TECHNICAL EFFICIENCY AND PRODUCTIVITY CHANGES IN SPANISH AIRPORTS: A PARAMETRIC DISTANCE FUNCTIONS APPROACH

BEATRIZ TOVAR
ROBERTO RENDEIRO MARTÍN-CEJAS

FUNDACIÓN DE LAS CAJAS DE AHORROS
DOCUMENTO DE TRABAJO
Nº 395/2008

De conformidad con la base quinta de la convocatoria del Programa de Estímulo a la Investigación, este trabajo ha sido sometido a evaluación externa anónima de especialistas cualificados a fin de contrastar su nivel técnico.

ISSN: 1988-8767

Technical efficiency and productivity changes in Spanish airports: A parametric distance functions approach.

Beatriz Tovar[1]

Research Group Economics of Infrastructure and Transport (EIT)
Departamento de Análisis Económico Aplicado, Universidad de Las Palmas de Gran Canaria,
Campus de Tafira, 35017 Las Palmas de Gran Canaria, Spain, e-mail address:
btovar@daea.ulpgc.es

Roberto Rendeiro Martín-Cejas

Research Group Economics of infrastructure and Transport (EIT)
Departamento de Análisis Económico Aplicado, Universidad de Las Palmas de Gran Canaria,
Campus de Tafira, 35017 Las Palmas de Gran Canaria, Spain, e-mail address:
rrendeiro@daea.ulpgc.es

Abstract

Nowadays, most of the effort is being put towards applying non-parametric techniques such as Data Envelopment Analysis (DEA) in airport performance studies. This work explores another methodology that could either confirm or disagree with the empirical evidence attained by those studies. This methodology is a parametric technique which estimates an efficient frontier by making assumptions that enables to separate the random and efficiency factor. In a parametric context, a functional form has to be chosen. We have selected a distance function because of its advantages to deal with the multiple output nature of airport activities in a parametric context. Parameters estimated through the multi-output input distance function let us calculate the evolution of the Total Factor Productivity (TFP) and its decomposition in Spanish airports.

Key words: Airport; Total Factor Productivity (TFP); Technical efficiency; Technological change
Parametric Distance Function.

---

[1] Corresponding author.
Departamento de Análisis Económico Aplicado,
Universidad de Las Palmas de Gran Canaria,
Campus de Tafira, Modulo D, Despacho 2.20.
35017 Las Palmas de Gran Canaria, Spain.
E-mail address: btovar@daea.ulpgc.es (B.Tovar).
Tel.: +34 928 451 794; fax: +34 928 458183

1. Introduction

An airport is more than a mere interchanger of transport modes. It is a system that serves a wide and complex range of needs related to the movements of persons and things worldwide. In that sense, to guarantee that those services are provided in the correct way, a performance measurement of the airport industry becomes crucial. However, the evaluation of airport performance has been, for quite some time, neglected by transport research. Recently, a great variety of airport studies have been performed in order to overcome this existent lack in transport literature (see Table 1 in section 3).

A review of the productivity literature, including airports, shows that the most used method is the Data Envelopment Analysis (DEA) for the non-parametric group and the Stochastic Frontier Analysis (SFA) for the parametric one. These methods could be applied to cross-section samples, but if panel data are available, it can also be used to measure technical change and change in efficiency.

Both methods have advantages and drawbacks. DEA neither impose any functional form for the frontier, nor assume distributional form for the inefficiency error terms and can easily handle multiple outputs, but it can be influenced by noise and traditional hypotheses tests cannot be carried out unless bootstrapping techniques are used (Simar and Wilson, 2000). On the other hand, SFA involves the cost of imposing a particular functional form and making particular distributional assumptions for the one-side error term associated with technical efficiency, which could introduce a potential source of error. However, SFA also has advantages. To begin with, it is capable to manage random shocks and/or measurement error[1]. Moreover, traditional hypothesis tests could be used and, finally, environmental variables are easier to deal with.

This paper attempts to analyse the technical efficiency and productive change for Spanish airport using a parametric distance function approach. The main objective of this work is to overcome the lack of parametric studies in the area of airport industry and to test the empirical evidence achieved by non-parametric approaches. This work is organized as follows. First, in section 2, the methodological approach applied to this work is described. Subsequently, in section 3, a literature review on airport productivity analysis is undertaken. Afterwards, in section 4, the estimation of the distance function for a sample of Spanish airports is presented and the results are discussed. Finally, some conclusions are pointed out.

2.Methodology

Productivity is generally defined in economics as the ratio of what is produced to what is required to produce. Productivity measurement has a long history. The earliest approach to productivity measurement was based on single or partial factor productivity measurement. Although easy to calculate, this index is too simple in practice and could provide a misleading picture of performance when there is more than a single output or a single input. When there is more than one input and more than one output (which is usually the case), productivity measurement must take this into account using the Total Factor Productivity (TFP) measurement and the change in productivity over time could be measured through TFP growth.

---

[1] Although recent developments surveyed by Simar and Wilson (2000a, 2000b y 2005) allow making statistical inference and hypothesis testing with DEA and other nonparametric efficiency estimators.

The different approaches to productivity measurement could be divided into two groups[2]. The traditional group ignores inefficiency and could be non-parametric (index number) or parametric (average function). Any case, traditional group consider that observed output is always the best output, so they are non-frontier techniques. However, when inefficiency exists, a frontier approach, which explicitly incorporates inefficiency, must be used. On the contrary, an overstatement of the unexplained residual and also a wrong allocation of productivity change and its sources is obtained because inefficiency change provides an independent contribution to productivity change which is being ignored. For this reason, we follow the frontier approach.

In the frontier approach a best practice frontier, by which each firm is to be compared, has to be estimated. It could be also done using non-parametric[3] or parametric[4] techniques but, in both cases, some assumption about technology must be done. Both approaches have advantages and disadvantages. A detailed analysis about the relative merits of all of these techniques could be found in Färe *et al.* (1997).

When airports are the subject, as we will show in the next section, almost all papers use DEA (see Table 1 in section 3). For this reason, to measure the productivity change of Spanish airports we have decided to estimate the best frontier using SFA, and then to analyze the productivity change and its decomposition, the Malmquist TFP index.

---

[2] A detailed analysis about the relative merits of all of these techniques is out of the scope of this article, but a good summary could be found in Grosskopft (1993).

[3] Like the Data Envelopment Analysis (DEA) and Free Disposable Hull (FDH).

[4] Linear programming or econometric techniques. Econometric group is also divided into two: deterministic and stochastic frontiers.

Moreover, in our case due to the heterogeneity of the sample, we think the advantages of SFA outweigh the disadvantages.

Malmquist productivity indexes were introduced by Caves *et al* (1982). They named these indexes after Malmquist, who proposed to construct input quantity indexes as ratios of distance functions (Malmquist, 1953). The distance function, introduced by Shephard (1953, 1970), allows estimation of the relative efficiency of firms in relation to the technological frontier described by the distance function.

Distance functions describe a multi-input, multi-output production technology without making behavioural assumption (such as cost minimization or profit maximization) which is especially suitably in regulated industries. Another important distance function's advantage is that input and output prices are not needed.

The distance function can take an input orientation or an output orientation. An input distance function characterizes the production technology by looking at a minimal proportional contraction of the input vector, given an output vector. On the contrary, an output distance function considers a maximal proportional expansion of the output vector, given an input vector. In this paper, we follow an input-oriented approach because in airports, like in most regulated industries, demand is beyond the airports' control and it has to be met. In this way, output is exogenous and hence, input orientation is the most relevant because input choice is endogenous (Coelli *et al.*, 2003).

Distance function can be estimated through SFA. SFA was introduced by Aigner *et al.* (1977) and it is motivated by the idea that deviations from the production frontier might not be entirely under the control of the agent being studied. Kumbhakar and Lovell (2000) provide a useful revision on this field. An input distance function can be thought of as a multiple output version of a production frontier and, as we stated before, it characterizes the production technology by looking at a minimal proportional contraction of the input vector, given an output vector and, in a parametric context, could be expressed as:

$$1 = D_i(y_{it}, x_{it}, T; \alpha, \beta, \gamma, \phi, \delta, \lambda)\exp(\xi_{it}) \qquad (1)$$

$$\text{with} \quad i = 1, 2, \ldots, N \; ; t = 1, 2, \ldots, T$$

where D_i (y_{it}, x_{it}, T) is the input distance function, y is a vector of outputs, x is a vector of inputs, T is a time trend, i relates to the *i-th* firm, α, β, γ, φ, δ, λ are parameters to be estimated. Lastly, ξ_{it} is an error term which is discussed later.

The empirical application of a parametric distance function calls for the definition of an appropriate functional form. It is desirable that the functional form presents the following advantages: it must be flexible[5], it must be easy to calculate and, lastly, it must allow imposition of the homogeneity condition. The translogarithmic functional form, proposed by Christensen *et al.* (1971), meets these conditions and this is the reason why we have chosen it.

In order to determine the frontier, D_i needs to be equal to the unit and, in that case, the term on the left of equation 1, according to the neperian logarithm, will equal zero. Consequently, it is necessary that inputs meet the homogeneity condition of degree 1.

---

[5] In order to weaken as much as possible the implications of assuming a particular functional form for the underlying input distance function.

Following Lovell *et al.* (1994)[6], this condition has been imposed by normalizing the distance function with one of the inputs. If in a translogarithmic distance function any input is chosen, say x_{mit}, the following expression results:

$$\ln(D_i / x_{nit}) = TL(y_{it}, x_{it} / x_{nit}, T; \alpha, \beta, \gamma, \phi, \delta, \lambda) \qquad (2)$$
$$with \quad i = 1, 2, ..., N \ ; t = 1, 2, ..., T$$

Finally, the following expression is obtained:

$$-\ln(x_{ni}) = TL(y_{it}, x_{it} / x_{ni}, T; \alpha, \beta, \gamma, \phi, \delta, \lambda) - \ln(D_i) \qquad (3)$$
$$with \quad i = 1, 2, ..., N \ ; t = 1, 2, ..., T$$

In equation (3), the *–ln*(*D*$_i$) is non-observable and can be interpreted as an error term. Equation 3 could be estimated by maximum likelihood following the stochastic frontier approach proposed by Aigner *et al.* (1977), if we replace *–ln*(*D*$_i$) with a composed error term (v_{it} - $u_{it,}$), where v_{it} and u_{it} represent statistical noise and technical inefficiency respectively. Applied to the distance function, this yields:

$$-\ln(x_{ni}) = TL(y_{it}, x_{it} / x_{ni}, T; \alpha, \beta, \gamma, \phi, \delta, \lambda) + v_{it} - u_{it} \qquad (4)$$
$$with \quad i = 1, 2, ..., N \ ; t = 1, 2, ..., T$$

Therefore, we estimate the following stochastic translogarithmic input distance function through Frontier[7], version 4.1, developed by Coelli (1996).

$$\begin{aligned} -\ln\left(x_{nit}\right) = {} & \alpha_0 + \sum_i^M \beta_i \ln y_{it} + \sum_i^{N-1} \alpha_i \ln x_{it}^* + \frac{1}{2} \sum_i^M \sum_j^M \beta_{ij} \ln y_{it} \ln y_{jt} + \\ & \frac{1}{2} \sum_i^{N-1} \sum_j^{N-1} \alpha_{ij} \ln x_{it}^* \ln x_{jt}^* + \sum_i^M \sum_j^{N-1} \gamma_{ij} \ln y_{it} \ln x_{jt}^* + \lambda_1 T + \lambda_{11} T^2 + \\ & \sum_i^{n-1} \delta_{1i} T \ln x_{it}^* + \sum_i^M \phi_{1i} T \ln y_{it} + v_{it} - u_{it}; \quad with \quad x_{it}^* = x_{it} / x_{nit} \end{aligned} \qquad (5)$$

---

[6] This methodology has been applied in some empirical papers (Coelli and Perelman, 1999, 2000; Morrison et al., 2000; Orea, 2002; Trujillo and Tovar, 2007; among others).

