  benefit the companies at the expense of the consumer, and as "pro-consumer" in the opposite case, in which its decisions benefit the consumer at the expense of the companies. In this classification we have considered that one parameter  $\rho = 0.5$ , would be a neutral situation, in the sense that the regulator would be sharing out cost efficiency improvements (or losses) equally between companies and consumers.

**Table I**  
**TAXONOMY OF THE REGULATOR'S DECISIONS**

		Regulator's Decisions		
		$0 \leq \rho < 0,5$	$\rho = 0,5$	$0,5 < \rho \leq 1$
Cases	$c^{DEA-i} > w^T x$	Pro-consumer	Neutral	Pro-industry
	$c^{DEA-i} < w^T x$	Pro-industry	Neutral	Pro-consumer

Thus, the alternatives for the regulator would be the following:

- (1) Set  $0 \leq \rho < 0.5$ . Faced with this decision, two situations could arise:
  - a)  $c^{DEA-i}(y,w) > w^T x$ . In this case the company actual costs are lower than the corresponding DEA-estimated costs, excluding  $i$  from technology, (in short,  $c^{DEA-i}$ ), a situation described as *superefficiency*. In this situation, the consumer retains more than half of its efficiency effort, by means of a lower reimbursement to the companies, which is translated into lower tariffs. On the other hand, the company receives less than half of the value of its efforts. In this case we would say that the regulator is being "pro-consumer". If the factor  $\rho=0$ , the company would not benefit at all from the efforts to reduce its costs, since it would receive as a reimbursement exactly the costs incurred. It would be a reimbursement for the cost of the service, and therefore would eliminate any incentive which encourages cost reduction.
  - b)  $c^{DEA-i}(y,w) < w^T x$ . In this case the company would be being cost inefficient, since its actual costs would be higher than the  $c^{DEA-i}$ . The regulator would subtract from its reimbursement less than half of this inefficiency, and it is the consumer who would bear the greater part of the company cost inefficiency, by way of a greater reimbursement for the activity, which translate into higher tariffs. In this case we could say that the regulator is being "pro-industry". If  $\rho=0$ , the consumer would bear all the inefficiency since the company would be paid its actual costs. Once again, the incentive to improve and be cost efficient would be nil in this case.
- (2) Set  $0.5 < \rho \leq 1$ . Faced with this decision, two situations could arise:
  - a)  $c^{DEA-i}(y,w) > w^T x$ . This is the case of *superefficiency* described above. On applying a parameter greater than 0.5, the company would be keeping more than half of the value of its efficiency efforts. If the factor  $\rho=1$ , the company would receive a reimbursement equal to  $c^{DEA-i}$ , with the consequences already pointed out in the previous section, and the consumer would not benefit at all from the costs reduction. Therefore we can classify the regulator as "pro-industry",

since is the company who receives the greater part of the cost reduction achieved.

- b)  $c^{\text{DEA-i}}(y,w) < w^T x$ . In this case, the company actual costs would be greater than the  $c^{\text{DEA-i}}$  and the regulator would make the company bear more than half of its inefficiency, and the consumer therefore less than half. In this case we would say that the regulator is being "pro-consumer". As we have already seen, if  $\rho=1$  the company would bear all its inefficiency and the consumer nothing.
- (3) Set  $\rho=0,5$ . We would say in this case that the regulator appears to be neutral between company and consumer:
- a)  $c^{\text{DEA-i}}(y,w) > w^T x$ . In this case the consumer and the company share equally the situation of *superefficiency*. The company is compensated by receiving more than half of the value of its efficiency efforts. The consumers are also benefited, since they keep the other half of the company's cost efficiency efforts by way of a lower payment to the company, i.e. lower tariffs.
- b)  $c^{\text{DEA-i}}(y,w) < w^T x$ . In this case the company would be behaving cost inefficiently, and this inefficiency would be shared equally by the consumers and the company: the company is partly penalized because it obtains a lesser reimbursement than its actual costs, concretely  $0.5(c^{\text{DEA-i}} - w^T x)$  less, and the consumer would bear the other half by way of higher tariffs.

## 4. IMPLEMENTATION OF THE INCENTIVES MODEL

### 4.1. Definition of the base years

As we have seen, Spanish legislation, like the majority, establishes regulatory reforms that are in force throughout a series of periods. This is a common practice, and its logic lies in having to provide the distributing companies with a stable and certain income context over the medium and long term; otherwise it would be difficult to undertake the investments needed for the distribution activity. In the simulation of the model proposed for the case of Spanish electricity distribution companies we shall apply this practice, in such a way that we will consider that the regulator sets the incentives model described in expression (8) over the periods in which the legislation changes, and that this is maintained until the following legislative reform. As we have seen in section 2, over the period 1988-2002 we can distinguish three regulatory stages: 1988–1993, 1994–1998 and 1999–2002. These three stages coincide with the different regulatory frameworks applied to the distribution activity. The moments in time in which the regulatory changes occurred: 1988, 1994 y 1999, are defined as base periods.

Together with the data referring to the period analyzed, 1988–2002, we used historical data on Spanish electricity distribution companies corresponding to the period 1952–1987, which has defined as an initial best-practice technology. To this data we added sequentially, as described above, the information pertaining to the period 1988–2002. Thus, for the analysis of the period 1988–1993, all available data from the period between 1952 and 1987 were used to define the starting technology. Additionally we added sequentially the information for the period 1988–1993 excluding in each year (except in the base year 1988) the evaluated company, in accordance with expression (6). Similarly, for the analysis of the period 1994–1998, all the data corresponding to the period 1952–1993 were used to define the base technology, and those corresponding to the period 1994–1998 were added sequentially, excluding in each year the evaluated company (except in the base year 1994). Finally, for the analysis of the period 1999–2002, all data from 1952 to 1998 were used to define the starting technology, and the information corresponding to the period 1999–2002 was added sequentially, excluding every year the evaluated company (except in the base year 1999).

To calculate the value of parameter  $\rho$  in expression (8) applied by the Spanish regulator, we need to know three variables: the costs incurred by the companies in the distribution activity  $w^T x$ ; the efficient costs  $c^{\text{DEA-}i}(y, w)$ , and the reimbursement  $R$  obtained by each of the companies in each of the years analyzed. While the remuneration obtained by the companies ( $R$ ) can be observed directly, this is not the case with the actual costs, since, as we have pointed out, Spanish electricity companies were vertically integrated. Evidently, we also have to estimate the costs  $c^{\text{DEA-}i}(y, w)$ . We shall discuss these aspects below, and additionally we shall introduce the concept of *renegotiation rents*.

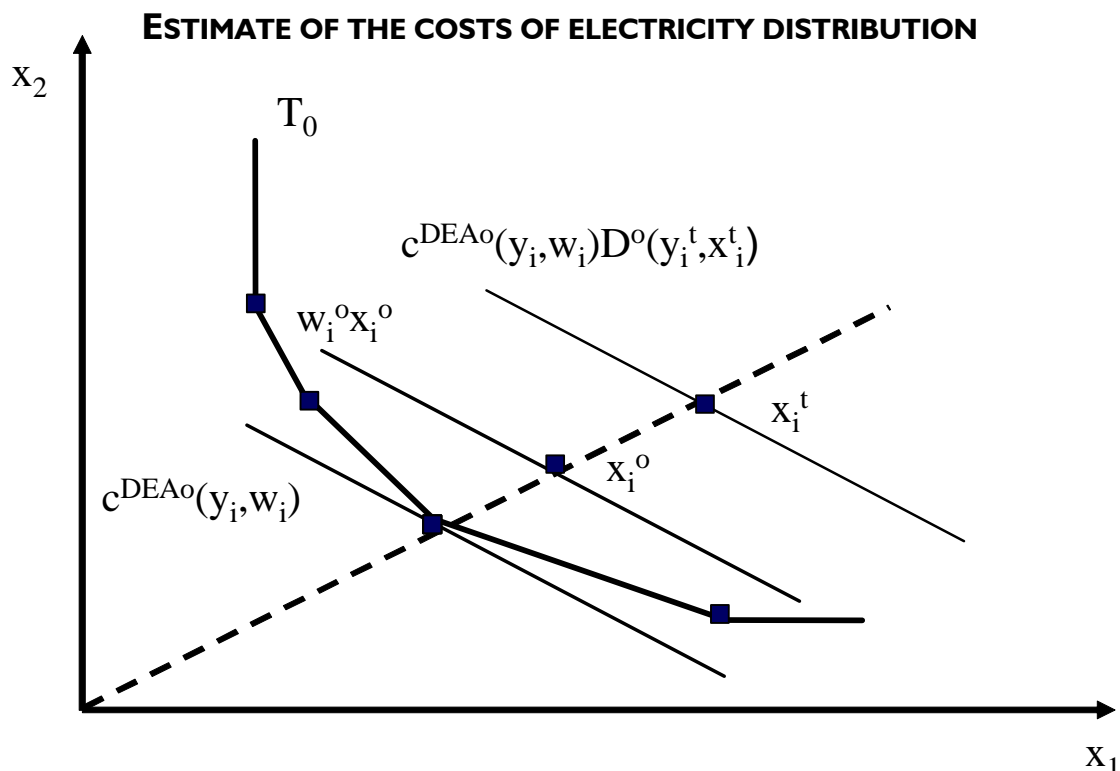
## 4.2. The Costs of Electricity Distribution

In order to apply the reimbursement model defined by (8), we have considered that the regulator was aware of the companies *ex post* costs for the electricity distribution activity. Nonetheless, in the Spanish case, Spanish electricity companies were vertically integrated until 1998, and therefore there was neither legal nor accounting separation of the activities of generation and distribution. This made it difficult for the regulator to be able to observe *ex post* the costs corresponding exclusively to the electricity distribution activity. From 1998 onwards, the companies were obliged to present their accounts separately for each activity carried out, which in theory would allow the costs attributable to the electricity distribution activity to be observed separately. Nonetheless, even today, the companies accounting data are not sufficiently homogenized, and its use presents serious drawbacks.

To solve these issues, we propose a methodology in this study which allows distribution costs to be estimated for each year of the analysis period, so that the proposed incentives model can be applied. To do so, we have used as a starting point the costs negotiated between the companies and the regulator at the moments of change of regulation, i.e. in the periods defined as base: 1988, 1994 and 1999. It should be remembered that any change in the Spanish electricity legislation has been put into effect following an approval of a Protocol agreed between the companies and the regulator. Therefore, both the companies and the regulator are in agreement with these agreed costs. Nonetheless, there is no absolute certainty that the costs agreed upon are the company actual costs, since there are asymmetries in the information during the negotiation process. We shall return to this point in the next section. We should also be aware that these costs agreed upon are not necessarily efficient, i.e. that they minimize the DEA costs.

