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Tourism indicators and airports' technical efficiency

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ABSTRACT

The Spanish airports are managed centrally by a government-owned company (AENA). The public investments made in the latest years, airports managers' inability to decide commercial policies and the lack of competition end with more than one under-used airport within an amenity distance. Airports' managerial decisions require considering regional needs. In the first stage, a stochastic frontier analysis is used to estimate airports' technical inefficiency with the inclusion of fixed effects. Tourism indicators related to the location of airports are used in a second stage regression. The results show that airports' geographical location affects efficiency in touristic areas. The type of accommodation becomes a driver of airports' efficiency with positive and negative impact. In non-touristic areas, touristic factors are not relevant.

1. Introduction

The liberalization of the aviation market in Europe towards a single sky along with the aviation strategy adopted in Europe (European Commission, December 2015) confirms the importance of aviation sector underpinning connectivity internationally at more competitive prices. Airline passenger traffic is the world's fastest growing economic sectors compared with global GDP growth (European Commission, March 2017). Regions growing in population and national and international economic activity have an increase in air travel demand (Goetz, 1992). Although the European Commission (2011) stresses the requirement of an inter-modal and competitive air transport system, the Spanish regulatory framework is a constraint for a competitive air travel market.[1] The Spanish airports are managed by a central authority named AENA, a government-owned company. The centralised management is to the extent that airports operators do not have the flexibility to decide commercial policies (Comisión Nacional de los Mercados y la Competencia, 2014). Airports within the same regional areas frequently suffer from low traffic since these are not differentiated in terms of the quality of the services provided. The airports' charges are also decided by AENA rather than by the airports' individual managers. The lack of competition along with excessive investments made in the past years and the existing alternative travel modes imply geographical areas with more than one regional airport not use efficiently for air transport.

The relevance in making the Spanish airport system attractive to airlines and passengers relays on airports being a key factor in the economic development of local economies (Sarkis, 2000). The airport industry has an impact in other sectors such as tourism and trade. The geographical location of airports involves environmental factors related to the socio-economic structure of the population; intermodal connectivity; the industrial potential and others leisure services (Tapiador, Mateos, & Marti-Henneberg, 2008). The specific airports' location can provide better conditions for competitiveness for some airports in detriment of others. The growth of low-cost carriers' air traffic (LCCs) has driven the use of secondary regional airports used due to the low congestion, thus lower

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[1] The European airports must provide worldwide connectivity with an efficient mobility of passengers and freight by 2050.

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marginal costs (Barbot, 2006). Airports enhance economic regional development, but the adequate market conditions must be provided. Policy makers should consider differences across airports regarding capacity and location in order to apply adequate decisions according to regional needs rather than generalize measures such as happening in the Spanish airports. Decision-making requires considering the factors affecting operational activity (traffic). With this regard benchmarking allows comparing airports performance based on mapping airports' operational efficiency against others. Airports' benchmarking has extensive literature. Most of the studies use data development analysis (DEA) (for example, Barros, 2008; Gillen & Lall, 1997; Pels, Nijkamp, & Rietveld, 2001; Yoshida, 2004) compared to parametric methods such as stochastic frontier analysis (Barros, 2008a, 2008b; Martin-Cejas, 2002; Pels et al., 2001) or Bayesian approach (Assaf, 2008, 2010). Few studies consider the implication of assuming heterogeneity in data (Assaf, 2010; Barros, 2008a), but homogeneity (Pels, Nijkamp, & Rietveld, 2003). Overall differences in efficiency in the Spanish airports are usually explained by the number of passengers (Ripoll-Zarraga & Mar-Molinero, 2017). In tourism literature at micro and macro levels, the studies using data envelopment analysis represent a 74% of the total (Assaf & Josiassen, 2015). Authors found aspects such as geographical location enhanced by the population resources; airports associated with tourism, industry and available services affecting efficiency. For instance, Assaf (2010) suggested that factors such as privatization; economic growth; price regulation; location; and quality standards could have contributed improvements in efficiency. Otherwise, Yu (2004) pointed out the importance of the development of tourism to explain the prosperity of the offshore airports in Taiwan. In this sense, Tapiador et al. (2008) evaluated tourism potential and existing leisure-related services as geographical efficiency determinants of Spanish regional airports. They use a tourist index and found that coastal tourism-based airports were better placed than others to compete in a liberalized market. The location may constraint improvements in efficiency for some specific airports. The Spanish airports clearly require individual management strategies (Tapiador et al., 2008).