[7] We follow Battese and Coelli (1992) specification to model the temporal pattern of technical inefficiency, but we ensure the frontier program treats each observation individually to avoid imposing that the technical efficiency of each firm must be constant.

where y is a vector of M outputs, x is a vector of N factors, T is a time trend, i relates to the *i-th* firm, α, β, ψ, γ, ρ, θ are the coefficients to estimate. v_{it} is a symmetrical error term, iid with a zero average (which represents the random variables uncontrollable by the operator) and u_i is a one-sided negative error term (which measures the technical inefficiency of each operator) and is distributed independently of v_{it}.

The parameters obtained through the distance function estimation allow us to calculate the input oriented Malmquist productivity index to measure and decompose productivity change in the following way[8]:

$$\ln\left(\frac{TFP_{i1}}{TFP_{i0}}\right)=\ln\left(\frac{TE_{i1}}{TE_{i0}}\right)+0.5\left[\left(\frac{\partial \ln D_{i0}}{\partial t}\right)+\left(\frac{\partial \ln D_{i1}}{\partial t}\right)\right]+0.5\sum_{m=1}^{M}\left[\left(SF_{i0}\,\varepsilon_{mi0}+SF_{i1}\varepsilon_{mi1}\right)\left(\ln y_{ji1}-\ln y_{ji0}\right)\right] \quad (6)$$

$$\text{with} \quad i=1,2,\ldots,N\,;\, t=1,2,\ldots,T$$

where:

$$\text{Pure Technical Efficiency Change (pech)}=\ln\left(\frac{TE_{i1}}{TE_{i0}}\right); \quad (7)$$

$$\text{Technical Change (techch)}= 0.5\left[\left(\frac{\partial D_{i0}}{\partial t}\right)+\left(\frac{\partial D_{i1}}{\partial t}\right)\right] \quad (8)$$

$$\text{Scale Efficiency Change (sech)} =0.5\sum_{m=1}^{M}\left[\left(SF_{i0}\,\varepsilon_{mi0}+SF_{i1}\varepsilon_{mi1}\right)\left(\ln y_{ji1}-\ln y_{ji0}\right)\right] \quad (9)$$

The interpretation of these components is the usual one. TE_{ni} is the inverse of the input distance measure and varies between 0 and 1 as required. The technical change is measured as the mean to technical change obtained in two consecutive periods and is equal to:

---

[8] We follow the general approach outlined in Orea (2002) but adjusted to suit input distance function used here instead output distance function.

$$\left(\frac{\partial \ln D_{it}}{\partial t}\right) = \lambda_1 + \lambda_{11}\, t + \sum_{n=1}^{N} \delta_n \ln x_{nit} + \sum_{m=1}^{M} \phi_m \ln y_{mit} \qquad (10)$$

$with \quad i = 1, 2, ..., N \; ; t = 1, 2, ..., T$

Finally in order to calculate the scale efficiency change, production elasticity and scale factors are needed. We can calculate productions elasticity for each output and each observation through the following expression:

$$\varepsilon_{mit} = \left(\frac{\partial \ln D_{it}}{\partial \ln y_{mit}}\right) = \beta_m + \sum_{m=1}^{M} \beta_{mi} \ln y_{mit} + \sum_{n=1}^{N} \gamma_{ni} \ln x_{nit} + \phi_m t \qquad (11)$$

$with \quad i = 1, 2, ..., N \; ; t = 1, 2, ..., T$

In order to obtain scale factor we use:

$$SF_{it} = \frac{(\varepsilon_{it} + 1)}{\varepsilon_{it}} \qquad where \quad \varepsilon_{it} = \sum_{m=1}^{M} \varepsilon_{mit} \qquad (12)$$

$with \quad i = 1, 2, ..., N \; ; t = 1, 2, ..., T$

3.-Literature review: key issues

Early, economic analysis of airport has been concentrated on congestion process and its related costs. Different issues such as pricing structure, regulation and investment emerged (Carlin and Park, 1970a,1970b). Also, management aspects were considered crucial for understanding the industry performance (Doganis, 1992). However, actually, most of the effort is being approached towards developing models to measure airport productive. Table 1 shows a summary of airport performance studies with different specification. This gives an idea about the rapid growth in the literature related to this aspect of airport industry.

As it is apparent in Table 1, most of airport efficiency studies have used non-parametric methods to evaluate the level of airport inefficiency. The DEA approach is the most common method used. It has the advantage that it does not require any hypothesis about production technology and therefore it is free of specification bias. However, DEA approach provides a measure of the "Farrell" inefficiency rather than an explanation of it. In order to overcome this limitation some authors use the DEA-efficiency score in a second-stage regression to construct an ad hoc model to explain inefficiency (Abbott and Wu, 2002; Gillen and Lall, 1997; Pels *et al*., 2001, 2003).

On the other hand, the first papers focusing on parametric frontier approach estimated a production frontier function (deterministic, -Martín-Cejas, 2002- or stochastic -Pels *et al*., 2001, 2003) ignoring the multioutput nature of airport activity. To the best of our knowledge, this paper provides the first attempt to use a stochastic parametric frontier approach to measure productivity changes from airport taking into account multiples output. We could do that using a stochastic distance function.

As we stated before, the choice of a translog input distance function[9] gives us several advantages, that is, we could deal with multiple nature of airport production, we do not need behavioural assumption, or input and output prices. Moreover, it allows us to decompose productivity change in its sources (efficiency change and technical change) which are crucial for regulators.

---

[9] Stochastic input distance functions have been used to measure efficiency and/or productivity changes in other regulated infrastructure service such as, i.e., railway (Coelli et al., 1999, 2000), electric utilities (Atkinson et al., 2003), ports (Rodríguez-Álvarez et al., 2007).

Finally, other authors have proposed the endogenous-weight TFP index (EW-TFP). The EW-TFP method is a variant of the distance function oriented methods and specifies a flexible functional form for the production transformation function with multiple inputs and outputs (see Yoshida, 2004 for methodological details)[10]. This method has been used by the Air Transport Research Group (ATRS) in the airport-benchmarking projects (2002). Some examples of this methodology can also be seen in Oum *et al.*, (2003), Yoshida (2004) and Yoshida and Fujimoto (2004). Although the EW-TFP method has some of the input distance function's advantages, we consider that input distance function approach outperforms the EW-TFP method because the latter has relatively more assumptions such as separability and constant elasticity among inputs and output which could be tested using stochastic distance function.

On the other hand, it should also be pointed out that the majority of airport performance studies show a diverse range of specification that, in some cases, produces different and sometimes contradictory results. Two features become crucial to the sensitive analysis of these results: 1) The choice of output and input variables to be used in the efficiency analysis and 2) The approach to estimate the "best practice" production frontier. With regard to the former, as we stated before, airport infrastructures are multi-product firms with different sets of functions. For example, the terminal building serves more than one function, such as passenger processing and duty-free retailing. In that sense, a troublesome element in the evaluation of airport performance is defining the output to be utilized in the analysis. Table 2 shows a summary of outputs and inputs variables utilized in the majority of airport efficiency studies.

---

[10] A possible extension of the EW-TFP method is incorporating it to the production function the soft-cost input and concession revenue in order to measure the effect of outsourcing and commercial intensity at terminal building on airport efficiency (Yoshida, 2004).

Airport output is easy to identify but it is not homogenous. For instance, it can be defined in terms of aircraft movements, passengers and cargo volumes. However, each of these output measures is only related to a part of the infrastructure. Runways are related to the number of aircrafts landing, while terminal building size depends upon the amount of passengers and cargo processed. Therefore, none of these measures taken in isolation comprehensively explain airport production structure. Gillen and Lall (1997) and Pels *et al.*, (2001, 2003) analyze airport efficiency from the air side and the land side point of view. These authors argue that although outputs and inputs in both sides are clearly related, production technology is not. However, the first two authors conclude that, in presence of externalities, more research is needed to integrate airside and terminal operations. On the other hand, as Yoshida (2004) points out, airport industry is the typical example of joint production. While sharing the same set of inputs such as capital, labour, land, and other miscellaneous materials, it yields various kinds of outputs, such as passenger loading/unloading, aircraft movements and cargo handling. Therefore, this joint-production characteristic makes it difficult to evaluate the efficiency of airport activities in a unanimous measure.

Monetary outputs are also used in performance studies. In this case, an additional problem emerges from the price differential between different time periods or countries (with international airports samples) and a comparability bias can be introduced. Other types of output that have to be taken into account in airport efficiency study are the undesirable outputs. Yu (2004) estimated an n-year-window DEA model considering noise as an undesirable output. Pathomsiri *et al.*, (2008) computed a non-parametric directional output distance function which allows to manage undesirable outputs such as the number of delayed flights and time delays in minutes. In the past, some authors noted the relationship between undesirable output and airport performance (see Gillen and Lall, 1997 and Salazar de la Cruz, 1999). The finding was that DEA approach tends to identify congested airports as efficient.

On the other hand, if output measures are relatively easy to obtain, then consequently there should not be any problems in obtaining the necessary data required by the analysis, in turn, input measures give rise to more serious problems. The most important inputs at airports are labor and capital. Regarding the former, the easiest measure is provided by the number of employees. However, this is not homogenous, as it includes both part- and full-time personnel, in addition to qualified workers such as technicians and managers, and unskilled personnel. Therefore, given that different types of employees carry out different tasks at airports, it would be necessary to develop a more comprehensive and accurate measure for determining the labor input. A solution may be found by considering the financial value of the input. Nevertheless, such a measure also presents considerable problems since it reflects not only the quantity of the input applied, but also the relative wage differentials among airports.

Regarding the capital factor, the situation is even more complicated. This is essentially due to the diverse nature of capital inputs. For instance, the difference arising between small capital resources with a short economic life and large long term investments such as runways and buildings makes posterior input allocation very difficult to measure. ICAO (1991) recommends the utilization of assets value in order to measure capital.

However, the existence of diverse accounting methods means care has to be taken. For example, if capital goods investments are financed by government funds, it is very likely that depreciation is not entered into the accounts. This procedure is common at those airports traditionally operated as public firms. Determining asset value at such airports is misleading due to a lack of regular accounting practices. Therefore, any other measuring of capital input has to be used. A list of no monetary (physical) input has been used in many studies (see Table 2). In our case, however, Spanish Airport Authority (AENA-Aeropuertos Españoles y Navegación Aérea) is the only data source and therefore the dates are supported by homogeneity of accounting criteria.

4.-Discussion of results

This section reports a parametric decomposition of input oriented Malmquist index for Spanish Airport network. We were able to collect data from 26 airports between 1993 and 1999. The airports covered by the sample were the two hubs Madrid-Barajas and El Prat-Barcelona. Other nine tourist airports in which the percentage of international passengers is above 50%. These are Alicante, Fuerteventura, Gran Canaria, Gerona, Ibiza, Lanzarote, Málaga, Palma de Mallorca and Menorca. Finally, medium and small regional airports such as Almería, Asturias, Bilbao, Coruña, La Palma, Melilla, Pamplona, Santander, Santiago, Sevilla, San Sebastián, Jerez, Valencia, Vigo and Zaragoza. We tried to get enough representation of the main types of organizational structures for airport authorities in terms of their specialization (i.e. hub, tourist, regional, etc).