We have estimated the distribution costs corresponding to the years in which a regulation has been in effect (MLE, LOSEN and LSE) under the hypothesis that the *proportions* among the different *input*, for each of the companies, are efficient and have remained constant over the period in which the regulation has been in effect in, as can be seen in graph 2. It is a very reasonable hypothesis, in particular for the electricity distribution activity, that proportions remain constant for relatively short periods of time. In fact we have observed that this assumption is true for the Spanish companies making up the sample. Additionally, we assume that companies are allocative efficient in every period.

**Graph 2**





In order to estimate electrical distribution costs for the intermediate years, we first introduce the concept of the Shepard (1953) distance function, which measures the maximum proportional contraction of all the *inputs*  $x$ , which allows to produce  $y$ , for the case of company  $i$ . We have:

$$D^t(y_i^t, x_i^t) = \max\{\theta: (y_i^t, x_i^t/\theta) \in T^t\}, t = 1, \dots, T \quad (9)$$

where  $1/\theta$  is the usual *input* oriented Debreu(1951)-Farrell(1957) efficiency measurement. This value defines the efficiency level of the evaluated company and satisfies that  $\theta \geq 1$ , with a value of 1 indicating that the company is efficient, and defining a point on the best-practice frontier. Now we can calculate the optimum costs in the periods of legislation change. These will be given by:

$$c^{DEA^o}(y_i, w_i) = w_i^{oT}(x_i^o/D^o(y_i^o, x_i^o)), \quad 'o' = 1988, 1994, 1999 \quad (10)$$

where  $w_i^{oT}x_i^o$  are the costs recognized by the regulator for the evaluated company in each of the base periods 'o' in which changes occur in the legislation. For the remaining years passed until the next reform, we estimate company  $i$ 's distribution costs in the period  $t$  as:

$$w_i^{tT}x_i^t = c^{DEA^o}(y_i, w_i) D^o(y_i^t, x_i^t) = (w_i^{oT}x_i^o) \left( \frac{D^o(y_i^t, x_i^t)}{D^o(y_i^o, x_i^o)} \right), t = 1, \dots, T \quad (11)$$

where  $D^o(y_i^t, x_i^t)$  expresses the radial distance from the observation  $i$  in period  $t$ , to the base period technology. Its definition is the same as that given in (9), but using technology  $T^o$  instead of  $T^t$ . Graph 2 shows the costs situation of the company  $i$  in the base period  $o$ , its DEA costs and the costs estimated in  $t$  using expression (11). Additionally, these  $w_i^{tT}x_i^t$  costs must be adjusted to take account of inflation from the moment in time defined as base until  $t$ . This was done by applying the Consumer Price Index.

### 4.3. Renegotiation incomes

We have seen that, at moments of change in the regulation, a negotiation process takes place between the regulator and the company concerning the costs associated with electricity distribution. Since in this negotiation process the agent has more information than the principal, it may result in the costs agreed upon not corresponding to the company actual costs. The difference between the actual cost and the recognized costs can be interpreted as informational rents or *renegotiation rents*. We will speculate whether rents were generated in the negotiation processes happened in 1994 and 1999. In order to estimate these rents, it is assumed that in 1988 the real distribution costs of the firms were revealed to the regulator and renegotiated in 1994. Once the actual costs for 1994 are estimated, they can be compared with the recognized by the regulator. The difference between these two costs is considered as the renegotiation rents derived from this reform. Similarly, in the estimation of the

renegotiation rents correspondent to the 1999 regulatory change, is assumed that the actual companies costs were revealed to the regulator in 1994. The difference between the estimated actual costs and the recognized cost in 1999 will be considered as the renegotiation rents derived from this reform process. Then, we have:

$$\begin{aligned} \text{Renegotiation rents}_i^o &= w_i^{oT} x_i^o - c^{\text{DEA}88}(y_i, w_i) D^{88}(y_i^o, x_i^o). \quad 'o' = 1994 \\ \text{Renegotiation rents}_i^o &= w_i^{oT} x_i^o - c^{\text{DEA}94}(y_i, w_i) D^{94}(y_i^o, x_i^o). \quad 'o' = 1999 \quad (\text{III.12}) \end{aligned}$$

Expression (12) will allow us to see whether the electricity distribution companies have obtained rents associated with their superior information in the negotiation processes at the times of regulatory change, in a market characterized by a progressive concentration.

#### 4.4. A calculation of $c^{\text{DEA-}i}(y_i, w_i)$

In order to apply the incentives model defined by expression (8) we need to estimate the  $c^{\text{DEA-it}}(y_i, w_i)$ . To do so we introduce the *input* oriented distance function,  $D^{-it}(y_i^t, x_i^t)$ , which is defined as in (9) but with technology  $T^{-it}$ , defined in (6), instead of  $T^t$ . We exclude the evaluated company in the definition of best practice technology (except in the base year), and in this context,  $D^{-it}(y_i^t, x_i^t)$  may be equal to, greater than, or less than one. When the previous distance function takes lower values than one, this means that the evaluated company consumes lesser quantities of *inputs* than any other convex combination of the remaining observations that now define the best practice frontier - a situation that we have classified as *superefficiency*. Now we can define  $c^{\text{DEA-it}}(y_i, w_i)$  as:

$$c^{\text{DEA-it}}(y_i, w_i) = w_i^{tT} (x_i^t / D^{-it}(y_i^t, x_i^t)), \quad t = 1, \dots, T \quad (13)$$

where  $w^T x$  has been previously adjusted to take inflation into account. Now we all have the elements to be able to calculate the value of  $\rho$  and the optimal value of  $R$  in (8) for each of the electricity distribution companies and for each of the years.

## 5. DEFINITION OF THE DATA AND VARIABLES

As we have seen, the period 1952-2002 has been divided into two parts: 1988-2002, which is the object of study, and the period before this: 1952-87. For this last period, we have 61 observations that we have used to form the sequential starting technology for 1988. A panel of non-balanced data has been drawn up, since information is not available for all the companies for all the years prior to 1988. Additionally, due to the mergers and takeovers that have occurred in the sector the number of observations has been reducing throughout 1988-2002. In total, for the period 1952-2002 overall, we have 170 observations. The electricity distribution companies making up the study period,

1988-2002, are the following: Unión Eléctrica Fenosa (UEF), Iberdrola (IB), Iberduero (IBE), Hidroeléctrica Española S.A. (HDE), Hidroeléctrica del Cantábrico (HC), Hidroeléctrica de Cataluña (HECSA), Fuerzas Eléctricas de Cataluña (FECSA), Empresa Nacional Hidroeléctrica Ribagorzana (ENHER) and Compañía Sevillana de Electricidad (CSE), to which we must add ENDESA, which was only considered by the legislation as a distributing company from 1999 onwards. This set of companies covers practically the whole electricity distribution market in Spain.

Data has been obtained from various sources. The Companies Annual Reports, the Spanish Ministry of Industry and Energy Annual Reports, and the Market Reimbursement Reports of OFICO (*Oficina de Compensaciones de la Energía Eléctrica*) have supplied us with data on the companies' *outputs* and *inputs* for the whole period of analysis. The reimbursement paid to the distributing companies has been obtained from the aforementioned OFICO Market Compensation Reports for the years 1988–1997; the reimbursement for 1998 was calculated using the information set out in the Order of June 14, 1999; those corresponding to 1999, 2000 and 2001 were obtained from the reports on the final yearly accounts and verifications published by the *National Energy Commission* and lastly, the reimbursement for 2002 was estimated from the report on the final annual accounts and verifications performed for 2001 and from Royal Decree 1483/2001 of December 27<sup>th</sup> which established the electricity tariff for 2002.

#### *Definition of the variables*

As for the choice of variables, *outputs* have been selected based on the fact that the regulator pays for each of these. The MLE defines *outputs* on which to base its reimbursement, and this is the guideline that we have followed. Nevertheless, we have had certain information restrictions due to the fact that a part of the data corresponds to the period 1952-87. The need to have information prior to the period when the MLE was in force has obliged us to aggregate high and medium voltage. This is due to the fact that numerous changes in the structure of the tariffs, and in its nomenclature, took place over this period, so that some concepts were considered at one time to be high voltage, and in another, medium voltage, thereby preventing the series from being uniform. As to the selection of the *inputs*, this can be considered as standard, and coincides with that adopted by Grifell-Tatjé and Lovell (2003) with the exception that we do not introduce differentiation in the transformation capacity. Thus the *outputs* and *inputs* used in the application are the following:

#### *Outputs:*

- i) Number of consumers supplied by each distributor, expressed in millions.
- ii) High and medium voltage electricity delivered, expressed in Gw/h.



iii) Low voltage electricity delivered, expressed in Gw/h.

*Inputs:*

- i) High voltage distribution networks (between 36kV and 132kV), expressed in kilometers of length.
- ii) Medium voltage distribution networks (between 1kV and 36kV), expressed in kilometers of length.
- iii) Low voltage distribution networks (<1kV), expressed in kilometers of length.
- iv) Transformation capacity of the substations for high to high voltage, high to medium voltage, and additionally, medium to low transformation centers, expressed in MVA.

It would have been interesting to include work as a production factor, however as the companies are vertically integrated, it has proved impossible to obtain the specific data for the distribution activity. Bearing in mind that the distribution activity is very capital intensive, we believe that this fact should have little impact on the results. Tables 2, 3 and 4 set out some statistics of these variables for each of the companies and for each of the three periods that the legislation has been in force. We can see how the number of companies has dropped over time as a consequence of the process of mergers and takeovers that characterized the period under study.