The literature shows the requirement of analysing the determinants of airports' efficiency beyond controllable factors such as input or outputs (namely traffic). External factors not controlled by the management such as the population density in the airport catchment area and environmental aspects (weather), can become operational barriers. The results of previous analysis following the specification of Battese and Coelli (1995), concluded the existence of a little impact of non-touristic variables as function of the inefficiency term (Ripoll-Zarraga, 2017). As far as our knowledge is concerned literature has not investigated the role of individual tourism variables as determinants of airports' inefficiency. Although previous studies refer to decisions among inputs affecting airports' efficiency in the case of the Spanish airport system this relation is not that clear. One of the reasons is the strong centralised management (Ripoll-Zarraga & Lozano, 2019). In the same way, it would be expected tourism demand and supply not only affecting airports' operating environment, but their efficiency.

In the first stage, a stochastic frontier analysis is applied under Battese and Coelli (1992) specification of the inefficiency term. Following Greene (2003) fixed effects are considered in the production function to capture other factors affecting the individual inefficiencies. Fixed effects refer to special features identified in specific individual airports, but not in others. These are assumed to be time-invariant and correlated with the explanatory variables. On this basis, this study becomes a new empirical application based on Stochastic Frontier Analysis (SFA) within the Spanish airport system. The homogeneity is assumed across the panel data, but taking into account potential unobserved heterogeneity in some special cases. Following Battese and Coelli (1992) the unrestricted specification allows efficiency to vary over-time for random effects, but not for specific effects. A regression model is used in the second stage accounting for tourism variables explaining the airports' individual efficiencies. The main idea in using two phases is to differ from the inefficiency caused by the management and unobserved heterogeneity related to airports' infrastructure versus the inefficiency affected by the airports' geographical location. Based on the centralised management, the first inefficiency is considered fully controllable including the firm effects since investments' decisions are decided by the Spanish government. The results provide insights regarding the inefficiency that could be reduced by AENA and the inefficiency caused by touristic environmental variables (not-controllable).

The paper is structured as follows. Section 2 describes the Spanish airports' management model and provides some figures about the importance of Spain as a relevant tourism destination. Section 3 shows the models used. Section 4 the data description. Section 5 presents the results for both phases and the discussion. Section 6 summarizes the main conclusions.

2. The Spanish airports' regulatory framework

The Spanish airports are government owned and managed by a public company named AENA (Aeropuertos Españoles y Navegación Aérea). AENA manages 49 civil aviation airports including four general aviation airports and two heliports. The management is fully centralised including commercial and accounting policies. In an airport-system, airports are cross-subsidized meaning that financial resources from profitable airports finance no-profitable airports. The fact that AENA is not subsidized by the Government has promoted the airports' commercial development with a relevant presence of commercial activities versus aeronautical in some cases (Ripoll-Zarraga & Mar-Molinero, 2017). The requirement of the Spanish airport-system financial sustainability implies new sources of income, but essentially cost reduction strategies. The excess of investments made in the last decade in Europe (European Commission, European Court of Auditors, 2014) highlights the inadequacy of having a centralised management and the requirement of transferring competences to the regional level (Ripoll-Zarraga & Mar-Molinero, 2017).

One of the consequences of AENA's centralised management is the absence of competition (Ripoll-Zarraga & Mar-Molinero, 2017). There are several geographical areas with more than one airport within an amenity distance serving the same areas becoming cost inefficient (Martin, Roman, & Voltes-Dorta, 2011). Previous studies concluded that airports' location affects efficiency and large and small airports being more geographical efficient (Martin & Roman, 2001; Tapiador et al., 2008). Nevertheless, it is not clear which geographical aspects are affecting airports' efficiency (Fig. 1). A review of previous studies in the Spanish airport system and the main

Fig. 1. The Spanish airport system.
(Source: AENA, 2013)

findings are summarized in Ripoll-Zarraga and Mar-Molinero (2017).

Spain is the third European country in terms of the volume of passengers transported by air, after the United Kingdom and Germany. In addition, three Spanish airports, Madrid-Barajas; Barcelona and Palma de Mallorca are in the European ranking of the 15 busiest airports. Madrid-Barajas is coming as number four. Spain is one of the most popular tourist destinations worldwide, occupying the third place in 2016 in the world ranking of tourist arrivals after France and the United States. In terms of tourism revenue is also the third tourism destination after the US and China (WTO). From the point of view of tourism's contribution to the Spanish economy, the Tourism Satellite Account (TSA) represents around the 11% of GDP.[2]

The physical environment positively influences the choice of Spain as a tourist destination. The country has 108 days per year of temperatures above 25°, 2451 h of sunshine, which is equivalent to 6.7 h of daily sun. It boasts 8000 km of coastline and the highest number of blue flag beaches in the world. Moreover, 24% of Spanish territory is classified as a protected area coming third in the European ranking. Spain has a total of 44 world heritage monuments and sites being the second country in the world in terms of this factor, preceded only by Italy, which has 47. The range of hotels available positions Spain as the second place in Europe with 1.8 million hotel-beds available, and ranked the fourth in the number of establishments.