For each of these airports, we have collected information on airports movements in terms of aircraft and passengers volume and the level of commercial activities. Three outputs measures were considered. The first, aircraft movement (ATM); the second, average size of aircraft (defined as the ratio between passenger's volume and ATM) and the third, the share of non-aeronautical revenue in total airport revenue. The latter represents the level of commercial activity developed by the airport. There is some empirical evidence that shows that large airports have higher TFP index. In relation to the third variable, airports which exploit demand complementary between aeronautical and commercial services appear as more efficient (Oum *et al*., 2003).

The information available about inputs only allows us to consider three inputs to approximate capital and labor. The latter is approached by the average number of persons employed by the airport. Capital is obtained by two variables: the surface of land occupied by the airport measured by hectare and the number of gates. Table 3 summarizes all the relevant statistical information about those variables. The spread between the maxima and minima give a good sense of the heterogeneity of the sample. It suggests that we are estimating the performance of an average airport which handles annually 32 516 ATM, with an average of 81 passengers by ATM, and its non aeronautical revenue means 57% of aeronautical revenue. This airport delivers its activities on 302 hectares, has 11 gates and employs an annual average of 190 workers.

In Table 4, the estimated Maximum-likelihood parameters from the input distance function are shown. It can be seen that all first order parameters are statistically significant and have the correct sign. This implies that the distance function estimated complies with all the expected theoretical properties. At the sample mean, the regularity conditions are satisfied: it is non-decreasing and quasi-concave in inputs and decreasing in outputs. The variables have been divided by the geometric mean. Therefore, the first order coefficients can be interpreted as elasticity. Moreover, the variance parameters, σ^2 and γ, are statistical significant at 5% level and the estimated value of parameter γ is 0.9282 showing that technical efficiency have an important role to play explaining TFP change.

Before analyzing productivity change and its decomposition we present the airport's average[11] technical efficiency in the period. Figure 1 shows the technical efficiency of Spanish airports which is estimated to be on average at 80.11%. This average, however, hides very significant differences across airports. Indeed, the performance ranges from 60% to 93%.

Among Spanish airports the ones that show a higher technical efficiency than the average are: La Palma, Melilla, Ibiza, Jerez, Vigo, Coruña, Madrid, Asturias, Bilbao, Pamplona, Alicante, Lanzarote, Málaga, Mallorca, Barcelona, Fuerteventura, Menorca, San Sebastian and Gerona. Finally, airports that show a lower technical efficiency than the average are: Santander, Gran Canaria, Valencia, Almería, Zaragoza, Santiago and Sevilla.

As we stated before, the parameters of the input distance function are used to calculate the Mamlquist index of the Total Factor Productivity and to decompose it into technological change, pure technical efficiency change and scale efficiency change.

---

[11] For the sake of brevity we only report average results.

Again, for the sake of brevity we only report average results. The mean results for each year are shown in Table 5.

In order to understand the index, it could be useful remember that a value larger than 1 for the Malmquist index, or any of its components, indicates an improvement in that source of inefficiency. A value smaller than 1, indicates a decrease in the productivity. Finally, the average growth rate in the specific source is the difference between the measured index and 1.

The Malmquist index indicates that the overall productivity has increased by the whole period as noted in Figure 2 (this means an increase rate of about 23% between 1993 and 1999).

To understand what is driving this productivity growth, it is useful to analyze the components of the Malmquist index. On a year to year basis, Figure 2 shows clearly that technical change has grown smoothly during the whole period at a constant rate. It has been the most important source of productivity growth during the period examined. On the other hand, pure efficiency change played a positive role in the first part of the period, but it has been source of deterioration in the second part of it.

The mean result for each airport is shown in Table 6. As we can see the airports of San Sebastian, Madrid and Barcelona were the best-performing airport during that period. Moreover there are only five airports whose productivity decreases for the same period. These are Santander, Jérez, Zaragoza, Sevilla and Menorca.

When the decomposition of TFP changes in technological change (TECHCH), pure technical effect (PECH) and scale economy effect (SECH) for each airport is analyzed. It is obvious that technical change growth is concentrated in hub and tourist airports, except for Sevilla. Airports with a technical change growth above average are: Gran Canaria, Mallorca, Lanzarote, Malaga, Madrid, Fuerteventura, Ibiza, Alicante, Barcelona, Gerona, Menorca and Zaragoza. The average Spanish economy growth over the period 1993 to 1999 was 2.7%. By contrast, the average TFP growth of Spanish airport was 0.9%. This means that the growth of productivity is way below the rest of the Spanish economy for the same period.

5.Conclusions

As we have seen above, almost all of the papers have used the non-parametric DEA approach to analyze airport productivity. In order to contrast the empirical evidence attained by these studies, we propose a different methodology to estimate airport productivity. In this study the productivity change of Spanish airports was analyzed by a parametric technique. The estimation of a best frontier for Spanish airports was made using a Stochastic Frontier Analysis. The paper relies on a distance function which can be viewed as a multiple output version of a production frontier. And then, to analyze the productivity change and its decomposition the Malmquist TFP index was used.

The empirical evidence found in this study is similar to those in the literature reviewed. Hub airports showed a level of efficiency above the average. We also found a significance difference in efficiency between main land airports and island airports.

Except for the case of Gran Canaria airport, the rest of island airports included in the sample showed a level of efficiency above the average. In accordance with Fung *et al*., (2007) airport efficiency depends on their geographical location. Airports in the north of Spain seem to be more efficient than those in the south. The same is true for island airports. In this latter case, the reason perhaps is the touristic characteristic of the traffic in island airports.

In general terms, we found that, for our airport sample, the average rate of productivity showed a slight improvement of 0.9% per annum and the core engine of this productivity increase was the technical progress (3% increase) rather than efficiency improvement. By airports, there was a rapid technological change in almost all airports with only three exceptions Pamplona, Santander and Jerez airports. Tourist airports verified the same rate of technical change like the two hubs Madrid and Barcelona. Only these two hubs airports verified a significant improvement in pure technical efficiency. The efficiency change associated to the airport size was negligible for almost all of airports in the sample.

A natural extension of this work would be to include undesirable output on the productivity analysis. Yu *et al*., (2007) and Pathomsiri *et al*., (2008) have used non-parametric techniques to estimate the impact of this derived external effect, noise and delay respectively, on the productivity of airports. The methodology used here, the Stochastic Frontier Analyses, could be a suitable form of integrating this kind of undesirable output. This technique is capable of managing random shocks, measurement errors, and hypothesis tests and could be an easier method to deal with environmental variables.

Acknowledgements.

This research was funded with Grant from *Gobierno Autónomo de Canarias*. Project PI042005/155.

References

Abbott, M., Wu, S., 2002. Total Factor Productivity and Efficiency of Australian Airports. The Australian Economics Review 35 (3), 244-260.

Adler, N., Berechman, J., 2001. Measuring airport quality from airlines' viewpoint: an application of data envelopment analysis. Transport Policy 8, 171-181.

Aigner, D.J., Lovell, C.A.K., Schmidt, P., 1977. Formulation and Estimation of Stochastic Frontier Production Function Models. Journal of Econometrics 6 (1), 21-37.

Atkinson, S.E., Cornwell, C., Honerkamp, O., 2003. Measuring and Decomposing productivity change. Journal of Business and Economic Statistics. 21 (1), 284-294.

Barros, C., Sampaio, A., 2004. Technical and Allocative Efficiency in Airports. International Journal of Transport Economics 3, 355-377.

Barros, C., Dieke, P., 2007. Performance evaluation of Italian airports: a data envelopment analysis. Journal of Air Transport Management 13, 184-191.

Battese, G. E., Coelli T. J., 1992. Frontier Production Function, technical efficiency and panel data: with application to Paddy Farmers in India. Journal of Productivity Analysis 3, 153-169.

Bazargan, M., Vasigh, B., 2003. Size versus efficiency: a case study of US commercial airports. Journal of Air Transport Management 9, 187-193.

Carlin, A. and Park, R.E., 1970a. A model of long delay at busy airport. Journal of Transport Economics and Policy, 37-52.

Carlin, A. and Park, R.E., 1970b. Marginal cost pricing of airport runway capacity. The American Economic Review 60,310-319.

Caves, D.W., Christensen, L.R., Diewert, W.E., 1982. The economic theory of index numbers and the measurement of input, output, and productivity. Econometrica 50, 1393–1414.

Coelli, T., 1996. A guide to FRONTIER Version 4.1: a computer program for stochastic frontier production and cost function estimation. Centre for Efficiency and Productivity Analysis. University of New England.

Coelli, T., Perelman, S., 1999. A Comparison of Parametric and Non-Parametric Distance Functions: with Application to European Railways. European Journal of Operational Research 117, 326-339.

Coelli, T., Perelman, S., 2000. Technical Efficiency of European Railways: a Distance Function Approach. Applied Economics 32, 1967-1976.

Coelli, T., Estache, A., Perelman, S., Trujillo, L., 2003. A Primer on Efficiency Measurement for Utilities and Transport Regulators. WBI Development Studies. The World Bank. Washington, D.C.

Cólen Guedes, E., Prado dos Santos, R., Ribeiro Correia, A., 2006. Airport Efficiency: A Comparative Approach with data envelopment Analysis and Inverted Frontier. Proceedings of 10th Annual World Conference of Air Transport Research Society, Nagoya, Japan.

Christensen, L., Jorgenson, D., and Lau, L., 1971 . Conjugate duality and the transcendental logarithmic production function. Econometrica 39, 255–256.

Doganis, R., 1992. The Airport Business. Routledge editions. London. UK.

Färe, R., Grosskopf, S., Roos, P., 1997. Malmquist productivity indexes: a survey of Theory and Practice. *Index Numbers: Essay in Honour of Stern Malmquist*, eds R. Färe, S. Grosskopf and R.R. Rusell. Kluwer Academic Publisher, Boston.

Fernandez, E., Pacheco, R., 2002. Efficient use of airport capacity. Transportation Research Part A 36, 225-238.

Forsyth, P., 2000. Handbook of Transport Modelling. Elsevier Science Ltd.

Fung, M., Wan, K., Hui, Y., 2007. Productive changes in Chinese airports 1995-2004. Transportation Research Part E 44, 521-542. .

Gillen, D., Lall, A., 1997. Developing Measures of Airport Productivity and performance: An Application of Data Envelopment Analysis. Transportation Research Part E 33, 261-273.

Gillen, D., Lall, A., 2001. Non Parametric Measures of Efficiency of US Airports. Transport Economics 28, 283-306.

Grosskopf, S.,1993. Efficiency and Productivity. *TheMeasurement of Productivity Efficiency* ed Fried, H.O., Lovell, CAK., Schmidt, S.S., Oxford University Press. New York.

Hong, S., Kim, T., 2006. A Performance Analysis of the Airports in Korea-Super-Efficiency and DEA Approach using WLU. Proceedings of 10th Annual World Conference of Air Transport Research Society, Nagoya, Japan

Hooper, P., Hensher, D., 1997. Measuring Total Factor Productivity of Airports-An Index Number Approach. Transportation Research Part E 33, 249-259.

ICAO, 1991. ICAO Journal.

Kumbhakar, S., Lovell, K.C.A., 2000. Stochastic Frontier Analysis, Cambridge University Press, New York.

Lovell, C.A.K., Richardson, S., Travers, P., Wood, L., 1994. Resources and Functioning: a New View of Inequality in Australia. *Models and Measurement of Welfare and Inequality* ed Eichhorn W. Springer-Verlag. Berlin.

Malmquist, S., 1953. Index numbers and indifference curves. Trabajos de Estadística 4, 209–242.