**Table 2**  
**STATISTICS. SUMMARY FOR THE PERIOD IN WHICH THE**  
**MLE WAS IN FORCE. AVERAGE DATA**

	Number of customers (millions)	High and Medium Voltage Energy (Kw/h)	Low Voltage Energy (Kw/h)	Kms of HV network	Kms of MV network	Kms of LV network	Transforming Capacity (MVA)	Reimbursement (millions current €)
UEF	2,525	11.670	7.862	8.213	28.972	45.719	21.483	288,5
IB	8,046	29.979	23.872	20.831	67.323	99.377	87.464	904,6
IBE	3,263	14.679	9.087	12.489	41.709	41.349	27.362	348,7
HDE	3,892	10.571	11.175	7.696	23.182	52.557	55.381	360,3
HC	0,448	4.556	1.121	976	4.129	8.944	4.375	46,1
HECSA	0,518	1.151	2.396	1.153	3.626	4.528	4.991	74,4
FECSA	1,786	6.251	7.023	3.641	18.019	24.041	13.809	225,0
ENHER	0,873	4.783	4.160	2.752	7.144	10.301	11.937	151,1
CSE	3,144	8.734	8.450	11.201	30.142	23.926	25.749	317,4

**Table 3**  
**STATISTICS. SUMMARY FOR THE PERIOD IN WHICH THE**  
**LOSEN WAS IN FORCE. AVERAGE DATA**

	Number of customers (millions)	High and Medium Voltage Energy (Kw/h)	Low Voltage Energy (Kw/h)	Kms of HV network	Kms of MV network	Kms of LV network	Transforming Capacity (MWA)	Reimbursement (millions current €)
UEF	2,807	12.526	9.427	8.557	33.369	56.599	24.383	402,848
IB	8,034	29.899	26.045	21.863	73.731	103.744	90.448	1056,957
HC	0,490	4.814	1.483	1.090	4.754	10.317	4.655	63,654
HECSA	0,347	1.417	2.703	1.264	4.362	4.865	5.413	100,609
FECSA	1,849	7.297	8.065	3.682	20.817	27.778	15.956	302,948
ENHER	0,945	5.083	4.941	2.959	9.900	13.474	15.046	198,604
CSE	3,502	10.354	10.637	11.065	39.440	30.470	28.921	426,703

**Table 4**  
**STATISTICS. SUMMARY FOR THE PERIOD IN WHICH THE**  
**LSE WAS IN FORCE. AVERAGE DATA**

	Number of customers (millions)	High and Medium Voltage Energy (Kw/h)	Low Voltage Energy (Kw/h)	Kms of HV network	Kms of MV network	Kms of LV network	Transforming Capacity (MWA)	Reimbursement (millions current €)
UEF	3,064	14.357	11.755	9.159	35.657	60.715	27.081	467,611
IB	8,870	39.415	33.246	23.649	78.651	113.308	100.202	1075,766
HID	0,533	5.714	1.893	953	5.093	11.739	4.937	84,056
ENDESA	9,839	40.505	40.847	26.329	100.982	152.569	94.459	1362,534

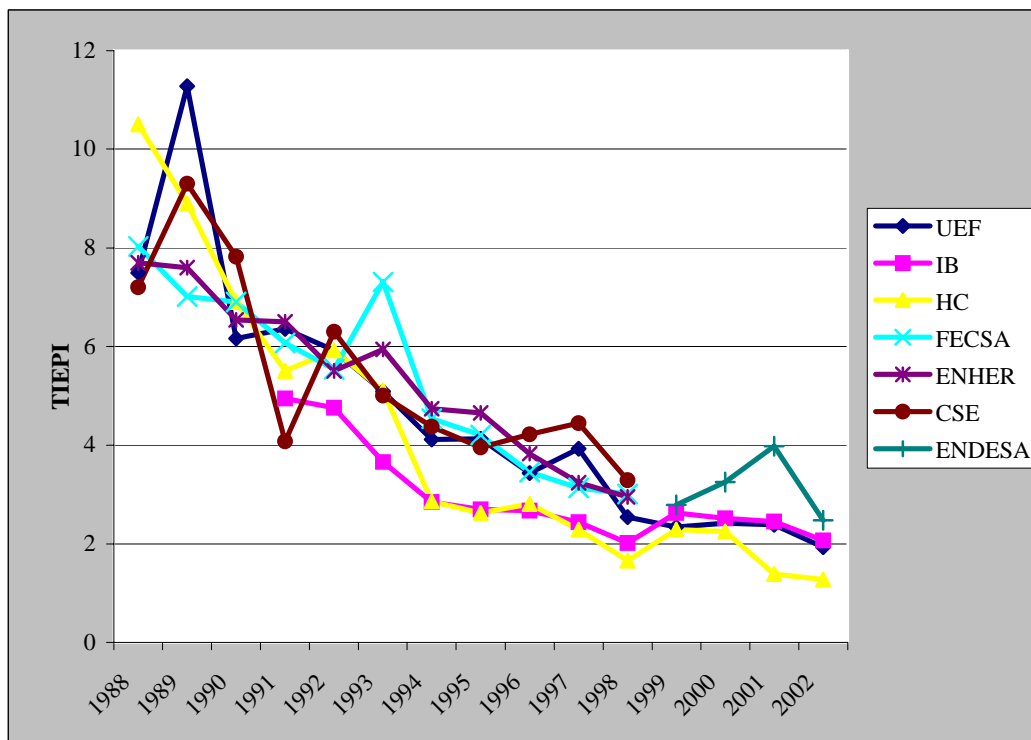
### *The quality of the Service*

The quality of the service deserves special attention. In Spain this is measured by the "Equivalent Interruption Time for the Installed Capacity" (*Tiempo de Interrupción Equivalente de la Potencia Instalada -TIEPI*) defined by the ration between the medium and low voltage electricity delivered and the medium and low voltage electricity losses by unplanned interruptions. In consequence, the lower the TIEPI, the higher the service quality. Graph 3 shows how the TIEPI has evolved for the main companies in the sample, for the period 1998-2002. We can see that in all cases there is a clear downward trend, i.e. an increase in

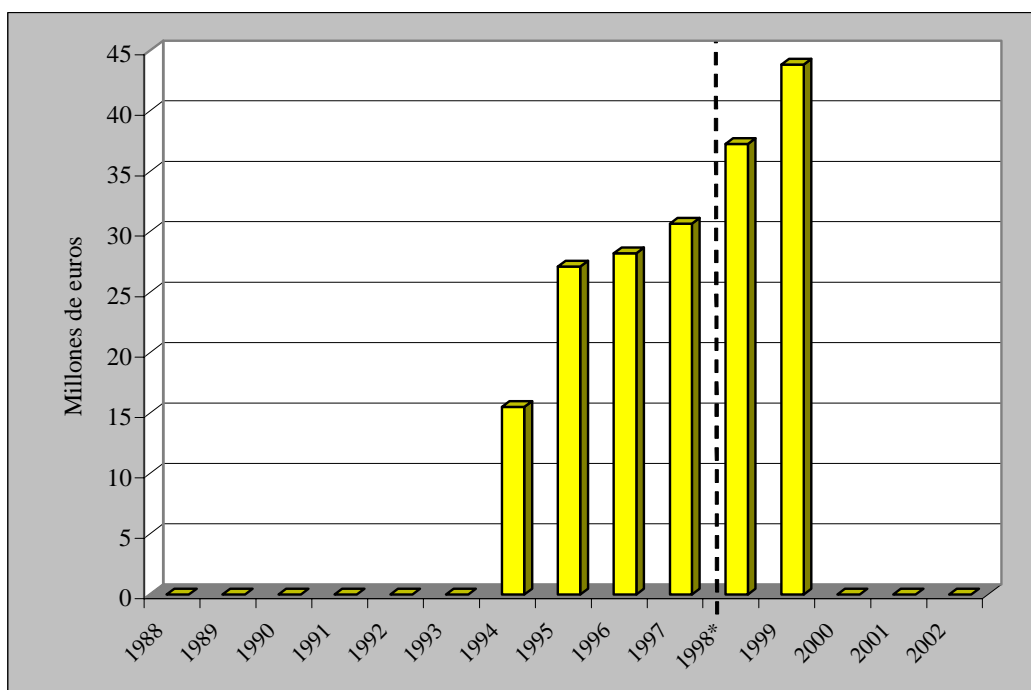


the quality of the service. The periods of greatest improvements correspond to the MLE (1988–93 period) and to the LOSEN (1994–1998 period), followed at some distance by the LSE (1999–2002).

**Graph 3**  
**THE SERVICE QUALITY. 1998-2002**



**Graph 4**  
**TOTAL QUALITY REIMBURSEMENT**



As we can see in graph 4, and have already pointed out in Section 2, regulation has only considered quality as a parameter to be compensated at particular moments: companies only received reimbursement for this factor in the period 1994-99. To put these figures in perspective, the reimbursement for this factor in the best year, 1999, only came to 1.5% of the total reimbursement. Blázquez and Grifell-Tatjé (2004) explain how a rare case of positive externality led to the striking improvement in the quality of service during the MLE period, when the incentive for this factor was non-existent. For his part, Pérez Arriaga (2005:28) considers that the only incentive for improving the quality of distributing companies is the pressure exerted by the media when there are serious incidents and the threat of penalties when the minimum quality limits set for individual consumers are not satisfied. In addition, as López (2006:46) correctly points out, “(...) until the publication of Royal Decree 1955/2000, developed by Order ECO/797/2002, there has been no procedure for collecting and calculating data about the continuity of the supply established and supervised by the Administration. Thus figures prior to 2003 (the first year for which data produced in line with said regulation is available) have not been audited in any way, and there is not even any guarantee that they have been calculated in a completely homogenous way.” In consequence, we do not know whether the TIEPI calculated by the companies are compatible with each other, nor whether these have used the same methodology over the years, or whether the results have in certain circumstances been adapted to their needs.

We therefore decided to exclude the quality of the service as a variable in the model, for the three reasons pointed out: i) the lack of continuity in the incentives provided by the law for the improvement of quality; ii) the little weight that their reimbursement carries compared to the total; iii) the doubts that the TIEPI data present due to the possible lack of homogeneity in their production, making it impossible to compare them over time and between companies. Graph 3 should be interpreted with care, although we believe that it does indeed reflect correctly the trend towards an improvement in the quality of the service during the 1988-2002 period.

## 6. RESULTS

The results of the application are set out in tables 5, 6 and 7, corresponding respectively to each of the three stages of regulation: 1988-1993, 1994-1998 y 1999-2002. The first column of the tables sets out the average results for each of the periods considered, expressed as the inverse of the distance function, i.e.  $\theta^{-i} = 1/D^{-i}(y_i, x_i)$ . We have used the inverse of the distance function since the interpretation of the results is intuitively easier. Values above one express a

situation which we have classified as one of *superefficiency*, below one inefficiency, and equal to one on the best practice frontier, excluding the evaluated observation. In the case of superefficiency, the company costs are less than the DEA, excluding the company evaluated, ( $c^{DEA-i}$ ) and greater than the  $c^{DEA-i}$  with inefficiency (see expression 13). The second column shows the term  $\rho$  which the Spanish regulator would have applied as an average for each of the periods and each of the companies, calculated in accordance with expression (8)<sup>13</sup>. The third column, in line with the previous data, determines the behavior of the Spanish regulator for each company in each of the periods, expressed in the above-defined terminology. The final column shows the average percentage which represented the difference between the reimbursement received and the optimum reimbursement according to the proposed incentives model, in relation to the reimbursement received. This percentage can be interpreted as an excess (lack) of reimbursement. The optimum reimbursement is calculated with a  $\rho$  value equal to 0.5, which we have defined as *neutral*.