The individual geographical and hospitality characteristics reflect different conditions under the Spanish airports operate. These may cause season effects restricting the traffic to specific period of times. This is known as unobserved heterogeneity and since it is not controlled by the airports' operator, creates inefficiency. Unobserved heterogeneity has different sources such as economic cycles, market levels characteristics or low transfer capacity of inputs (Bottaso & Conti, 2010). The relevance of accounting for heterogeneity is to avoid biasing the estimated efficiency levels. Examples of unobserved heterogeneity are demographic characteristics (e.g., population and weather), but also airports' structural characteristics not changeable at least in the short-term (e.g. longer runways). In some studies, runways are considered in the production function as a fixed input representing a stage of technology (Pels et al., 2003). Additionally, the regulatory framework and ownership forms could also generate inefficiency. These are particularly relevant in the Spanish airport system since airports' managers are not granted with managerial decision power. Nevertheless, the analysis of ownership and government forms in efficiency are not the scope of the paper.

In the first stage, the heterogeneity is captured by accounting for airport-firm effects related to infrastructure characteristics since investments are decided by AENA. The unobserved heterogeneity is identified as airports' time-invariant singularities enclosed in the production function. In the second stage, the unobserved characteristics are related to the airports' specific geographical location. Two areas are identified named as touristic and non-touristic areas based on the number of second residences.

3. Methodology

The distance function provides a characterisation of the structure of the production technology (Shepard, 1970). The concept and properties of distance functions are widely develop (for example, Coelli, Rao, O'Donnell, & Battese, 2005; Färe, 1988; Färe & Primont, 1995; Kumbhakar & Lovell, 2000). The stochastic frontier analysis model was developed by Aigner, Lovell, and Schmidt (1977) and Meeusen and van den Broeck, (1977) to describe the production technology. The main advantage of the stochastic frontier approach

[2] The Tourism Satellite Account allows measuring the relevance of tourism activities on the economy as a whole.

is that it isolates the influence of factors other than inefficient behavior. A stochastic production function based on distance functions is used being more reliable than cost functions since air traffic is a derived demand (Coelli et al., 2005). Neither the input distance function nor the output distance function depends on any explicit behavioral assumptions, such as cost minimisation, revenue or profit maximisation (Coelli et al., 2005; Kumbhakar & Lovell, 2000). There is a requirement of demonstrating the reality of how airports are operating beyond traditional objective function (revenue maximisation or costs minimisation) which may not be reliable due to the effects in efficiency of AENA's centralised management (Ripoll-Zarraga & Lozano, 2019) In this case, an input distance function is used due to the inability of the individual airports' operators to decide regarding commercial policies to attract passengers and airlines. Therefore, the outputs are given (exogenous) and decisions are made to reduce the consumption of inputs. The model is a translog distance function being the most adequate framework since airports are multi-output firms (Coelli & Perelman, 1999; Kumbhakar & Lovell, 2000). The translog function has a flexible functional form. The use of the translog production function is based on its properties of flexibility and homogeneity (Lovell et al., 1994) allowing partial elasticities of inputs-substitution to vary.

The model specification follows Battese and Coelli (1992) accounting for entity fixed effects (Greene, 2003). Fixed effects account for singularities of certain airports that remain constant over time (unobserved heterogeneity). When fixed effects are not taking into account, these could bias the predictor variables. Therefore, by considering fixed effects the impact of the time-invariant characteristics is removed. Another important assumption behind fixed effects is that the singular effect of the individual decision-making unit is not correlated to the rest of the characteristics of the same unit. Assuming m outputs and k inputs; choosing arbitrary one of the inputs as the $\varkappa - th$ input for normalising purposes ($k = \frac{1}{x_{\ it}}$) and normalising the rest of the k -1 inputs by k, the translog stochastic distance function follows,