Martín, J.C., Roman, C., 2001. An application of DEA to measure the efficiency of Spanish airport prior to privatization. Journal of Air Transport Management 7, 149-157.

Martín-Cejas, R., 2002. An approximation to productive efficiency of the Spanish airports networks through a deterministic cost frontier. Journal of Air Transport Management 8, 233-238.

Morrison, C.J., Johnston, W.E., Frengley, G.A.G., 2000. Efficiency in New Zealand Sheep and Beef Farming: the Impacts of Regulation Reform. Review of Economics and Statistics 82, 325-337.

Murillo-Melchor, C., 1999. An analysis of Technical Efficiency and Productivity changes in Spanish Airports using the Malmquist Index. International Journal of Transport Economics 2, 271-291.

Nyshadham, E.A., Rao, V.K., 2000. Assessing efficiency of European airports. Public Works Management and Policy 5, 106-114.

Orea, L., 2002. Parametric Decomposition of a Generalized Malmquist Productivity Index, Journal of Productivity Analysis 18, 5-22.

Oum, T., Yu, C., Fu, X., 2003. A comparative analysis of productivity performance of the world´s major airport: summary report of the ATRS global airport benchmarking research report-2002. Journal of Air Transport Management 9, 285-297.

Oum, T., Yu, C., 2004. Measuring airports' operating efficiency: a summary of the 2003 ATRS global airport benchmarking report. Transportation Research Part E, 515-532.

Oum, T., Adler, N., Yu, C., 2006. Privatization, corporatization, ownership forms and their effects on the performance of the world's major airports. Journal of Air Transport and Management 12, 109-121.

Pacheco, R., Fernández, E. and Sequeira Santos, M. 2006. Management style and airport performance in Brazil. Journal of Air Transport and Management 12, 324-330.

Parker, D., 1999. The performance of BAA before and after privatization. Journal of Transport Economics and Policy 33, 133-146.

Pathomsiri, S., Haghani A., 2004. Benchmarking efficiency of airports in the competitive multiple-airport systems: the international perspective. Proceedings of the 19th Transport Chicago Conference (CD-ROM), Chicago, IL.

Pathomsiri, S., Haghani A., Schonfeld, P.S., 2005. Operational efficiency of airports in multiple-airport systems. Transportation Research Board 84th Annual Meeting Compendium of Papers (CD-ROM), Washington DC.

Pathomsiri, S., Haghani A.., Dresner, M., and Windle, R.J., 2006. Measurement and determination of airport productivity in competitive markets. Transportation Research Board 85th Annual Meeting Compendium of Papers (CD-ROM), Washington DC.

Pathomsiri, S., Haghani, A., Dresner, M., Windle, R. 2008. Impact of undesirable outputs on the productivity of US airports. Transportation Research Part E 44, 235-259.

Pels, E., Nijkamp, P., Rietveld, P., 2001. Relative Efficiency of European Airports. Transport Policy 8, 183-192.

Pels, E., Nijkamp, P., Rietveld, P., 2003. Inefficiencies and Scale of European Airports Operations. Transportation Research Part E 39, 341-361.

Rodríguez-Álvarez, A., Tovar, B., Trujillo, L., 2007. Firm and time varying technical and allocative efficiency: An application to port cargo handling firms. International Journal of Production Economics 109, 149-161.

Salazar de la Cruz, F., 1999. A DEA Approach to the Airport Production Function. International Journal of Transport Economics 2, 255-270.

Sarkis, J., 2000. An analysis of the operational efficiency of major airports in the United States. Journal of Operations Management 18, 335-351.

Sarkis, J. and Talluri, S., 2004. Performance based clustering for benchmarking of US airports. Transportation Research Part A 38, 329-346.

Shephard, R.W., 1953. Cost and Production Functions. Princeton University Press. Princeton.

Shephard, R.W., 1970. Theory of Cost and Production Functions. Princeton University Press, Princeton.

Simar, L., Wilson, P., 2000a. A General Methodology for Boostraping in Nonparametric Frontier Models. Journal of Applied Statistics 27, 779-802.

Simar, L., Wilson, P., 2000b. Statistical Inference in Nonparametric Frontier Models: The State of the Art. Journal of Productivity Analysis, 13, 49-78.

Simar, L., Wilson, P., 2005. Statistical Inference in Nonparametric Frontier Models: Recent developments and perspectives. *The Measurement of Productivity Efficiency*, ed. H Fried, C.A.K. Lovell and S. Schmidt, 2nd ed., Oxford University Press. Oxford.

Trujillo, L., Tovar, B., 2007. The European Port Industry: An analysis of its Economic Efficiency. Maritime Economics & Logistics 9, 148-171.

Yoshida, Y., 2004. Endogenous-weight TFP measurement: methodology and its applications to Japanese-airport benchmarking. Transportation Research Part E 40, 151-182.

Yoshida, Y., Fujimoto, H., 2004. Japanese-airport benchmarking with the DEA and endogenous-weight TFP methods: testing the criticism of overinvestment in Japanese regional airport. Transportation Research Part E 40, 533-546.

Yu, M., 2004. Measuring physical efficiency of domestic airports in Taiwan with undesirable outputs and environment factors. Journal of Air Transport Management 10, 295-303.

Yu, M., Hsu, S., Chang, C. And Lee, D. 2008. Productivity growth of Taiwan's major domestic airports in the presence of aircraft noise. Transportation Research Part E 44, 3, 333-576.

Table1: Summary of airport performance studies

Year	Authors	Methodology			Measures	Data	Observations
		Frontier?	Parametric?	Model			
1997	Gillen *et al*	Yes	No	DEA	TE	21 USA airports (1989/1993)	Explain ET through Tobit
	Hooper *et al*	No	No	PIN	TFP	5 Australian airports (1988/89-1991/92)	Estimate Two regression models for estimating output adjusted-TFP
1999	Salazar	Yes	No	DEA	CE	16 Spanish airports (1993/1995)	
	Parker	Yes	No	DEA	TE	22 UK airports (1988/89-1996/97)	
	Murillo-Melchor	Yes	No	DEA	TE, TFP	33 Spanish airports (1992/1994)	Use a Malmquist Index (and decompose it)
2000	Sarkis	Yes	No	DEA	TE	44 USA airports (1990/1994)	ET scores are analyzed using Mann-Witney Test
	Nyshadham *et al*	No	No	PIN	TFP	25 European airports (1995)	Use a Translog Multilateral Index
2001	Adler *et al*	Yes	No	DEA	TE	26 Worldwide airports (1996)	Use Principle Component Analysis and applied Superefficient DEA model
	Pels *et al*	Yes	No	DEA	TE	34 European airports (1995/1997)	
		Yes	Yes	SPF	TE		Use a Coob-Douglas function
	Martin *et al*	Yes	No	DEA	TE	37 Spanish airports (1997)	
	Gillen *et al*	Yes	No	DEA	TE, TFP	22 USA airports (1989/1993)	Use a Malmquist Index (and decompose it)
2002	Abbott *et al*	Yes	No	DEA	TE, TFP	12 Australian airports (1989/90, 99/2000)	Malmquist Index (and decompose it), explain TFP's variations through Tobit
	Fernandes *et al*	Yes	No	DEA	TE	35 Brazilian airports (1998)	
	Martín-Cejas	Yes	Yes	DCF	TE	40 Spanish airports (1996-1997)	
2003	Bazargan el al	Yes	No	DEA	TE	45 USA airports (1996-2000)	ET scores are analyzed using Kruskal-Wallis and Mann-Witney Tests
	Oum *et al*	No	Yes	EW-TFP	TFP	50 World airports (1999)	Further analysing TFP by regression models
	Pels *et al*	Yes	No	DEA	TE	34 European airports (1995/1997)	
		Yes	Yes	SPF	TE		Use a Translog function and explain de ineficiency
2004	Yoshida *et al*	Yes	No	DEA	TE	67 Japanese airports (2000)	Explain ET through Tobit
		No	Yes	EW-TFP	TFP		Explain ET through OLS
	Oum *et al*	No	Yes	EW-VFP	VFP	76 Worlwide airports (2000-2001)	Further analysing VFP by regression models
	Barros *et al*	Yes	No	DEA	TE, AE	13 Portuguese airports (1990-2000)	Explain CE through Tobit
	Yu	Yes	No	DEA	TE	14 Taiwan airports (1994-2000)	Undesirable (noise) are taken into account
	Sarkis *et al*	Yes	No	DEA	TE	44 USA airports (1990-1994)	
	Pathomsiri *et al*	Yes	No	DEA	TE	63 Worlwide airports (2000, 2002)	Use paired-sample t-test to test differences in ET scores before/after Sept-11
	Yoshida	No	Yes	EW-TFP	TFP	30 Japanese airports (2000)	Further analysing TFP by regression models
2005	Pathomsiri *et al*	Yes	No	DEA	TFP	72 Worldwideairports (2000, 2002)	Parametric and non parametric test to test ET differences before/after Sept-11
2006	Oum *et al*	No	Yes	EW-VFP	VFP	116 Worlwide airports (2001-2003)	Further analysing VFP by regression models
	Pacheco *et al*	Yes	No	DEA	TE	58 Brazilian airports (1998, 2001)	Use financial and operating performance as outputs
	Pathomsiri *et al*	Yes	No	DEA	TFP	72 Worlwide airports (2000, 2002)	Tobit to explain variation in airport productivity
	Colón *et al*	Yes	No	DEA	TE	30 Brazilian airports (2004)	Inverted frontier is used to discriminate false efficient unit
	Hong *et al*	Yes	No	DEA	TE	14 Korean airports (2000-2004)	Identification of super efficient airports
2007	Barros *et al*	Yes	No	DEA	TE	31 Italian airports (2001-2003)	ET scores are analyzed using Mann-Witney Test
	Fung *et al*.	Yes	No	DEA	TE, TFP	25 Chinese airports (1995/2004)	Use a Malmquist Index (and decompose it)
2008	Pathomsiri *et al*	Yes	No	DEA	TFP	56 USA airports (200-2003)	Use a Malmquist-Lumberger Index Undesirable (delays) are taken into account
	Yu *et al*	Yes	No	DEA	TFP	4 Taiwan airports (1995-1999)	Use a Malmquist-Lumberger Index.Undesirable (noise) are taken into account

Note: TE= Technical Efficiency; AE = Allocative Efficiency CE= Cost Efficiency; TFP = Total Factor Productivity; VFP = Variable Factor Productivity; PIN = Price-based Index Number; DEA=Data Envelopment Analysis; DCF = Deterministic Cost Frontier; SPF = Stochastic Production Frontier; EW-TFP=Endogenous-weight TFP
Source: own elaborated from several studies

Table 2: Summary of output and input measures in airport performance studies

Output	Input	
No monetary outputs:	*No monetary inputs:*	
-Numbers of passenger	-Number of runway	- Number of check-in desk
-Number of domestic passenger	-Number of gates	- Runway length
-Aircraft movements (ATM)	-Terminal building area	- Apron area
-Number of air carrier operations	-Number of employees	- Departure long area
-Percentage of on time operations	-Minimum connecting time	- Length of curb frontage
-Cargo tonnes	-Number of baggage claim	- Baggage claim area
-Mail tonnes	-Distance to nearest city center	- Airport surface area
-Work load Unit	-Number of remote aircraft parking	
	-Number of public parking spots	
Monetary outputs:	-Number of air routes connecting with other airports	
	-Number of full time equivalent employees	
-Aeronautical revenue	-Number of aircraft parking position at terminal	
-Non-aeronautical revenue		
-Defected revenue index		
-Total revenue	*Monetary inputs:*	
-Operational revenue		
-Sales to plane	-Labour cost	- Operational cost
-Sales to passengers	-Capital cost	- Airport charge
-Noise fees (undesirable output)	-Capital stock	- Material cost
-Commercial revenue	-Other expenditures	- Soft cost
-Handling revenue	-Total cost	- Access cost
Undesirable output:		
-Noise		
-Delay		

Source: own elaboration from several studies.