**Table 5**  
**AVERAGE RESULTS FOR THE PERIOD IN WHICH THE MLE**  
**WAS IN FORCE: 1988-1993**

	$\theta = 1/D^{-i}(y,x)$	$\rho$	Regulator's Behaviour	Received Reimbursement over Optimum Reimbursement (%)
UEF	0,793	-0,581	Pro-industry	19,87%
IB	0,850	-1,548	Pro-industry	24,81%
IBE	0,880	-0,444	Pro-industry	10,52%
HDE	1,044	2,078	Pro-industry	6,31%
HC	1,034	3,342	Pro-industry	7,48%
HECSA	1,146	0,052	Pro-consumer	-7,22%
FECSA	1,113	1,906	Pro-industry	11,98%
ENHER	1,117	0,586	Pro-industry	0,83%
CSE	0,984	-2,373	Pro-industry	7,93%

<sup>13</sup> When  $D^{-i}(y_i, x_i) = 1$  we have expression (13) that:  $C^{DEA-i}(y_i, w_i) = w_i^T x_i$  and it is not possible to calculate the value of  $\rho$  using expression (8) since it can take any value. There are six situations in which the values are very close to one. These are the cases in CSE years 1990, 1995; HC years 1993, 1996; HECSA year 1989 and ENHER year 1997. We have excluded these values from the  $\rho$  averages calculated in tables 4 and 5.



**Table 6**  
**AVERAGE RESULTS FOR THE PERIOD IN WHICH THE LOSEN**  
**WAS IN FORCE: 1994-1998**

	$\theta = 1/D^{-i}(y,x)$	$\rho$	Regulator's Behaviour	Received Reimbursement over Optimum Reimbursement (%)
UEF	0,803	-0,320	Pro-industry	14,32%
IB	0,793	-0,128	Pro-industry	12,55%
HC	1,091	3,727	Pro-industry	10,43%
HECSA	1,033	2,140	Pro-industry	5,66%
FECSA	1,037	2,231	Pro-industry	4,62%
ENHER	0,961	-4,821	Pro-industry	13,84%
CSE	0,916	-0,066	Pro-industry	3,93%

**Table 7**  
**AVERAGE RESULTS FOR THE PERIOD IN WHICH THE LSE**  
**WAS IN FORCE: 1999-2002**

	$\theta = 1/D^{-i}(y,x)$	$\rho$	Regulator's Behaviour	Received Reimbursement over Optimum Reimbursement (%)
UEF	0,851	0,168	Pro-industry	5,11%
IB	0,871	-0,239	Pro-industry	8,95%
HC	1,127	0,086	Pro-consumer	-4,98%
ENDESA	0,855	-0,049	Pro-industry	7,60%

*Efficiency levels and  $\rho$  values*

Generally speaking, it can be said that in the three legislative periods considered, the regulator, except with very rare exceptions, has behaved in a way that was beneficial to the companies, the majority of which have obtained reimbursements higher than the optimum reimbursement. Secondly, it is worth pointing out that in the three periods the regulator has set a  $\rho$  term outside the interval [0,1] for the majority of the companies, which, as we have shown previously, reveals to us a set of situations incompatible with a correctly designed incentives system.

In the first period analyzed, 1988–1993, it is important to highlight the merger in 1991 of the two biggest electricity distributing companies at this moment: Iberduero and Hidroeléctrica Española S.A, which gave rise to

Iberdrola in 1991. The table 5 shows the average results corresponding to this first legislative period. In the light of the data, we can see that the companies that behave inefficiently, such as UEF, IB, IBE, and to a lesser extent, CSE, are not penalized in any way by the regulator. On the contrary, this regulator has applied a  $\rho$  parameter lower than zero to all of them, meaning that these companies were paid not only their inefficient costs but also a higher quantity, i.e. somehow they have been “rewarded” for this inefficiency. In this sense, the cases of the companies UEF and IB are especially flagrant, since for them, on average, the reimbursement higher than the optimum obtained represents 19.87% and 24.81% of the incomes received, respectively. The consumers, for their part, are the victims of this situation, since it is they are who have to bear fully, not only the distributing companies inefficient costs, but also, an additional quantity given as a “bonus” by the regulator. This means a transfer of incomes from consumers to the companies by fixing a surcharge. In addition, as we have seen, when a  $\rho < 0$  is applied, as in the case of the worst companies, any incentive for efficiency is eliminated. In fact, as can be seen in tables 6 and 7, none of the inefficient companies in the first period improved or improved just a little in the two later periods.

For their part, the majority of companies that have an average efficiency that is greater than one, i.e. that are superefficient, in such a way that their actual costs are lower than the  $c^{DEA-i}$ , such as HDE, HC, FECSA and ENHER are compensated by the regulator, who adopts a *pro-industry* behavior, although not to the same extent for all the companies. The most *neutral* case corresponds to the public company ENHER<sup>14</sup>, with a  $\rho = 0.59$ , meaning a share-out of the profits of efficiency with a moderate bias toward the company. For the other companies, the  $\rho$  values are higher than one. In this situation the company receives a reimbursement higher than the sum of its actual costs plus the cost saving achieved with the efficiency improvements. This situation is the opposite of that which would occur in a perfectly competitive market, in which cost reductions are transferred wholly to the consumer by means of lower purchase prices. As in the cases of inefficiency in which negative  $\rho$  have been applied, this overcharging means a transfer of incomes from the consumer to the companies, or what is the same thing, to the shareholders, since the companies analyzed, with the exception of ENHER, were all private. We thus have reimbursements which are on average higher than the optimum ones. The case of FECSA is especially flagrant, with the figure for this company being up to 12%.

The clearly *pro-industry* behavior of the regulator in the period the MLE was in force can be justified by the difficult economic and financial situation in which

---

<sup>14</sup> In 1988, the public company Endesa had a 91.5% shareholding in the company Enher, and they formed part of the state industrial group TENEO. This situation continued until the complete privatization of Endesa in 1998.

Spanish electricity companies 1988 found themselves in 1988. The only exception to this situation is that of HECSA, which is a superefficient company to which  $\rho < 0.5$  was applied, passing on to consumers the greater part of the cost reductions. For this reason, the company had an average reimbursement 7.22% lower than the optimum quantity.

In table 6 we can see that the previously described situation was maintained for the period 1994-1998, which is the period in which the LOSEN was in effect. It should be pointed out that in the final year of the period analyzed, 1998, the companies ENHER and HECSA<sup>15</sup> were integrated into FECSA<sup>16</sup>. Once again, in all the cases, the regulator benefited the distributing companies to the detriment of the consumers. To the inefficient companies: UEF, IB, ENHER and CSE, it continued to apply negative  $\rho$ s, thereby removing any incentive to the efficiency, with the companies receiving reimbursements higher than the optimum ones. In the case of the superefficient companies HC, HECSA and FECSA, the  $\rho$  is in every case higher than one, producing the same situation as that discussed above in the case of the MLE. It should once again be stressed that the companies UEF and IB, with which ENHER joined up, are those that received reimbursements that were higher than the optimum ones, although the percentages were now more moderate compared with the previous period. It is logical for the situation not to be very different from the MLE period, since as we have seen in section 2, this period was a transitory one in which some reimbursement parameters were adjusted for the distribution activity, although the general model for compensating the activity was retained.

Lastly, in the period 1999-2002, with the LSE in force, we should highlight the process of concentration taking place in the sector, leading to it being made up of only four companies, as table 7 shows. This was produced by the effective merging of FECSA-ENHER and CSE into the public company ENDESA. This company, which had historically devoted its efforts to electricity generation, had, in the years prior to its full privatization, been gradually acquiring effective control of the companies which it would now absorb, with the aim of ensuring that the vertical integration resulting from the incorporation of the former companies would make it more attractive for the stock market<sup>17</sup>.

---

<sup>15</sup> In 1994, HECSA was taken over by Iberdrola, which held practically all of its capital. Before its take-over, HECSA had separated part of its assets and created HECSA-I, of which Enher acquired 55% in 1994 and the remaining 45% in 1995. We refer to this company as HECSA in this period. In June 1998 ENHER took over HECSA once and for all. In this same year both companies became part of Fecsa.

<sup>16</sup> Table 6 does not show this observation since it is just for one year, which moreover coincided with the year of the merger.

<sup>17</sup> In 1998 ENDESA was transferred completely into private hands. At the beginning of this year, the State still held 41% of the company.



In this third period we see that the  $\rho$  values are closer to zero, although some of them continue to be negative. The companies UEF and IB continued the trend of previous periods, being inefficient, a trend now shared by the other big company: ENDESA. The big companies IB and ENDESA, which now control approximately 80% of the distribution market, have moderate negative  $\rho$  values applied to them, meaning, just as in the two preceding periods, a transfer of incomes from the consumer to the company. In the case of UEF, the regulator continues to behave in a *pro-industry* way, since on average it only deducts from its reimbursement 17% of the costs increase due to inefficiency. As for HC, which is the smallest company, with a percentage of approximately 4% of the distribution market, the regulator applies a  $\rho < 0.5$ , with the company receiving a remuneration which includes less than half of its cost savings. We shall return to this result when analyzing the “renegotiation” costs in the following sections.

#### *Excess reward and renegotiation rents*

Table 8 sets out the difference between the reward received and the optimum reward, expressed in millions of 2002 euros, for each of the years analyzed, as well as for the total period. The final column shows us the average percentage that these incomes represented of the total reimbursement received. For the period as a whole it has been estimated that an additional amount of 4,401 million euros has been paid, representing 9.8% of the total reimbursement. However, if we analyze the evolution of additional incomes in relation to the optimum incomes for the three stages of regulation, we see that these have a clear downward trend, going from 11.7% in the MLE stage to 8.9% in the LOSEN stage, and finally, to 2.1% in the LSE period. A similar trend can be observed for the three companies represented in the three periods: UEF, IB and HC. We noted that these quantities have been shared out unequally, since approximately half of them were for IB, representing 14.5% of their total reimbursement.

**Table 8**  
**PERCEIVED REIMBURSEMENT – OPTIMUM REIMBURSEMENT ( $\rho = 0.5$ ).**  
**MILLIONS OF 2002 EUROS**

	MLE in force	LOSEN in force	LSE in force	Total	Percentage
	Period 1988-93	Period 1994-98	Period 1999-2002		
UEF	470,0	314,6	109,8	894,5	12,79%
IB	946,6	770,2	406,9	2.123,6	14,51%
IBE	146,8			146,8	8,39%
HDE	79,6			79,6	4,41%
HC	27,3	33,9	-12,9	48,3	4,19%

(Sigüe)

(Continuación)

	MLE in force	LOSEN in force	LSE in force	Total	Percentage
	Period 1988-93	Period 1994-98	Period 1999-2002		
HECSA	-40,7	22,2		-18,6	-1,60%
FECSA	211,7	52,0		263,7	7,51%
ENHER	10,4	113,3		123,7	5,29%
CSE	196,5	95,7		292,2	5,37%
ENDESA			447,9	447,9	7,80%
Total	2.048,0	1.401,8	951,7	4.401,4	9,62%

The above results can be completed using those in table 9, which shows the rents obtained by the companies as a result of the renegotiation of electricity distribution costs every time a new regulatory system came into effect. As we have seen, the results of this renegotiation can be seen in the years 1994 and 1999, and the incomes have been calculated according to expression (12). Table 8 provides information that seems to confirm the accuracy of the estimate, at least for 1994. The situation where the regulator had more information available, and the asymmetries of information may have been less, was the case of the company ENHER, which, as we have seen, was in public ownership. In this case, the costs that we have estimated for the year 1994 were 176.9 million euros, and the LOSEN compensated ENHER to the tune of 180.9 million euros, resulting in a difference of slightly over 2%.

**Table 9**  
**RENEGOTIATION RENTS FROM THE ELECTRICITY DISTRIBUTION COSTS.**  
**MILLIONS OF 2002 EUROS**

	LOSEN, 1994	Percentage	LSE, 1999	Percentage	Total
UEF	90,6	20,5%	75,5	15,0%	166,4
IB	142,0	11,5%	-30,0	-2,6%	111,9
HC	5,1	7,3%	21,3	24,4%	26,4
HECSA	4,2	3,6%			4,2
FECSA	57,1	16,5%			57,1
ENHER	5,1	2,2%			5,1
CSE	46,0	9,3%			46,0
ENHER	—		—		—
Total	350,1	12,0%	67,0	2,1%	417,1



We have calculated that, for the sector as a whole, renegotiation rents represented approximately 6% of the received incomes. Nonetheless, we can see that these show a clear downward trend, from 12% in the LOSEN period to 2.1% in the LSE. For the sector as a whole, it cannot be said that there are renegotiation incomes in the case of the LSE, although it should be borne in mind that the ENDESA data is missing, as it cannot be estimated due to the concentration process. Note however that the individual results vary widely between companies. Of note in table 9 is the negative sign for IB in 1999. It also shows the success of HC renegotiation strategy, which was based on the proposal of what was known as the "reference network" (see Grifell-Tatjé y Lovell, 2003)<sup>18</sup>. Nevertheless, in subsequent years HC did not achieve substantial additional increases in reimbursement. This is why it appears as a "pro-consumer" in the results in table 7.

Finally, we can look at external indicators to see whether the results of this study conflict with them. One of these indicators is the electricity sector profitability, which we can analyze using the Madrid Stock Exchange Totals Index. For their calculation these incorporate the concepts of capital gains, dividends and increases in capital, among others. It can be seen that the average annual profitability for the electricity sector was 3.1% lower than the average annual profitability of the stock market as a whole in 1990. Three years later, it was 3.3% higher; and five years later, in 1998, the profitability of the energy sector was still 2.3% higher than the stock market average. Only after 1999, with the LSE now in full effect, did the distances between the sector's profitability and that of the stock market as a whole begin to narrow and show a converging trend. Although the stock market profitability behavior described should be treated with caution since it reflects the valuation of the vertically integrated electricity company, i.e. generation and distribution, it is interesting to note that it follows the previously described criteria when the results in tables 5-8 for the electricity distribution companies as a whole are discussed.

## 7. CONCLUSIONS

This study analyzes the consequences that the different regulation systems applied to the activity of electricity distribution in Spain had during the period 1988-2002, both from the point of view of productive efficiency and with regard to the protection of the interests of the consumer vis-à-vis the companies.

---

<sup>18</sup> HC drew up the program known as BULNES whose first results were generated in 1997, to calculate the ideal network for electricity distribution in Spain. It seems that the reason for drawing up this program was that HC considered that the regulator was underestimating their distribution costs. The results that we have presented in table 6 do not support HC's theory but they do show that they were not as generously paid as other companies.

In the Spanish electricity industry, intervention by the regulator has been carried out, above all, by establishing the tariffs that the final consumers have had to pay for their electricity consumption. These tariffs have been calculated using the simple quotient between the costs that the regulator considered necessary to compensate the activities which have to be done to supply electricity properly, and the estimated demand from the final consumers. In fact, the costs established by the regulator have made up the reimbursement received by the companies. In this way, we can affirm that, in general, the regulator has applied a system of price-cap, to which some of the characteristics of *yardstick competition* models were added during the period 1988-1997 (Blázquez and Grifell-Tatjé, 2004).

The perception of the agents affected by the regulation varies widely. While companies insist that tariffs have been fixed since 1987 below the consumer price index, thereby placing seriously at risk the investments that the sector needs to make, consumers have seen how the electricity companies' profits have kept on growing over this same period. This study has contrasted both parties' postures with regard to the regulation of the electricity distribution activity.

The analysis was carried out by comparing the reward obtained by the companies for their electricity distribution activity during the 1988-2002 period with what they would have received had the regulation by incentives model proposed by Bogetoft (1997) been applied to them. This model links the reward obtained by the companies with their productive efficiency, permitting, at the same time, to minimize the incomes obtained as a consequence of the information asymmetries existing between the regulator and the companies. In addition, the model overcomes some of the problems associated with the application of price cap regulation, such as the arbitrariness in the setting of discount factors, or the *ratchet effect*, and allows us to study how the efficiency improvements obtained by the companies are shared out between these and consumers.

The comparison of the two models has allowed us to see, first and foremost, that the Spanish regulator, in designing its reimbursement scheme, failed to link the companies' efficiency with the reimbursements that these obtained. This has meant that the companies that were inefficient at the beginning of the period studied, continued to be so throughout that period. Secondly, we can see how, during the whole period examined and except for some rare exceptions, the Spanish regulator behaved in a clearly *pro-industry* way, to the detriment of the consumer's interests. The regulator paid the inefficient companies not only their actual costs but also a greater amount, i.e. somehow they have been rewarded for their inefficiency. This is the reason why no incentive for improvement was introduced during the period of study. In the case of efficient companies these receive a reimbursement higher than the sum of their actual costs plus the cost



savings achieved with the efficiency improvements. In both cases the consumer is paying a higher price than would have been set in a competitive market. In effect this overcharging means a transfer of incomes from the consumers to the electricity distribution companies, which were mostly privately owned. In the third place, we can see that companies obtain incomes in the renegotiation of distribution costs recognized by the regulator, especially in the case of the LOSEN in the 1994. These results are in line with those obtained by Arocena, Cotín and Huerta (2002), which also reveal that in the Spanish electricity sector the regulator has given companies preferential treatment in their prices policy, contrary to the consumer's interests.

The clearly *pro-industry* behavior of the regulator may be due to its concern at the beginning of the period analyzed about the precarious financial situation that companies were going through at that point, since some of them were on the brink of bankruptcy. In order to remedy this situation, the regulator awarded reimbursements far above those that would be desirable from the point of view of efficiency. It should be pointed out that consecutive legislative reforms, although they have softened the initial situation substantially, have not yet succeeded in solving the problem, and under the current legislation the majority of companies continue to obtain incomes regulated above the optimum.

This situation, in which companies obtain incomes over time that are higher than those that an incentives model linking efficiency to reward would consider as optimum, and in which consumers are systematically prejudiced, reveals the perverse aspects of a regulatory system incapable of reproducing the conditions of a competitive market, in which improvements in efficiency, innovation and technical progress are stimulated.



## REFERENCES

- AGRELL, P.; BOGETOFT, P and TIND, J. (2005): "DEA and Dynamic Yardstick Competition in Scandinavian Electricity Distribution", *Journal of Productivity Analysis*, n.º 23, pp. 173-201.
- ANDERSEN, P. and PETERSEN, N.C. (1993): "A Procedure for Ranking Efficient Units in Data Envelopment Analysis", *Management Science*, n.º 39(10), pp. 1261-1264.
- AROCENA, P.; CONTÍN, I. and HUERTA, E. (2002): "Price Regulation in the Spanish Energy Sectors: Who Benefits?", *Energy Policy*, n.º 20(10), pp. 885-95.
- BLÁZQUEZ, L. and GRIFELL-TATJÉ, E (2004): "Regulación de la Distribución Eléctrica en España: Análisis Económico de una década, 1987-1997", *Documento de trabajo 04/01*, Departament de l'Empresa. Universitat Autònoma de Barcelona.
- BOGETOFT, P. (1997): "DEA-based yardstick competition: The optimality of best practice regulation", *Annals of Operations Research*, n.º 73, pp. 277-298.
- (2000): "DEA and Activity Planning under Asymmetric Information", *The Journal of Productivity Analysis*, n.º 13, pp. 7-48.
- CHARNES, A.; COOPER, W.W. and RHODES, E. (1978): "Measuring the Efficiency of Decision Making Units", *European Journal of Operational Research*, n.º 2, pp. 429-444.
- COMISIÓN NACIONAL DE LA ENERGÍA (2004): *Informe 7/2004 sobre la propuesta de Real Decreto de tarifa eléctrica 2005*, Madrid.
- (2002): *Informe 16/2002 sobre la propuesta de Real Decreto por el que se establece la metodología para la aprobación o la modificación de la tarifa media o de referencia and se modifican algunos artículos del Real Decreto 2017/1997*, Madrid.
- CRAMPES, C. and LAFFONT, J.J. (1995): "Transfers and incentives in the Spanish electricity sector", *Revista Española de Economía*, Monográfico: "Regulación", pp. 117-140.
- CRAMPES, C. and FABRA, N. (2004): "The Spanish Electricity Industry: Plus ça change...", *Cambridge Working Paper 0502*, Department of Applied Economics, University of Cambridge.
- DEBREU, G. (1951): "The Coefficient of Resource Utilization", *Econometrica*, n.º 19(3), July, pp. 273-292.
- DOYLE, C. (1998): "Liberalizing Europe's network industries: ten conflicting priorities", *Business Strategy Review*, 9(3), pp. 55-66.

- FÄRE, R.; GROSSKOPF, S. and LOVELL, C.A.K. (1985): “*The Measurement of Efficiency of Production.*” Boston: Kluwer-Nijhoff Publishing.
- FARREL, M.J. (1957): “The Measurement of Productive Efficiency”, *Journal of The Royal Statistical Society, Series A, General*, n.º 120 (3), pp. 253-290.
- GRIFELL-TATJÉ, E. and LOVELL, C.A.K.(2003): “Managers versus the consultants”, *Scandinavian Journal of Economics*, n.º 105(1), pp. 119-138.
- HOLMSTRÖM, B. (1982): "Moral hazard in teams", *Bell Journal of Economics*, n.º 13, pp. 324-340.
- KNITTEL, C.R. (2002): “Alternative Regulatory Methods and Firm Efficiency: Stochastic Frontier Evidence from the US Electricity Industry,” *Review of Economics and Statistics*, n.º 84,3 (august), pp. 530-40.
- LAFFONT, J.J. and TIROLE, J. (1993): *A theory of incentives in procurement and regulation*, MIT Press: Boston.
- LÓPEZ MILLA, J. (2006): “La calidad del suministro eléctrico y la regulación de los ingresos de las actividades de red”, *Hacienda Pública Española*, n.º 176(1/2006), pp. 43-71.
- MCKERRON, G. and PEARSON, P. (eds) (2000): *The International Energy Experience: Market, Regulation and The Environment*. Imperial College Press. London.
- PÉREZ ARRIAGA, J.I. (2006): *Libro Blanco sobre la Reforma del marco regulatorio de la generación de electricidad en España*, Instituto de Investigación Tecnológica (IIT). Universidad Pontificia de Comillas, Madrid.
- RODRIGUEZ, L. and CASTRO, F. (1994): "Aspectos económicos de la configuración del sector eléctrico en España: ¿una falsa competencia referencial?", *Cuadernos Económicos de Información Comercial Española*, n.º 57, pp. 161-183.
- RODRÍGUEZ ROMERO, L. (1995): “La LOSEN, Una nueva regulación del sistema eléctrico”, *Economistas*, número especial.
- SHLEIFER, A. (1985): "A theory of yardstick competition", *Rand Journal of Economics*, pp. 319-327.
- STRASSER, K.A. and KOHLER, M.F. (1989): *Regulating Utilities with Management Incentives*, Quorum Books, Greenwood Press.