Table 3. Descriptive statistics of variables used in estimations

Variables	Units	Average	Maximun	Minimum	Standar deviation	C.Pearson
ATM	Number	32.516	252.428	1.803	49.539	1,52
Aircraft size	Passenger/ATM	81	148	11	28	0,34
NAR/AR	Percentage	57	153	16	20	0,34
Labor	Number	190	823	42	162	0,85
Area	Hectare	302	1.038	37	249	0,83
Gates	Number	11	74	1	16	1,39

Table 4. Input Distance Function parameter estimates

Variable	coefficient	standard-error	t-ratio
cte	0,2815	0,0330	8,5272
ATM	-0,4529	0,0205	-22,1313
Aircraft size (pas/ATM)	-0,4693	0,0568	-8,2575
NAR/AR	-0,3098	0,0479	-6,4616
ATM sq	-0,1968	0,0291	-6,7741
Aircraft size sq	-0,6294	0,1453	-4,3327
NAR/AR sq	0,1962	0,1309	1,4988
ATM x Aircraft size	0,1878	0,0479	3,9177
ATM x NAR/AR	-0,1101	0,0602	-1,8290
Aircraft size x NAR/AR	-0,2273	0,1315	-1,7280
Gates	0,1404	0,0529	2,6549
area	0,1641	0,0434	3,7840
Labor	0,6955	0,0480	14,5045
Gates sq	0,1788	0,1313	1,3616
area sq	0,1201	0,0837	1,4358
Labor sq	0,0917	0,1848	0,4963
gates x area	-0,1036	0,0622	-1,6661
gates x labor	-0,0752	0,1315	-0,5719
area x labor	-0,0165	0,1070	-0,1543
gates x ATM	0,0123	0,0566	0,2172
gates x Aircraft size (pas/ATM)	-0,0102	0,1068	-0,0955
gates x NAR/AR	0,0661	0,0883	0,7495
area x ATM	0,2110	0,0323	6,5386
area x Aircraft size (pas/ATM)	0,0839	0,1077	0,7785
area x NAR/AR	-0,0157	0,1206	-0,1305
labor x ATM	-0,2233	0,0607	-3,6804
labor x Aircraft size (pas/ATM)	-0,0737	0,1496	-0,4923
labor x NAR/AR	-0,0504	0,1430	-0,3525
Gates x t	0,0118	0,0154	0,7655
area x t	-0,0262	0,0149	-1,7580
Labor x t	0,0145	0,0186	0,7776
ATM x t	0,0084	0,0072	1,1754
Aircraft size x t	0,0296	0,0191	1,5497
NAR/AR x t	-0,0348	0,0177	-1,9642
t	0,0298	0,0069	4,3318
t sq	0,0294	0,0072	4,0892
sigma-squared	0,0785	0,0110	7,1626
gamma	0,9282	0,0319	29,1059
mu	is restricted to be zero		
eta	Is restricted to be zero		

Table 5. Malmquist index and its decomposition. Summary of years' means

	TECHCH	PECH	SECH	TFP change
1993				
1994	0,9546	0,9074	0,9960	0,8588
1995	0,9873	1,0169	0,9881	0,9934
1996	1,0143	1,0799	0,9795	1,0745
1997	1,0469	0,9806	1,0000	1,0282
1998	1,0796	0,9693	0,9892	1,0387
1999	1,1070	0,9899	0,9861	1,0835
MEAN	**1,0303**	**0,9893**	**0,9898**	**1,0099**

Table 6. Malmquist Index and its decomposition. Summary of firms' means

AIRPORT	TECHCH	PECH	SECH	TFP change
Alicante	1,0484	1,0034	0,9716	1,0230
Almería	1,0234	0,9947	0,9952	1,0151
Asturias	1,0108	0,9938	0,9990	1,0020
Barcelona	1,0417	1,0266	0,9779	1,0470
Bilbao	1,0092	0,9950	0,9983	1,0020
Coruña	1,0160	0,9971	0,9978	1,0099
Fuerteventura	1,0595	0,9822	0,9676	1,0112
Gran Canaria	1,0746	0,9506	0,9771	1,0042
Gerona	1,0409	0,9908	0,9930	1,0269
Ibiza	1,0506	0,9836	0,9817	1,0169
Lanzarote	1,0673	0,9771	0,9619	1,0095
La Palma	1,0243	0,9822	0,9992	1,0060
Madrid	1,0626	1,0265	0,9627	1,0540
Malaga	1,0631	0,9978	0,9679	1,0292
Mallorca	1,0690	0,9879	0,9679	1,0271
Melilla	1,0168	1,0021	1,0036	1,0220
Menorca	1,0393	0,9675	0,9917	0,9987
Pamplona	0,9980	1,0066	1,0200	1,0224
Santander	0,9995	0,9650	0,9869	0,9504
Santiago	1,0231	0,9939	0,9926	1,0087
Sevilla	1,0050	0,9658	1,0042	0,9778
San Sebastian	1,0174	1,0172	1,0170	1,0570
Jerez	0,9613	0,9976	0,9992	0,9531
Valencia	1,0232	0,9957	0,9955	1,0136
Vigo	1,0132	0,9887	1,0005	1,0019
Zaragoza	1,0379	0,9380	1,0077	0,9755
MEAN	**1,0303**	**0,9893**	**0,9898**	**1,0099**

Figure I. Average technical efficiency of Spanish airports. 1993-1999.

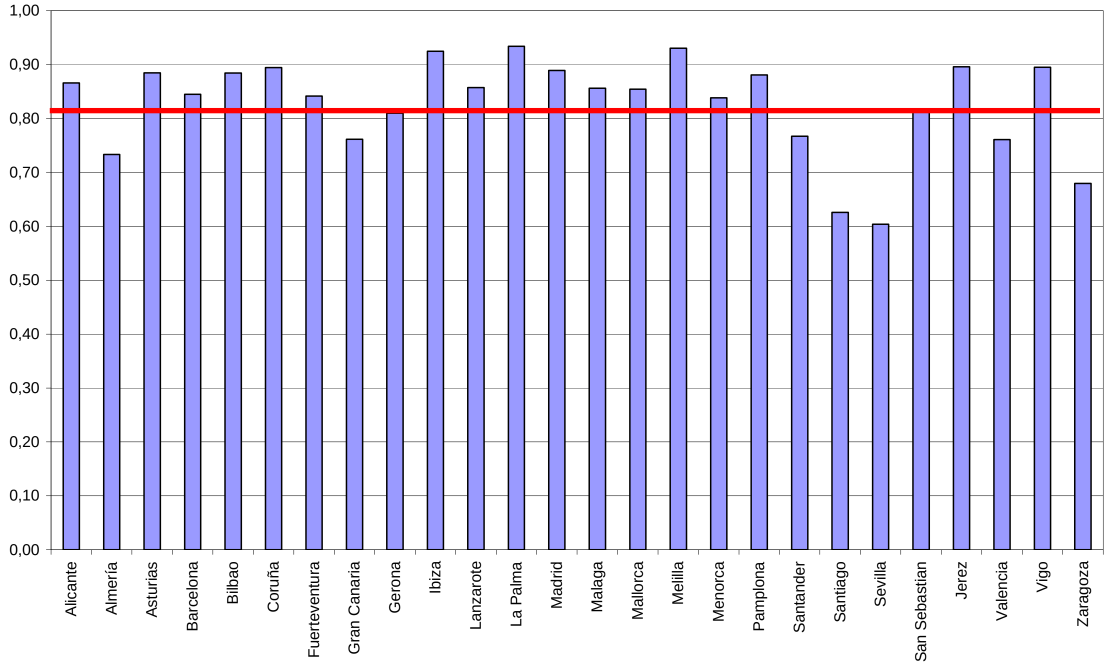
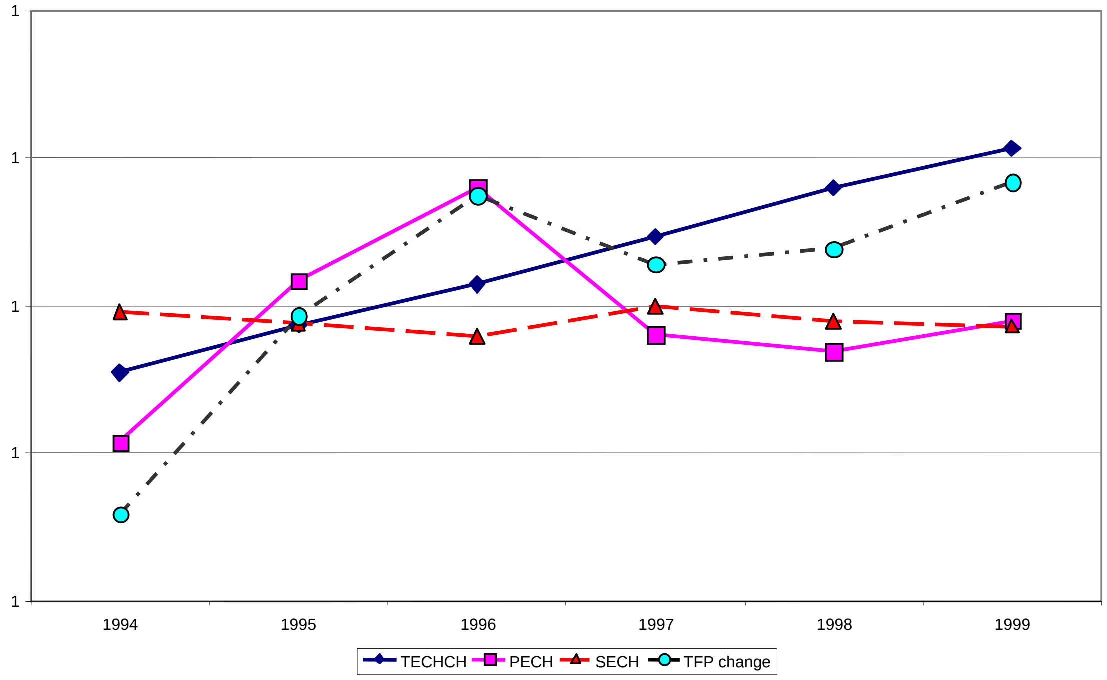


Figure 2. Malmquist Index and its decomposition. Summary of years' means



FUNDACIÓN DE LAS CAJAS DE AHORROS

DOCUMENTOS DE TRABAJO

Últimos números publicados

159/2000 Participación privada en la construcción y explotación de carreteras de peaje
Ginés de Rus, Manuel Romero y Lourdes Trujillo

160/2000 Errores y posibles soluciones en la aplicación del *Value at Risk*
Mariano González Sánchez

161/2000 Tax neutrality on saving assets. The spahish case before and after the tax reform
Cristina Ruza y de Paz-Curbera

162/2000 Private rates of return to human capital in Spain: new evidence
F. Barceinas, J. Oliver-Alonso, J.L. Raymond y J.L. Roig-Sabaté

163/2000 El control interno del riesgo. Una propuesta de sistema de límites
riesgo neutral
Mariano González Sánchez

164/2001 La evolución de las políticas de gasto de las Administraciones Públicas en los años 90
Alfonso Utrilla de la Hoz y Carmen Pérez Esparrells