## SÍNTESIS

### PRINCIPALES IMPLICACIONES DE POLÍTICA ECONÓMICA

En las últimas décadas, los países de la Unión Europea han introducido importantes reformas en el sector eléctrico, que, desde el punto de vista de la regulación, han supuesto introducir la competencia en las actividades de generación y servicios, mientras que el transporte y la distribución han seguido considerándose como monopolios naturales regulados. En el caso de la distribución eléctrica, se han abandonando paulatinamente los modelos basados en el coste del servicio, en los que los precios reflejaban los costes de las empresas, adoptándose en su lugar modelos basados en incentivos, que motivan e inducen a las empresas a incrementar su eficiencia productiva, repercutiendo en unos menores costes de explotación.

Para que los modelos de incentivos funcionen correctamente, la legislación debe ser clara, describiendo los parámetros determinantes de la retribución de las empresas y estableciendo el periodo de tiempo para el cuál estos criterios se van a mantener inalterados. Sin embargo, su implementación práctica suele llevar aparejada un grado de complejidad tal, que hace difícil evaluar lo acertado de la actuación del regulador. Un segundo aspecto a considerar es a quién debería beneficiar la regulación. Teniendo en cuenta que la regulación se justifica cuando no es posible el correcto funcionamiento del mercado, pretendiendo sustituir el comportamiento competitivo del mismo, el consumidor debería ser el principal beneficiado de las medidas regulativas. Sin embargo, los consumidores consideran que el regulador, capturado por las empresas y temeroso las consecuencias políticas que un fallo en el suministro podría acarrearle, legisla primordialmente a favor de las empresas.

El principal propósito de este trabajo es evaluar la actuación del regulador español en la actividad de distribución eléctrica durante el periodo 1988-2002. Para ello se ha analizado si los cambios legislativos introducidos por el regulador llevaron a las empresas a mayores niveles de eficiencia; si su retribución estuvo ligada a la eficiencia lograda; y si la regulación ha permitido que tanto consumidores como empresas perciban los beneficios del nuevo modelo aplicado, o si, por el contrario, alguno de los grupos se ha visto favorecido en detrimento de los intereses del otro.

El análisis se ha efectuado comparando la retribución obtenida por las empresas por su actividad de distribución con la que habrían obtenido si se hubiera aplicado el modelo de regulación por incentivos inicialmente propuesto por Bogetoft (1997). En este modelo se vincula la retribución recibida por las empresas con su eficiencia productiva, de tal forma que se incentiva a las empresas a la mejora, a la vez que se minimizan las rentas obtenidas como consecuencia de las asimetrías informativas existentes entre ellas y el regulador.

La comparación de los dos modelos ha arrojado tres conclusiones principales. En primer lugar, que las retribuciones otorgadas por el regulador español a las empresas eléctricas como pago por la actividad de distribución no han estado ligadas a la

eficiencia de las mismas, no introduciéndose incentivo alguno a la mejora de este parámetro. Esto ha provocado que las empresas que al principio del periodo considerado eran ineficientes, hayan seguido siéndolo a lo largo del mismo. En segundo lugar, el regulador, con este comportamiento, ha beneficiado a las empresas en detrimento del consumidor. Y en tercer lugar, se observa que las empresas han obtenido “rentas de renegociación” cada vez que se han introducido modificaciones importantes en la regulación. Aunque las reformas legislativas, especialmente las introducidas tras la liberalización del sector, han ido corrigiendo la situación inicial, en la que el regulador claramente apostó por el saneamiento económico y financiero de las empresas, la mayoría de ellas sigue obteniendo unos ingresos regulados por encima de los óptimos.

La conclusión final del análisis efectuado es que los sistemas de regulación aplicados en las últimas décadas a la actividad de distribución eléctrica han beneficiado más a las empresas que a los consumidores, observándose que la liberalización del sector ha prolongado la condición ventajosa de las empresas mantenida anteriormente. La razón fundamental de esta situación se encuentra en la falta de independencia del regulador, que pacta con las empresas las normas del sector, al margen de los consumidores, manejando la legislación de forma discrecional en pos de intereses políticos o empresariales, en lugar de establecer unas reglas claras y estrictas para el régimen económico de la actividad que propicien el correcto funcionamiento de los incentivos.

## **NORMAS DE PUBLICACIÓN DE PAPELES DE TRABAJO DEL INSTITUTO DE ESTUDIOS FISCALES**

Esta colección de *Papeles de Trabajo* tiene como objetivo ofrecer un vehículo de expresión a todas aquellas personas interesadas en los temas de Economía Pública. Las normas para la presentación y selección de originales son las siguientes:

1. Todos los originales que se presenten estarán sometidos a evaluación y podrán ser directamente aceptados para su publicación, aceptados sujetos a revisión, o rechazados.
2. Los trabajos deberán enviarse por duplicado a la Subdirección de Estudios Tributarios. Instituto de Estudios Fiscales. Avda. Cardenal Herrera Oria, 378. 28035 Madrid.
3. La extensión máxima de texto escrito, incluidos apéndices y referencias bibliográficas será de 7000 palabras.
4. Los originales deberán presentarse mecanografiados a doble espacio. En la primera página deberá aparecer el título del trabajo, el nombre del autor(es) y la institución a la que pertenece, así como su dirección postal y electrónica. Además, en la primera página aparecerá también un abstract de no más de 125 palabras, los códigos JEL y las palabras clave.
5. Los epígrafes irán numerados secuencialmente siguiendo la numeración arábica. Las notas al texto irán numeradas correlativamente y aparecerán al pie de la correspondiente página. Las fórmulas matemáticas se numerarán secuencialmente ajustadas al margen derecho de las mismas. La bibliografía aparecerá al final del trabajo, bajo la inscripción "Referencias" por orden alfabético de autores y, en cada una, ajustándose al siguiente orden: autor(es), año de publicación (distinguiendo a, b, c si hay varias correspondientes al mismo autor(es) y año), título del artículo o libro, título de la revista en cursiva, número de la revista y páginas.
6. En caso de que aparezcan tablas y gráficos, éstos podrán incorporarse directamente al texto o, alternativamente, presentarse todos juntos y debidamente numerados al final del trabajo, antes de la bibliografía.
7. En cualquier caso, se deberá adjuntar un disquete con el trabajo en formato word. Siempre que el documento presente tablas y/o gráficos, éstos deberán aparecer en ficheros independientes. Asimismo, en caso de que los gráficos procedan de tablas creadas en excel, estas deberán incorporarse en el disquete debidamente identificadas.

***Junto al original del Papel de Trabajo se entregará también un resumen de un máximo de dos folios que contenga las principales implicaciones de política económica que se deriven de la investigación realizada.***



## **PUBLISHING GUIDELINES OF WORKING PAPERS AT THE INSTITUTE FOR FISCAL STUDIES**

This serie of *Papeles de Trabajo* (working papers) aims to provide those having an interest in Public Economics with a vehicle to publicize their ideas. The rules governing submission and selection of papers are the following:

1. The manuscripts submitted will all be assessed and may be directly accepted for publication, accepted with subjections for revision or rejected.
2. The papers shall be sent in duplicate to Subdirección General de Estudios Tributarios (The Deputy Direction of Tax Studies), Instituto de Estudios Fiscales (Institute for Fiscal Studies), Avenida del Cardenal Herrera Oria, nº 378, Madrid 28035.
3. The maximum length of the text including appendices and bibliography will be no more than 7000 words.
4. The originals should be double spaced. The first page of the manuscript should contain the following information: (1) the title; (2) the name and the institutional affiliation of the author(s); (3) an abstract of no more than 125 words; (4) JEL codes and keywords; (5) the postal and e-mail address of the corresponding author.
5. Sections will be numbered in sequence with arabic numerals. Footnotes will be numbered correlatively and will appear at the foot of the corresponding page. Mathematical formulae will be numbered on the right margin of the page in sequence. Bibliographical references will appear at the end of the paper under the heading "References" in alphabetical order of authors. Each reference will have to include in this order the following terms of references: author(s), publishing date (with an a, b or c in case there are several references to the same author(s) and year), title of the article or book, name of the journal in italics, number of the issue and pages.
6. If tables and graphs are necessary, they may be included directly in the text or alternatively presented altogether and duly numbered at the end of the paper, before the bibliography.
7. In any case, a floppy disk will be enclosed in Word format. Whenever the document provides tables and/or graphs, they must be contained in separate files. Furthermore, if graphs are drawn from tables within the Excell package, these must be included in the floppy disk and duly identified.