165/2001 Bank cost efficiency and output specification
Emili Tortosa-Ausina

166/2001 Recent trends in Spanish income distribution: A robust picture of falling income inequality
Josep Oliver-Alonso, Xavier Ramos y José Luis Raymond-Bara

167/2001 Efectos redistributivos y sobre el bienestar social del tratamiento de las cargas familiares en el nuevo IRPF
Nuria Badenes Plá, Julio López Laborda, Jorge Onrubia Fernández

168/2001 The Effects of Bank Debt on Financial Structure of Small and Medium Firms in some European Countries
Mónica Melle-Hernández

169/2001 La política de cohesión de la UE ampliada: la perspectiva de España
Ismael Sanz Labrador

170/2002 Riesgo de liquidez de Mercado
Mariano González Sánchez

171/2002 Los costes de administración para el afiliado en los sistemas de pensiones basados en cuentas de capitalización individual: medida y comparación internacional.
José Enrique Devesa Carpio, Rosa Rodríguez Barrera, Carlos Vidal Meliá

172/2002 La encuesta continua de presupuestos familiares (1985-1996): descripción, representatividad y propuestas de metodología para la explotación de la información de los ingresos y el gasto.
Llorenc Pou, Joaquín Alegre

173/2002 Modelos paramétricos y no paramétricos en problemas de concesión de tarjetas de credito.
Rosa Puertas, María Bonilla, Ignacio Olmeda

174/2002	Mercado único, comercio intra-industrial y costes de ajuste en las manufacturas españolas. José Vicente Blanes Cristóbal
175/2003	La Administración tributaria en España. Un análisis de la gestión a través de los ingresos y de los gastos. Juan de Dios Jiménez Aguilera, Pedro Enrique Barrilao González
176/2003	The Falling Share of Cash Payments in Spain. Santiago Carbó Valverde, Rafael López del Paso, David B. Humphrey Publicado en “Moneda y Crédito” nº 217, pags. 167-189.
177/2003	Effects of ATMs and Electronic Payments on Banking Costs: The Spanish Case. Santiago Carbó Valverde, Rafael López del Paso, David B. Humphrey
178/2003	Factors explaining the interest margin in the banking sectors of the European Union. Joaquín Maudos y Juan Fernández Guevara
179/2003	Los planes de stock options para directivos y consejeros y su valoración por el mercado de valores en España. Mónica Melle Hernández
180/2003	Ownership and Performance in Europe and US Banking – A comparison of Commercial, Co-operative & Savings Banks. Yener Altunbas, Santiago Carbó y Phil Molyneux
181/2003	The Euro effect on the integration of the European stock markets. Mónica Melle Hernández
182/2004	In search of complementarity in the innovation strategy: international R&D and external knowledge acquisition. Bruno Cassiman, Reinhilde Veugelers
183/2004	Fijación de precios en el sector público: una aplicación para el servicio municipal de suministro de agua. Mª Ángeles García Valiñas
184/2004	Estimación de la economía sumergida es España: un modelo estructural de variables latentes. Ángel Alañón Pardo, Miguel Gómez de Antonio
185/2004	Causas políticas y consecuencias sociales de la corrupción. Joan Oriol Prats Cabrera
186/2004	Loan bankers’ decisions and sensitivity to the audit report using the belief revision model. Andrés Guiral Contreras and José A. Gonzalo Angulo
187/2004	El modelo de Black, Derman y Toy en la práctica. Aplicación al mercado español. Marta Tolentino García-Abadillo y Antonio Díaz Pérez
188/2004	Does market competition make banks perform well?. Mónica Melle
189/2004	Efficiency differences among banks: external, technical, internal, and managerial Santiago Carbó Valverde, David B. Humphrey y Rafael López del Paso

190/2004 Una aproximación al análisis de los costes de la esquizofrenia en españa: los modelos jerárquicos bayesianos
F. J. Vázquez-Polo, M. A. Negrín, J. M. Cavasés, E. Sánchez y grupo RIRAG

191/2004 Environmental proactivity and business performance: an empirical analysis
Javier González-Benito y Óscar González-Benito

192/2004 Economic risk to beneficiaries in notional defined contribution accounts (NDCs)
Carlos Vidal-Meliá, Inmaculada Domínguez-Fabian y José Enrique Devesa-Carpio

193/2004 Sources of efficiency gains in port reform: non parametric malmquist decomposition tfp index for Mexico
Antonio Estache, Beatriz Tovar de la Fé y Lourdes Trujillo

194/2004 Persistencia de resultados en los fondos de inversión españoles
Alfredo Ciriaco Fernández y Rafael Santamaría Aquilué

195/2005 El modelo de revisión de creencias como aproximación psicológica a la formación del juicio del auditor sobre la gestión continuada
Andrés Guiral Contreras y Francisco Esteso Sánchez

196/2005 La nueva financiación sanitaria en España: descentralización y prospectiva
David Cantarero Prieto

197/2005 A cointegration analysis of the Long-Run supply response of Spanish agriculture to the common agricultural policy
José A. Mendez, Ricardo Mora y Carlos San Juan

198/2005 ¿Refleja la estructura temporal de los tipos de interés del mercado español preferencia por la liquidez?
Magdalena Massot Perelló y Juan M. Nave

199/2005 Análisis de impacto de los Fondos Estructurales Europeos recibidos por una economía regional: Un enfoque a través de Matrices de Contabilidad Social
M. Carmen Lima y M. Alejandro Cardenete

200/2005 Does the development of non-cash payments affect monetary policy transmission?
Santiago Carbó Valverde y Rafael López del Paso

201/2005 Firm and time varying technical and allocative efficiency: an application for port cargo handling firms
Ana Rodríguez-Álvarez, Beatriz Tovar de la Fe y Lourdes Trujillo

202/2005 Contractual complexity in strategic alliances
Jeffrey J. Reuer y Africa Ariño

203/2005 Factores determinantes de la evolución del empleo en las empresas adquiridas por opa
Nuria Alcalde Fradejas y Inés Pérez-Soba Aguilar

204/2005 Nonlinear Forecasting in Economics: a comparison between Comprehension Approach versus Learning Approach. An Application to Spanish Time Series
Elena Olmedo, Juan M. Valderas, Ricardo Gimeno and Lorenzo Escot

205/2005	Precio de la tierra con presión urbana: un modelo para España Esther Decimavilla, Carlos San Juan y Stefan Sperlich
206/2005	Interregional migration in Spain: a semiparametric analysis Adolfo Maza y José Villaverde
207/2005	Productivity growth in European banking Carmen Murillo-Melchor, José Manuel Pastor y Emili Tortosa-Ausina
208/2005	Explaining Bank Cost Efficiency in Europe: Environmental and Productivity Influences. Santiago Carbó Valverde, David B. Humphrey y Rafael López del Paso
209/2005	La elasticidad de sustitución intertemporal con preferencias no separables intratemporalmente: los casos de Alemania, España y Francia. Elena Márquez de la Cruz, Ana R. Martínez Cañete y Inés Pérez-Soba Aguilar
210/2005	Contribución de los efectos tamaño, book-to-market y momentum a la valoración de activos: el caso español. Begoña Font-Belaire y Alfredo Juan Grau-Grau
211/2005	Permanent income, convergence and inequality among countries José M. Pastor and Lorenzo Serrano
212/2005	The Latin Model of Welfare: Do ‘Insertion Contracts’ Reduce Long-Term Dependence? Luis Ayala and Magdalena Rodríguez
213/2005	The effect of geographic expansion on the productivity of Spanish savings banks Manuel Illueca, José M. Pastor and Emili Tortosa-Ausina
214/2005	Dynamic network interconnection under consumer switching costs Ángel Luis López Rodríguez
215/2005	La influencia del entorno socioeconómico en la realización de estudios universitarios: una aproximación al caso español en la década de los noventa Marta Rahona López
216/2005	The valuation of spanish ipos: efficiency analysis Susana Álvarez Otero
217/2005	On the generation of a regular multi-input multi-output technology using parametric output distance functions Sergio Perelman and Daniel Santin
218/2005	La gobernanza de los procesos parlamentarios: la organización industrial del congreso de los diputados en España Gonzalo Caballero Miguez
219/2005	Determinants of bank market structure: Efficiency and political economy variables Francisco González
220/2005	Agresividad de las órdenes introducidas en el mercado español: estrategias, determinantes y medidas de performance David Abad Díaz

221/2005 Tendencia post-anuncio de resultados contables: evidencia para el mercado español
Carlos Forner Rodríguez, Joaquín Marhuenda Fructuoso y Sonia Sanabria García

222/2005 Human capital accumulation and geography: empirical evidence in the European Union
Jesús López-Rodríguez, J. Andrés Faíña y Jose Lopez Rodríguez

223/2005 Auditors' Forecasting in Going Concern Decisions: Framing, Confidence and Information Processing
Waymond Rodgers and Andrés Guiral

224/2005 The effect of Structural Fund spending on the Galician region: an assessment of the 1994-1999 and 2000-2006 Galician CSFs
José Ramón Cancelo de la Torre, J. Andrés Faíña and Jesús López-Rodríguez

225/2005 The effects of ownership structure and board composition on the audit committee activity: Spanish evidence
Carlos Fernández Méndez and Rubén Arrondo García

226/2005 Cross-country determinants of bank income smoothing by managing loan loss provisions
Ana Rosa Fonseca and Francisco González

227/2005 Incumplimiento fiscal en el irpf (1993-2000): un análisis de sus factores determinantes
Alejandro Estellér Moré

228/2005 Region versus Industry effects: volatility transmission
Pilar Soriano Felipe and Francisco J. Climent Diranzo

229/2005 Concurrent Engineering: The Moderating Effect Of Uncertainty On New Product Development Success
Daniel Vázquez-Bustelo and Sandra Valle

230/2005 On zero lower bound traps: a framework for the analysis of monetary policy in the ‘age’ of central banks
Alfonso Palacio-Vera

231/2005 Reconciling Sustainability and Discounting in Cost Benefit Analysis: a methodological proposal
M. Carmen Almansa Sáez and Javier Calatrava Requena

232/2005 Can The Excess Of Liquidity Affect The Effectiveness Of The European Monetary Policy?
Santiago Carbó Valverde and Rafael López del Paso

233/2005 Inheritance Taxes In The Eu Fiscal Systems: The Present Situation And Future Perspectives.
Miguel Angel Barberán Lahuerta

234/2006 Bank Ownership And Informativeness Of Earnings.
Víctor M. González

235/2006 Developing A Predictive Method: A Comparative Study Of The Partial Least Squares Vs Maximum Likelihood Techniques.
Waymond Rodgers, Paul Pavlou and Andres Guiral.

236/2006 Using Compromise Programming for Macroeconomic Policy Making in a General Equilibrium Framework: Theory and Application to the Spanish Economy.
Francisco J. André, M. Alejandro Cardenete y Carlos Romero.

237/2006	Bank Market Power And Sme Financing Constraints. Santiago Carbó-Valverde, Francisco Rodríguez-Fernández y Gregory F. Udell.
238/2006	Trade Effects Of Monetary Agreements: Evidence For Oecd Countries. Salvador Gil-Pareja, Rafael Llorca-Vivero y José Antonio Martínez-Serrano.
239/2006	The Quality Of Institutions: A Genetic Programming Approach. Marcos Álvarez-Díaz y Gonzalo Caballero Miguez.
240/2006	La interacción entre el éxito competitivo y las condiciones del mercado doméstico como determinantes de la decisión de exportación en las Pymes. Francisco García Pérez.
241/2006	Una estimación de la depreciación del capital humano por sectores, por ocupación y en el tiempo. Inés P. Murillo.
242/2006	Consumption And Leisure Externalities, Economic Growth And Equilibrium Efficiency. Manuel A. Gómez.
243/2006	Measuring efficiency in education: an analysis of different approaches for incorporating non-discretionary inputs. Jose Manuel Cordero-Ferrera, Francisco Pedraja-Chaparro y Javier Salinas-Jiménez
244/2006	Did The European Exchange-Rate Mechanism Contribute To The Integration Of Peripheral Countries?. Salvador Gil-Pareja, Rafael Llorca-Vivero y José Antonio Martínez-Serrano
245/2006	Intergenerational Health Mobility: An Empirical Approach Based On The Echp. Marta Pascual and David Cantarero
246/2006	Measurement and analysis of the Spanish Stock Exchange using the Lyapunov exponent with digital technology. Salvador Rojí Ferrari and Ana Gonzalez Marcos
247/2006	Testing For Structural Breaks In Variance Withadditive Outliers And Measurement Errors. Paulo M.M. Rodrigues and Antonio Rubia
248/2006	The Cost Of Market Power In Banking: Social Welfare Loss Vs. Cost Inefficiency. Joaquín Maudos and Juan Fernández de Guevara
249/2006	Elasticidades de largo plazo de la demanda de vivienda: evidencia para España (1885-2000). Desiderio Romero Jordán, José Félix Sanz Sanz y César Pérez López
250/2006	Regional Income Disparities in Europe: What role for location?. Jesús López-Rodríguez and J. Andrés Faíña
251/2006	Funciones abreviadas de bienestar social: Una forma sencilla de simultanear la medición de la eficiencia y la equidad de las políticas de gasto público. Nuria Badenes Plá y Daniel Santín González
252/2006	“The momentum effect in the Spanish stock market: Omitted risk factors or investor behaviour?”. Luis Muga and Rafael Santamaría
253/2006	Dinámica de precios en el mercado español de gasolina: un equilibrio de colusión tácita. Jordi Perdiguero García

254/2006 Desigualdad regional en España: renta permanente versus renta corriente.
José M.Pastor, Empar Pons y Lorenzo Serrano

255/2006 Environmental implications of organic food preferences: an application of the impure public goods model.
Ana Maria Aldanondo-Ochoa y Carmen Almansa-Sáez

256/2006 Family tax credits versus family allowances when labour supply matters: Evidence for Spain.
José Felix Sanz-Sanz, Desiderio Romero-Jordán y Santiago Álvarez-García

257/2006 La internacionalización de la empresa manufacturera española: efectos del capital humano genérico y específico.
José López Rodríguez

258/2006 Evaluación de las migraciones interregionales en España, 1996-2004.
María Martínez Torres

259/2006 Efficiency and market power in Spanish banking.
Rolf Färe, Shawna Grosskopf y Emili Tortosa-Ausina.

260/2006 Asimetrías en volatilidad, beta y contagios entre las empresas grandes y pequeñas cotizadas en la bolsa española.
Helena Chuliá y Hipòlit Torró.

261/2006 Birth Replacement Ratios: New Measures of Period Population Replacement.
José Antonio Ortega.

262/2006 Accidentes de tráfico, víctimas mortales y consumo de alcohol.
José Mª Arranz y Ana I. Gil.

263/2006 Análisis de la Presencia de la Mujer en los Consejos de Administración de las Mil Mayores Empresas Españolas.
Ruth Mateos de Cabo, Lorenzo Escot Mangas y Ricardo Gimeno Nogués.

264/2006 Crisis y Reforma del Pacto de Estabilidad y Crecimiento. Las Limitaciones de la Política Económica en Europa.
Ignacio Álvarez Peralta.

265/2006 Have Child Tax Allowances Affected Family Size? A Microdata Study For Spain (1996-2000).
Jaime Vallés-Giménez y Anabel Zárate-Marco.

266/2006 Health Human Capital And The Shift From Foraging To Farming.
Paolo Rungo.

267/2006 Financiación Autonómica y Política de la Competencia: El Mercado de Gasolina en Canarias.
Juan Luis Jiménez y Jordi Perdiguero.

268/2006 El cumplimiento del Protocolo de Kyoto para los hogares españoles: el papel de la imposición sobre la energía.
Desiderio Romero-Jordán y José Félix Sanz-Sanz.

269/2006 Banking competition, financial dependence and economic growth
Joaquín Maudos y Juan Fernández de Guevara

270/2006 Efficiency, subsidies and environmental adaptation of animal farming under CAP
Werner Kleinhanß, Carmen Murillo, Carlos San Juan y Stefan Sperlich

271/2006 Interest Groups, Incentives to Cooperation and Decision-Making Process in the European Union
A. Garcia-Lorenzo y Jesús López-Rodríguez

272/2006 Riesgo asimétrico y estrategias de momentum en el mercado de valores español
Luis Muga y Rafael Santamaría

273/2006 Valoración de capital-riesgo en proyectos de base tecnológica e innovadora a través de la teoría de opciones reales
Gracia Rubio Martín

274/2006 Capital stock and unemployment: searching for the missing link
Ana Rosa Martínez-Cañete, Elena Márquez de la Cruz, Alfonso Palacio-Vera and Inés Pérez-Soba Aguilar

275/2006 Study of the influence of the voters' political culture on vote decision through the simulation of a political competition problem in Spain
Sagrario Lantarón, Isabel Lillo, Mª Dolores López and Javier Rodrigo

276/2006 Investment and growth in Europe during the Golden Age
Antonio Cubel and Mª Teresa Sanchis

277/2006 Efectos de vincular la pensión pública a la inversión en cantidad y calidad de hijos en un modelo de equilibrio general
Robert Meneu Gaya

278/2006 El consumo y la valoración de activos
Elena Márquez y Belén Nieto

279/2006 Economic growth and currency crisis: A real exchange rate entropic approach
David Matesanz Gómez y Guillermo J. Ortega

280/2006 Three measures of returns to education: An illustration for the case of Spain
María Arrazola y José de Hevia

281/2006 Composition of Firms versus Composition of Jobs
Antoni Cunyat

282/2006 La vocación internacional de un holding tranviario belga: la Compagnie Mutuelle de Tramways, 1895-1918
Alberte Martínez López

283/2006 Una visión panorámica de las entidades de crédito en España en la última década.
Constantino García Ramos

284/2006 Foreign Capital and Business Strategies: a comparative analysis of urban transport in Madrid and Barcelona, 1871-1925
Alberte Martínez López

285/2006 Los intereses belgas en la red ferroviaria catalana, 1890-1936
Alberte Martínez López

286/2006 The Governance of Quality: The Case of the Agrifood Brand Names
Marta Fernández Barcala, Manuel González-Díaz y Emmanuel Raynaud

287/2006 Modelling the role of health status in the transition out of malthusian equilibrium
Paolo Rungo, Luis Currais and Berta Rivera

288/2006 Industrial Effects of Climate Change Policies through the EU Emissions Trading Scheme
Xavier Labandeira and Miguel Rodríguez

289/2006 Globalisation and the Composition of Government Spending: An analysis for OECD countries
Norman Gemmell, Richard Kneller and Ismael Sanz

290/2006 La producción de energía eléctrica en España: Análisis económico de la actividad tras la liberalización del Sector Eléctrico
Fernando Hernández Martínez

291/2006 Further considerations on the link between adjustment costs and the productivity of R&D investment: evidence for Spain
Desiderio Romero-Jordán, José Félix Sanz-Sanz and Inmaculada Álvarez-Ayuso

292/2006 Una teoría sobre la contribución de la función de compras al rendimiento empresarial
Javier González Benito

293/2006 Agility drivers, enablers and outcomes: empirical test of an integrated agile manufacturing model
Daniel Vázquez-Bustelo, Lucía Avella and Esteban Fernández

294/2006 Testing the parametric vs the semiparametric generalized mixed effects models
María José Lombardía and Stefan Sperlich

295/2006 Nonlinear dynamics in energy futures
Mariano Matilla-García

296/2006 Estimating Spatial Models By Generalized Maximum Entropy Or How To Get Rid Of W
Esteban Fernández Vázquez, Matías Mayor Fernández and Jorge Rodriguez-Valez

297/2006 Optimización fiscal en las transmisiones lucrativas: análisis metodológico
Félix Domínguez Barrero

298/2006 La situación actual de la banca online en España
Francisco José Climent Diranzo y Alexandre Momparler Pechuán

299/2006 Estrategia competitiva y rendimiento del negocio: el papel mediador de la estrategia y
las capacidades productivas
Javier González Benito y Isabel Suárez González

300/2006 A Parametric Model to Estimate Risk in a Fixed Income Portfolio
Pilar Abad and Sonia Benito

301/2007 Análisis Empírico de las Preferencias Sociales Respecto del Gasto en Obra Social de las Cajas de Ahorros
Alejandro Esteller-Moré, Jonathan Jorba Jiménez y Albert Solé-Ollé

302/2007 Assessing the enlargement and deepening of regional trading blocs: The European Union case
Salvador Gil-Pareja, Rafael Llorca-Vivero y José Antonio Martínez-Serrano

303/2007 ¿Es la Franquicia un Medio de Financiación?: Evidencia para el Caso Español
Vanesa Solís Rodríguez y Manuel González Díaz

304/2007 On the Finite-Sample Biases in Nonparametric Testing for Variance Constancy
Paulo M.M. Rodrigues and Antonio Rubia

305/2007 Spain is Different: Relative Wages 1989-98
José Antonio Carrasco Gallego

306/2007	Poverty reduction and SAM multipliers: An evaluation of public policies in a regional framework Francisco Javier De Miguel-Vélez y Jesús Pérez-Mayo
307/2007	La Eficiencia en la Gestión del Riesgo de Crédito en las Cajas de Ahorro Marcelino Martínez Cabrera
308/2007	Optimal environmental policy in transport: unintended effects on consumers' generalized price M. Pilar Socorro and Ofelia Betancor
309/2007	Agricultural Productivity in the European Regions: Trends and Explanatory Factors Roberto Ezcurra, Belen Iráizoz, Pedro Pascual and Manuel Rapún
310/2007	Long-run Regional Population Divergence and Modern Economic Growth in Europe: a Case Study of Spain María Isabel Ayuda, Fernando Collantes and Vicente Pinilla
311/2007	Financial Information effects on the measurement of Commercial Banks’ Efficiency Borja Amor, María T. Tascón and José L. Fanjul
312/2007	Neutralidad e incentivos de las inversiones financieras en el nuevo IRPF Félix Domínguez Barrero
313/2007	The Effects of Corporate Social Responsibility Perceptions on The Valuation of Common Stock Waymond Rodgers , Helen Choy and Andres Guiral-Contreras
314/2007	Country Creditor Rights, Information Sharing and Commercial Banks’ Profitability Persistence across the world Borja Amor, María T. Tascón and José L. Fanjul
315/2007	¿Es Relevante el Déficit Corriente en una Unión Monetaria? El Caso Español Javier Blanco González y Ignacio del Rosal Fernández
316/2007	The Impact of Credit Rating Announcements on Spanish Corporate Fixed Income Performance: Returns, Yields and Liquidity Pilar Abad, Antonio Díaz and M. Dolores Robles
317/2007	Indicadores de Lealtad al Establecimiento y Formato Comercial Basados en la Distribución del Presupuesto Cesar Augusto Bustos Reyes y Óscar González Benito
318/2007	Migrants and Market Potential in Spain over The XXth Century: A Test Of The New Economic Geography Daniel A. Tirado, Jordi Pons, Elisenda Paluzie and Javier Silvestre
319/2007	El Impacto del Coste de Oportunidad de la Actividad Emprendedora en la Intención de los Ciudadanos Europeos de Crear Empresas Luis Miguel Zapico Aldeano
320/2007	Los belgas y los ferrocarriles de vía estrecha en España, 1887-1936 Alberte Martínez López
321/2007	Competición política bipartidista. Estudio geométrico del equilibrio en un caso ponderado Isabel Lillo, Mª Dolores López y Javier Rodrigo
322/2007	Human resource management and environment management systems: an empirical study Mª Concepción López Fernández, Ana Mª Serrano Bedia and Gema García Piqueres