***Together with the original copy of the working paper a brief two-page summary highlighting the main policy implications derived from the research is also requested.***





## ÚLTIMOS PAPELES DE TRABAJO EDITADOS POR EL INSTITUTO DE ESTUDIOS FISCALES

### 2004

- 1/04 Una propuesta para la regulación de precios en el sector del agua: el caso español.  
*Autores:* M.<sup>a</sup> Ángeles García Valiñas y Manuel Antonio Muñoz Pérez.
- 2/04 Eficiencia en educación secundaria e *inputs* no controlables: sensibilidad de los resultados ante modelos alternativos.  
*Autores:* José Manuel Cordero Ferrera, Francisco Pedraja Chaparro y Javier Salinas Jiménez.
- 3/04 Los efectos de la política fiscal sobre el ahorro privado: evidencia para la OCDE.  
*Autores:* Montserrat Ferre Carracedo, Agustín García García y Julián Ramajo Hernández.
- 4/04 ¿Qué ha sucedido con la estabilidad del empleo en España? Un análisis desagregado con datos de la EPA: 1987-2003.  
*Autores:* José María Arranz y Carlos García-Serrano.
- 5/04 La seguridad del empleo en España: evidencia con datos de la EPA (1987-2003).  
*Autores:* José María Arranz y Carlos García-Serrano.
- 6/04 La ley de Wagner: un análisis sintético.  
*Autor:* Manuel Jaén García.
- 7/04 La vivienda y la reforma fiscal de 1998: un ejercicio de simulación.  
*Autor:* Miguel Ángel López García.
- 8/04 Modelo dual de IRPF y equidad: un nuevo enfoque teórico y su aplicación al caso español.  
*Autor:* Fidel Picos Sánchez.
- 9/04 Public expenditure dynamics in Spain: a simplified model of its determinants.  
*Autores:* Manuel Jaén García y Luis Palma Martos.
- 10/04 Simulación sobre los hogares españoles de la reforma del IRPF de 2003. Efectos sobre la oferta laboral, recaudación, distribución y bienestar.  
*Autores:* Juan Manuel Castañer Carrasco, Desiderio Romero Jordán y José Félix Sanz Sanz.
- 11/04 Financiación de las Haciendas regionales españolas y experiencia comparada.  
*Autor:* David Cantarero Prieto.
- 12/04 Multidimensional indices of housing deprivation with application to Spain.  
*Autores:* Luis Ayala y Carolina Navarro.
- 13/04 Multiple occurrence of welfare reciprocity: determinants and policy implications.  
*Autores:* Luis Ayala y Magdalena Rodríguez.
- 14/04 Imposición efectiva sobre las rentas laborales en la reforma del impuesto sobre la renta personal (IRPF) de 2003 en España.  
*Autoras:* María Pazos Morán y Teresa Pérez Barrasa.
- 15/04 Factores determinantes de la distribución personal de la renta: un estudio empírico a partir del PHOGUE.  
*Autores:* Marta Pascual y José María Sarabia.
- 16/04 Política familiar, imposición efectiva e incentivos al trabajo en la reforma de la imposición sobre la renta personal (IRPF) de 2003 en España.  
*Autoras:* María Pazos Morán y Teresa Pérez Barrasa.
- 17/04 Efectos del déficit público: evidencia empírica mediante un modelo de panel dinámico para los países de la Unión Europea.  
*Autor:* César Pérez López.

- 18/04 Inequality, poverty and mobility: Choosing income or consumption as welfare indicators.  
*Autores:* Carlos Gradín, Olga Cantó y Coral del Río.
- 19/04 Tendencias internacionales en la financiación del gasto sanitario.  
*Autora:* Rosa María Urbanos Garrido.
- 20/04 El ejercicio de la capacidad normativa de las CCAA en los tributos cedidos: una primera evaluación a través de los tipos impositivos efectivos en el IRPF.  
*Autores:* José María Durán y Alejandro Esteller.
- 21/04 Explaining. budgetary indiscipline: evidence from spanish municipalities.  
*Autores:* Ignacio Lago-Peñas y Santiago Lago-Peñas.
- 22/04 Local governments' asymmetric reactions to grants: looking for the reasons.  
*Autor:* Santiago Lago-Peñas.
- 23/04 Un pacto de estabilidad para el control del endeudamiento autonómico.  
*Autor:* Roberto Fernández Llera
- 24/04 Una medida de la calidad del producto de la atención primaria aplicable a los análisis DEA de eficiencia.  
*Autora:* Mariola Pinillos García.
- 25/04 Distribución de la renta, crecimiento y política fiscal.  
*Autor:* Miguel Ángel Galindo Martín.
- 26/04 Políticas de inspección óptimas y cumplimiento fiscal.  
*Autores:* Inés Macho Stadler y David Pérez Castrillo.
- 27/04 ¿Por qué ahorra la gente en planes de pensiones individuales?  
*Autores:* Félix Domínguez Barrero y Julio López-Laborda.
- 28/04 La reforma del Impuesto sobre Actividades Económicas: una valoración con microdatos de la ciudad de Zaragoza.  
*Autores:* Julio López-Laborda, M.<sup>a</sup> Carmen Trueba Cortés y Anabel Zárata Marco.
- 29/04 Is an inequality-neutral flat tax reform really neutral?  
*Autores:* Juan Prieto-Rodríguez, Juan Gabriel Rodríguez y Rafael Salas.
- 30/04 El equilibrio presupuestario: las restricciones sobre el déficit.  
*Autora:* Belén Fernández Castro.

## 2005

- 1/05 Efectividad de la política de cooperación en innovación: evidencia empírica española.  
*Autores:* Joost Heijs, Liliana Herrera, Mikel Buesa, Javier Sáiz Briones y Patricia Valadez.
- 2/05 A probabilistic nonparametric estimator.  
*Autores:* Juan Gabriel Rodríguez y Rafael Salas.
- 3/05 Efectos redistributivos del sistema de pensiones de la seguridad social y factores determinantes de la elección de la edad de jubilación. Un análisis por comunidades autónomas.  
*Autores:* Alfonso Utrilla de la Hoz y Yolanda Ubago Martínez.
- 4/05 La relación entre los niveles de precios y los niveles de renta y productividad en los países de la zona euro: implicaciones de la convergencia real sobre los diferenciales de inflación.  
*Autora:* Ana R. Martínez Cañete.
- 5/05 La Reforma de la Regulación en el contexto autonómico.  
*Autor:* Jaime Vallés Giménez.

- 6/05 Desigualdad y bienestar en la distribución intraterritorial de la renta, 1973-2000.  
*Autores:* Luis Ayala Cañón, Antonio Jurado Málaga y Francisco Pedraja Chaparro.
- 7/05 Precios inmobiliarios, renta y tipos de interés en España.  
*Autor:* Miguel Ángel López García.
- 8/05 Un análisis con microdatos de la normativa de control del endeudamiento local.  
*Autores:* Jaime Vallés Giménez, Pedro Pascual Arzoz y Fermín Cabasés Hita.
- 9/05 Macroeconomics effects of an indirect taxation reform under imperfect competition.  
*Autor:* Ramón J. Torregrosa.
- 10/05 Análisis de incidencia del gasto público en educación superior: nuevas aproximaciones.  
*Autora:* María Gil Izquierdo.
- 11/05 Feminización de la pobreza: un análisis dinámico.  
*Autora:* María Martínez Izquierdo.
- 12/05 Efectos del impuesto sobre las ventas minoristas de determinados hidrocarburos en la economía extremeña: un análisis mediante modelos de equilibrio general aplicado.  
*Autores:* Francisco Javier de Miguel Vélez, Manuel Alejandro Cardenete Flores y Jesús Pérez Mayo.
- 13/05 La tarifa lineal de Pareto en el contexto de la reforma del IRPF.  
*Autores:* Luis José Imedio Olmedo, Encarnación Macarena Parrado Gallardo y María Dolores Sarrión Gavilán.
- 14/05 Modelling tax decentralisation and regional growth.  
*Autores:* Ramiro Gil-Serrate y Julio López-Laborda.
- 15/05 Interactions inequality-polarization: characterization results.  
*Autores:* Juan Prieto-Rodríguez, Juan Gabriel Rodríguez y Rafael Salas.
- 16/05 Políticas de competencia impositiva y crecimiento: el caso irlandés.  
*Autores:* Santiago Díaz de Sarralde, Carlos Garcimartín y Luis Rivas.
- 17/05 Optimal provision of public *inputs* in a second-best scenario.  
*Autores:* Diego Martínez López y A. Jesús Sánchez Fuentes.
- 18/05 Nuevas estimaciones del pleno empleo de las regiones españolas.  
*Autores:* Javier Capó Parrilla y Francisco Gómez García.
- 19/05 US deficit sustainability revisited: a multiple structural change approach.  
*Autores:* Óscar Bajo-Rubio, Carmen Díaz-Roldán y Vicente Esteve.
- 20/05 Aproximación a los pesos de calidad de vida de los “Años de Vida Ajustados por Calidad” mediante el estado de salud autopercibido.  
*Autores:* Anna García-Altés, Jaime Pinilla y Salvador Peiró.
- 21/05 Redistribución y progresividad en el Impuesto sobre Sucesiones y Donaciones: una aplicación al caso de Aragón.  
*Autor:* Miguel Ángel Barberán Lahuerta.
- 22/05 Estimación de los rendimientos y la depreciación del capital humano para las regiones del sur de España.  
*Autora:* Inés P. Murillo.
- 23/05 El doble dividendo de la imposición ambiental. Una puesta al día.  
*Autor:* Miguel Enrique Rodríguez Méndez.
- 24/05 Testing for long-run purchasing power parity in the post bretton woods era: evidence from old and new tests.  
*Autor:* Julián Ramajo Hernández y Montserrat Ferré Cariacedo.

- 25/05 Análisis de los factores determinantes de las desigualdades internacionales en las emisiones de CO<sub>2</sub> *per cápita* aplicando el enfoque distributivo: una metodología de descomposición por factores de Kaya.  
*Autores:* Juan Antonio Duro Moreno y Emilio Padilla Rosa.
- 26/05 Planificación fiscal con el impuesto dual sobre la renta.  
*Autores:* Félix Domínguez Barrero y Julio López Laborda.
- 27/05 El coste recaudatorio de las reducciones por aportaciones a planes de pensiones y las deducciones por inversión en vivienda en el IRPF 2002.  
*Autores:* Carmen Marcos García, Alfredo Moreno Sáez, Teresa Pérez Barrasa y César Pérez López.
- 28/05 La muestra de declarantes IEF-AEAT 2002 y la simulación de reformas fiscales: descripción y aplicación práctica.  
*Autores:* Alfredo Moreno, Fidel Picos, Santiago Díaz de Sarralde, María Antiquera y Lucía Torrejón.

## 2006

- 1/06 Capital gains taxation and progressivity.  
*Autor:* Julio López Laborda.
- 2/06 Pigou's dividend versus Ramsey's dividend in the double dividend literature.  
*Autores:* Eduardo L. Giménez y Miguel Rodríguez.
- 3/06 Assessing tax reforms. Critical comments and proposal: the level and distance effects.  
*Autores:* Santiago Díaz de Sarralde Míguez y Jesús Ruiz-Huerta Carbonell.
- 4/06 Incidencia y tipos efectivos del impuesto sobre el patrimonio e impuesto sobre sucesiones y donaciones.  
*Autora:* Laura de Pablos Escobar.
- 5/06 Descentralización fiscal y crecimiento económico en las regiones españolas.  
*Autores:* Patricio Pérez González y David Cantarero Prieto.
- 6/06 Efectos de la corrupción sobre la productividad: un estudio empírico para los países de la OCDE.  
*Autores:* Javier Salinas Jiménez y M.<sup>a</sup> del Mar Salinas Jiménez.
- 7/06 Simulación de las implicaciones del equilibrio presupuestario sobre la política de inversión de las comunidades autónomas.  
*Autores:* Jaime Vallés Giménez y Anabel Zárate Marco.
- 8/06 The composition of public spending and the nationalization of party systems in western Europe.  
*Autores:* Ignacio Lago-Peñas y Santiago Lago-Peñas.
- 9/06 Factores explicativos de la actividad reguladora de las Comunidades Autónomas (1989-2001).  
*Autores:* Julio López Laborda y Jaime Vallés Giménez.
- 10/06 Disciplina crediticia de las Comunidades Autónomas.  
*Autor:* Roberto Fernández Llera.
- 11/06 Are the tax mix and the fiscal pressure converging in the European Union?  
*Autor:* Francisco J. Delgado Rivero.
- 12/06 Redistribución, inequidad vertical y horizontal en el impuesto sobre la renta de las personas físicas (1982-1998).  
*Autora:* Irene Perrote.