323/2007	Wood and industrialization. evidence and hypotheses from the case of Spain, 1860-1935. Iñaki Iriarte-Goñi and María Isabel Ayuda Bosque
324/2007	New evidence on long-run monetary neutrality. J. Cunado, L.A. Gil-Alana and F. Perez de Gracia
325/2007	Monetary policy and structural changes in the volatility of us interest rates. Juncal Cuñado, Javier Gomez Biscarri and Fernando Perez de Gracia
326/2007	The productivity effects of intrafirm diffusion. Lucio Fuentelsaz, Jaime Gómez and Sergio Palomas
327/2007	Unemployment duration, layoffs and competing risks. J.M. Arranz, C. García-Serrano and L. Toharia
328/2007	El grado de cobertura del gasto público en España respecto a la UE-15 Nuria Rueda, Begoña Barruso, Carmen Calderón y Mª del Mar Herrador
329/2007	The Impact of Direct Subsidies in Spain before and after the CAP'92 Reform Carmen Murillo, Carlos San Juan and Stefan Sperlich
330/2007	Determinants of post-privatisation performance of Spanish divested firms Laura Cabeza García and Silvia Gómez Ansón
331/2007	¿Por qué deciden diversificar las empresas españolas? Razones oportunistas versus razones económicas Almudena Martínez Campillo
332/2007	Dynamical Hierarchical Tree in Currency Markets Juan Gabriel Brida, David Matesanz Gómez and Wiston Adrián Risso
333/2007	Los determinantes sociodemográficos del gasto sanitario. Análisis con microdatos individuales Ana María Angulo, Ramón Barberán, Pilar Egea y Jesús Mur
334/2007	Why do companies go private? The Spanish case Inés Pérez-Soba Aguilar
335/2007	The use of gis to study transport for disabled people Verónica Cañal Fernández
336/2007	The long run consequences of M&A: An empirical application Cristina Bernad, Lucio Fuentelsaz and Jaime Gómez
337/2007	Las clasificaciones de materias en economía: principios para el desarrollo de una nueva clasificación Valentín Edo Hernández
338/2007	Reforming Taxes and Improving Health: A Revenue-Neutral Tax Reform to Eliminate Medical and Pharmaceutical VAT Santiago Álvarez-García, Carlos Pestana Barros y Juan Prieto-Rodriguez
339/2007	Impacts of an iron and steel plant on residential property values Celia Bilbao-Terol
340/2007	Firm size and capital structure: Evidence using dynamic panel data Víctor M. González and Francisco González

341/2007 ¿Cómo organizar una cadena hotelera? La elección de la forma de gobierno
Marta Fernández Barcala y Manuel González Díaz

342/2007 Análisis de los efectos de la decisión de diversificar: un contraste del marco teórico “Agencia-Stewardship”
Almudena Martínez Campillo y Roberto Fernández Gago

343/2007 Selecting portfolios given multiple eurostoxx-based uncertainty scenarios: a stochastic goal programming approach from fuzzy betas
Enrique Ballestero, Blanca Pérez-Gladish, Mar Arenas-Parra and Amelia Bilbao-Terol

344/2007 “El bienestar de los inmigrantes y los factores implicados en la decisión de emigrar”
Anastasia Hernández Alemán y Carmelo J. León

345/2007 Governance Decisions in the R&D Process: An Integrative Framework Based on TCT and Knowledge View of The Firm.
Andrea Martínez-Noya and Esteban García-Canal

346/2007 Diferencias salariales entre empresas públicas y privadas. El caso español
Begoña Cueto y Nuria Sánchez- Sánchez

347/2007 Effects of Fiscal Treatments of Second Home Ownership on Renting Supply
Celia Bilbao Terol and Juan Prieto Rodríguez

348/2007 Auditors’ ethical dilemmas in the going concern evaluation
Andres Guiral, Waymond Rodgers, Emiliano Ruiz and Jose A. Gonzalo

349/2007 Convergencia en capital humano en España. Un análisis regional para el periodo 1970-2004
Susana Morales Sequera y Carmen Pérez Esparrells

350/2007 Socially responsible investment: mutual funds portfolio selection using fuzzy multiobjective programming
Blanca Mª Pérez-Gladish, Mar Arenas-Parra , Amelia Bilbao-Terol and Mª Victoria Rodríguez-Uría

351/2007 Persistencia del resultado contable y sus componentes: implicaciones de la medida de ajustes por devengo
Raúl Iñiguez Sánchez y Francisco Poveda Fuentes

352/2007 Wage Inequality and Globalisation: What can we Learn from the Past? A General Equilibrium Approach
Concha Betrán, Javier Ferri and Maria A. Pons

353/2007 Eficacia de los incentivos fiscales a la inversión en I+D en España en los años noventa
Desiderio Romero Jordán y José Félix Sanz Sanz

354/2007 Convergencia regional en renta y bienestar en España
Robert Meneu Gaya

355/2007 Tributación ambiental: Estado de la Cuestión y Experiencia en España
Ana Carrera Poncela

356/2007 Salient features of dependence in daily us stock market indices
Luis A. Gil-Alana, Juncal Cuñado and Fernando Pérez de Gracia

357/2007 La educación superior: ¿un gasto o una inversión rentable para el sector público?
Inés P. Murillo y Francisco Pedraja

358/2007	Effects of a reduction of working hours on a model with job creation and job destruction Emilio Domínguez, Miren Ullibarri y Idoya Zabaleta
359/2007	Stock split size, signaling and earnings management: Evidence from the Spanish market José Yagüe, J. Carlos Gómez-Sala and Francisco Poveda-Fuentes
360/2007	Modelización de las expectativas y estrategias de inversión en mercados de derivados Begoña Font-Belaire
361/2008	Trade in capital goods during the golden age, 1953-1973 Mª Teresa Sanchis and Antonio Cubel
362/2008	El capital económico por riesgo operacional: una aplicación del modelo de distribución de pérdidas Enrique José Jiménez Rodríguez y José Manuel Feria Domínguez
363/2008	The drivers of effectiveness in competition policy Joan-Ramon Borrell and Juan-Luis Jiménez
364/2008	Corporate governance structure and board of directors remuneration policies: evidence from Spain Carlos Fernández Méndez, Rubén Arrondo García and Enrique Fernández Rodríguez
365/2008	Beyond the disciplinary role of governance: how boards and donors add value to Spanish foundations Pablo De Andrés Alonso, Valentín Azofra Palenzuela y M. Elena Romero Merino
366/2008	Complejidad y perfeccionamiento contractual para la contención del oportunismo en los acuerdos de franquicia Vanesa Solís Rodríguez y Manuel González Díaz
367/2008	Inestabilidad y convergencia entre las regiones europeas Jesús Mur, Fernando López y Ana Angulo
368/2008	Análisis espacial del cierre de explotaciones agrarias Ana Aldanondo Ochoa, Carmen Almansa Sáez y Valero Casanovas Oliva
369/2008	Cross-Country Efficiency Comparison between Italian and Spanish Public Universities in the period 2000-2005 Tommaso Agasisti and Carmen Pérez Esparrells
370/2008	El desarrollo de la sociedad de la información en España: un análisis por comunidades autónomas María Concepción García Jiménez y José Luis Gómez Barroso
371/2008	El medioambiente y los objetivos de fabricación: un análisis de los modelos estratégicos para su consecución Lucía Avella Camarero, Esteban Fernández Sánchez y Daniel Vázquez-Bustelo
372/2008	Influence of bank concentration and institutions on capital structure: New international evidence Víctor M. González and Francisco González
373/2008	Generalización del concepto de equilibrio en juegos de competición política Mª Dolores López González y Javier Rodrigo Hitos
374/2008	Smooth Transition from Fixed Effects to Mixed Effects Models in Multi-level regression Models María José Lombardía and Stefan Sperlich

375/2008 A Revenue-Neutral Tax Reform to Increase Demand for Public Transport Services
Carlos Pestana Barros and Juan Prieto-Rodriguez

376/2008 Measurement of intra-distribution dynamics: An application of different approaches to the European regions
Adolfo Maza, María Hierro and José Villaverde

377/2008 Migración interna de extranjeros y ¿nueva fase en la convergencia?
María Hierro y Adolfo Maza

378/2008 Efectos de la Reforma del Sector Eléctrico: Modelización Teórica y Experiencia Internacional
Ciro Eduardo Bazán Navarro

379/2008 A Non-Parametric Independence Test Using Permutation Entropy
Mariano Matilla-García and Manuel Ruiz Marín

380/2008 Testing for the General Fractional Unit Root Hypothesis in the Time Domain
Uwe Hassler, Paulo M.M. Rodrigues and Antonio Rubia

381/2008 Multivariate gram-charlier densities
Esther B. Del Brio, Trino-Manuel Ñíguez and Javier Perote

382/2008 Analyzing Semiparametrically the Trends in the Gender Pay Gap - The Example of Spain
Ignacio Moral-Arce, Stefan Sperlich, Ana I. Fernández-Saínz and Maria J. Roca

383/2008 A Cost-Benefit Analysis of a Two-Sided Card Market
Santiago Carbó Valverde, David B. Humphrey, José Manuel Liñares Zegarra and Francisco Rodriguez Fernandez

384/2008 A Fuzzy Bicriteria Approach for Journal Deselection in a Hospital Library
M. L. López-Avello, M. V. Rodríguez-Uría, B. Pérez-Gladish, A. Bilbao-Terol, M. Arenas-Parra

385/2008 Valoración de las grandes corporaciones farmaceúticas, a través del análisis de sus principales intangibles, con el método de opciones reales
Gracia Rubio Martín y Prosper Lamothe Fernández

386/2008 El marketing interno como impulsor de las habilidades comerciales de las pyme españolas: efectos en los resultados empresariales
Mª Leticia Santos Vijande, Mª José Sanzo Pérez, Nuria García Rodríguez y Juan A. Trespalacios Gutiérrez

387/2008 Understanding Warrants Pricing: A case study of the financial market in Spain
David Abad y Belén Nieto

388/2008 Aglomeración espacial, Potencial de Mercado y Geografía Económica: Una revisión de la literatura
Jesús López-Rodríguez y J. Andrés Faíña

389/2008 An empirical assessment of the impact of switching costs and first mover advantages on firm performance
Jaime Gómez, Juan Pablo Maícas

390/2008 Tender offers in Spain: testing the wave
Ana R. Martínez-Cañete y Inés Pérez-Soba Aguilar

391/2008	La integración del mercado español a finales del siglo XIX: los precios del trigo entre 1891 y 1905 Mariano Matilla García, Pedro Pérez Pascual y Basilio Sanz Carnero
392/2008	Cuando el tamaño importa: estudio sobre la influencia de los sujetos políticos en la balanza de bienes y servicios Alfonso Echazarra de Gregorio
393/2008	Una visión cooperativa de las medidas ante el posible daño ambiental de la desalación Borja Montaño Sanz
394/2008	Efectos externos del endeudamiento sobre la calificación crediticia de las Comunidades Autónomas Andrés Leal Marcos y Julio López Laborda
395/2008	Technical efficiency and productivity changes in Spanish airports: A parametric distance functions approach Beatriz Tovar & Roberto Rendeiro Martín-Cejas