- 13/06 Análisis económico del rendimiento en la prueba de conocimientos y destrezas imprescindibles de la Comunidad de Madrid.  
*Autores:* David Trillo del Pozo, Marta Pérez Garrido y José Marcos Crespo.
- 14/06 Análisis de los procesos privatizadores de empresas públicas en el ámbito internacional. Motivaciones: moda política versus necesidad económica.  
*Autores:* Almudena Guarnido Rueda, Manuel Jaén García e Ignacio Amate Fortes.
- 15/06 Privatización y liberalización del sector telefónico español.  
*Autores:* Almudena Guarnido Rueda, Manuel Jaén García e Ignacio Amate Fortes.
- 16/06 Un análisis taxonómico de las políticas para PYME en Europa: objetivos, instrumentos y empresas beneficiarias.  
*Autor:* Antonio Fonfría Mesa.
- 17/06 Modelo de red de cooperación en los parques tecnológicos: un estudio comparado.  
*Autora:* Beatriz González Vázquez.
- 18/06 Explorando la demanda de carburantes de los hogares españoles: un análisis de sensibilidad.  
*Autores:* Santiago Álvarez García, Marta Jorge García-Inés y Desiderio Romero Jordán.
- 19/06 Cross-country income mobility comparisons under panel attrition: the relevance of weighting schemes.  
*Autores:* Luis Ayala, Carolina Navarro y Mercedes Sastre.
- 20/06 Financiación Autonómica: algunos escenarios de reforma de los espacios fiscales.  
*Autores:* Ana Herrero Alcalde, Santiago Díaz de Sarralde, Javier Loscos Fernández, María Antiquera y José Manuel Tránchez.
- 21/06 Child nutrition and multiple equilibria in the human capital transition function.  
*Autores:* Berta Rivera, Luis Currais y Paolo Rungo.
- 22/06 Actitudes de los españoles hacia la hacienda pública.  
*Autor:* José Luis Sáez Lozano.
- 23/06 Progresividad y redistribución a través del IRPF español: un análisis de bienestar social para el periodo 1982-1998.  
*Autores:* Jorge Onrubia Fernández, María del Carmen Rodado Ruiz, Santiago Díaz de Sarralde y César Pérez López.
- 24/06 Análisis descriptivo del gasto sanitario español: evolución, desglose, comparativa internacional y relación con la renta.  
*Autor:* Manuel García Goñi.
- 25/06 El tratamiento de las fuentes de renta en el IRPF y su influencia en la desigualdad y la redistribución.  
*Autores:* Luis Ayala Cañón, Jorge Onrubia Fernández y María del Carmen Rodado Ruiz.
- 26/06 La reforma del IRPF de 2007: una evaluación de sus efectos.  
*Autores:* Santiago Díaz de Sarralde Míguez, Fidel Picos Sánchez, Alfredo Moreno Sáez, Lucía Torrejón Sanz y María Antiquera Pérez.
- 27/06 Proyección del cuadro macroeconómico y de las cuentas de los sectores institucionales mediante un modelo de equilibrio.  
*Autores:* Ana María Abad, Ángel Cuevas y Enrique M. Quilis.
- 28/06 Análisis de la propuesta del tesoro Británico “Fiscal Stabilisation and EMU” y de sus implicaciones para la política económica en la Unión Europea.  
*Autor:* Juan E. Castañeda Fernández.

- 29/06 Choosing to be different (or not): personal income taxes at the subnational level in Canada and Spain.  
*Autores:* Violeta Ruiz Almendral y François Vaillancourt.
- 30/06 A projection model of the contributory pension expenditure of the Spanish social security system: 2004-2050.  
*Autores:* Joan Gil, Miguel Ángel Lopez-García, Jorge Onrubia, Concepció Patxot y Guadalupe Souto.

## 2007

- 1/07 Efectos macroeconómicos de las políticas fiscales en la UE.  
*Autores:* Oriol Roca Sagalés y Alfredo M. Pereira.
- 2/07 Deficit sustainability and inflation in EMU: an analysis from the fiscal theory of the price level.  
*Autores:* Óscar Bajo-Rubio, Carmen Díaz-Roldán y Vicente Esteve.
- 3/07 Contraste empírico del modelo monetario de tipos de cambio: cointegración y ajuste no lineal.  
*Autor:* Julián Ramajo Hernández.
- 4/07 An empirical analysis of capital taxation: equity vs. tax compliance.  
*Autores:* José M.<sup>a</sup> Durán Cabré y Alejandro Esteller Moré.
- 5/07 Education and health in the OECD: a macroeconomic approach.  
*Autoras:* Cecilia Albert y María A. Davia.
- 6/07 Understanding the effect of education on health across European countries.  
*Autoras:* Cecilia Albert y María A. Davia.
- 7/07 Polarization, fractionalization and conflict.  
*Autores:* Joan Esteban y Debraj Ray.
- 8/07 Immigration in a segmented labor market: the effects on welfare.  
*Autor:* Javier Vázquez Grenno.
- 9/07 On the role of public debt in an OLG Model with endogenous labor supply.  
*Autor:* Miguel Ángel López García.
- 10/07 Assessing profitability in rice cultivation using the Policy Matrix Analysis and profit-efficient data.  
*Autores:* Andrés J. Picazo-Tadeo, Ernest Reig y Vicent Estruch.
- 11/07 Equidad y redistribución en el Impuesto sobre Sucesiones y Donaciones: análisis de los efectos de las reformas autonómicas.  
*Autores:* Miguel Ángel Barberán Lahuerta y Marta Melguizo Garde.
- 12/07 Valoración y determinantes del stock de capital salud en la Comunidad Canaria y Cataluña.  
*Autores:* Juan Oliva y Néboa Zozaya.
- 13/07 La nivelación en el marco de la financiación de las Comunidades Autónomas.  
*Autores:* Ana Herrero Alcalde y Jorge Martínez-Vázquez.
- 14/07 El gasto en defensa en los países desarrollados: evolución y factores explicativos.  
*Autor:* Antonio Fonfría Mesa.
- 15/07 Los costes del servicio de abastecimiento de agua. Un análisis necesario para la regulación de precios.  
*Autores:* Ramón Barberán Ortí, Alicia Costa Toda y Alfonso Alegre Val.
- 16/07 Precios, impuestos y compras transfronterizas de carburantes.  
*Autores:* Andrés Leal Marcos, Julio López Laborda y Fernando Rodrigo Saucó.

- 17/07 Análisis de la distribución de las emisiones de CO<sub>2</sub> a nivel internacional mediante la adaptación del concepto y las medidas de polarización.  
*Autores:* Juan Antonio Duro Moreno y Emilio Padilla Rosa.
- 18/07 Foreign direct investment and regional growth: an analysis of the Spanish case.  
*Autores:* Óscar Bajo Rubio, Carmen Díaz Mora y Carmen Díaz Roldán.
- 19/07 Convergence of fiscal pressure in the EU: a time series approach.  
*Autores:* Francisco J. Delgado y María José Presno.
- 20/07 Impuestos y protección medioambiental: preferencias y factores.  
*Autores:* María de los Ángeles García Valiñas y Benno Torgler.
- 21/07 Modelización paramétrica de la distribución personal de la renta en España. Una aproximación a partir de la distribución Beta generalizada de segunda especie.  
*Autores:* Mercedes Prieto Alaiz y Carmelo García Pérez.
- 22/07 Desigualdad y delincuencia: una aplicación para España.  
*Autores:* Rafael Muñoz de Bustillo, Fernando Martín Mayoral y Pablo de Pedraza.
- 23/07 Crecimiento económico, productividad y actividad normativa: el caso de las Comunidades Autónomas.  
*Autor:* Jaime Vallés Giménez.
- 24/07 Descentralización fiscal y tributación ambiental. El caso del agua en España.  
*Autores:* Anabel Zárata Marco, Jaime Vallés Giménez y Carmen Trueba Cortés.
- 25/07 Tributación ambiental en un contexto federal. Una aplicación empírica para los residuos industriales en España.  
*Autores:* Anabel Zárata Marco, Jaime Vallés Giménez y Carmen Trueba Cortés.
- 26/07 Permisos de maternidad, paternidad y parentales en Europa: algunos elementos para el análisis de la situación actual.  
*Autoras:* Carmen Castro García y María Pazos Morán.
- 27/07 ¿Quién soporta las cotizaciones sociales empresariales?. Una panorámica de la literatura empírica.  
*Autor:* Ángel Melguizo Esteso.
- 28/07 Una propuesta de financiación municipal.  
*Autores:* Manuel Esteban Cabrera y José Sánchez Maldonado.
- 29/07 Do R&D programs of different government levels overlap in the European Union.  
*Autoras:* Isabel Busom y Andrea Fernández-Ribas.
- 30/07 Proyecciones de tablas de mortalidad dinámicas de España y sus Comunidades Autónomas.  
*Autores:* Javier Alonso Meseguer y Simón Sosvilla Rivero.
- 2008**
- 1/08 Estudio descriptivo del voto económico en España.  
*Autores:* José Luis Sáez Lozano y Antonio M. Jaime Castillo.
- 2/08 The determinants of tax morale in comparative perspective: evidence from a multilevel analysis.  
*Autores:* Ignacio Lago-Peñas y Santiago Lago-Peñas.
- 3/08 Fiscal decentralization and the quality of government: evidence from panel data.  
*Autores:* Andreas P. Kyriacou y Oriol Roca-Sagalés.
- 4/08 The effects of multinationals on host economies: A CGE approach.  
*Autores:* María C. Latorre, Oscar Bajo-Rubio y Antonio G. Gómez-Plana.

- 5/08 Measuring the effect of spell recurrence on poverty dynamics.  
*Autores:* José María Arranz y Olga Cantó.
- 6/08 Aspectos distributivos de las diferencias salariales por razón de género en España: un análisis por subgrupos poblacionales.  
*Autores:* Carlos Gradín y Coral del Río.
- 7/08 Evaluating the regulator: winners and losers in the regulation of Spanish electricity distribution (1988-2002).  
*Autores:* Leticia Blázquez Gómez y Emili Grifell-Tatjé.