$$ln\left(\frac{1}{x_{\varkappa it}}\right) = \beta_0 + \sum_{j=1}^{k} \beta_j \ln(x^*_{jit}) + \frac{1}{2}\sum_{j=1}^{k}\sum_{j'}^{k} \beta_{jj'} \ln(x^*_{jit})\, ln(x^*_{j'it}) + \sum_{l=1}^{m} \alpha_l \ln(y_{lit}) + \frac{1}{2}\sum_{l=1}^{m}\sum_{l'=1}^{m} \alpha_{ll'} \ln(y_{lit}) \ln(y_{l'it}) + \sum_{j=1}^{k}\sum_{l=1}^{m} \beta_j\alpha_l \ln(x^*_{jit}) \ln(y_{lit}) + (v_{it} - u_{it}) \tag{1}$$

where $x^*_{jit} = \frac{x_{jit}}{x_{\ it}}$ is the normalised input distance function by one of the inputs, which in this regard is $x_{\varkappa it}$, to impose linear homogeneity property. By using linear homogeneity of input distance function, the translog distance function, $lnD_{it}(X, Y)$ can be transformed into an estimable regression model (Brümmer, Glauben, & Thijssen, 2002 and 2006; Coelli et al., 2005; Coelli & Perelman, 2000).

The homogeneity restrictions (Lovell et al., 1994) follow,

$$\sum\nolimits_{l=1}^{m} \alpha_l = 1,\ \sum\nolimits_{l'=1}^{m} \alpha_{ll'} = 0,\ \sum\nolimits_{l=1}^{m} \beta_j\alpha_l = 0 \tag{2}$$

These restrictions ensure that input distances with respect to the boundary of the production set are measured by radial expansion.

The error contains a random error (v_{it}) and the inefficiency term (u_{it}). Random effects allow a more consistent and unbiased estimation compared to fixed effects. Battese and Coelli (1992) specification of the inefficiency term (u_{it}) depends on a pattern term (η), which allows changes over-time and on an invariant component (u_i). Since efficiency can change over time, this model is more flexible compared to Pit and Lee (1981) that imposed a constant level of efficiency ($\eta_{it} = 1; \eta = 0$). The inefficiency error term has a non-negative truncated normal distribution with non-zero mean and constant variance $ui{\sim}N^+(\mu, {\sigma_u}^2)$. The random error is assumed to have zero mean and constant variance $vi{\sim}N^+(0, {\sigma_v}^2)$

$$u_{it} = u_i.\ (\exp(-\eta(t - T_i) \tag{3}$$

η is the rate of inefficiency decay for each airport i from a period t to T_i, which is the last and the reference period. A shortcoming of the time-varying decay model is that the inefficiency decays monotonically, increasing or decreasing towards a reference period. Therefore, the inefficiency cannot decrease over some periods and rise again.

The distance function provides inputs substitution measures and complementary effects on production process (Grosskopf, Margaritas, & Valdemanis, 1995; Paul, Johnston, & Frengley, 2000). The first order elasticities (β_j, α_l) represent respectively the input and output contributions to the consumption of the input $x_{\varkappa it}$ The second order elasticities ($\beta_{jj'}$, $\alpha_{ll'}$) are the cross effects, the complementary effect of the inputs or the outputs in the overall resource consumption or productivity.

The frontier function is estimated by the maximum likelihood method to estimate the inefficiency that is separated from the residuals of the regression.

The individual estimation of inefficiency can be obtained using the distribution of the inefficiency term conditioned to the estimation of the composite error term (Jondrow, Lovell, Materov, & Schmidt, 1982). Robust stochastic frontier analysis has been applied to account for potential heteroscedasticity.

The specific airports' characteristics (fixed effects) are introduced as dummies ($D_{ï}$) in the production function $D_{ï}\ \epsilon\ ï = 1, \ldots n$. Each dummy represents one specific airport ï identified for containing special features compared to the rest ($n - ï$). Airport-specific effects are assumed to be correlated with the regressors. Eq. (1) with fixed effects yields,

$$\ln\left(\frac{1}{X_{\varkappa it}}\right) = \beta_0 + \sum_{j=1}^{k} \beta_j \ln(x^*_{jit}) + \frac{1}{2}\sum_{j=1}^{k}\sum_{j'}^{k} \beta_{jj'} \ln(x^*_{jit})\, ln(x^*_{j'it}) + \sum_{l=1}^{m} \alpha_l \ln(y_{lit}) + \\ + \frac{1}{2}\sum_{l=1}^{m}\sum_{l'=1}^{m} \alpha_{ll'} \ln(y_{lit}) \ln(y_{l'it}) + \sum_{j=1}^{k}\sum_{l=1}^{m} \beta_j\alpha_l \ln(x^*_{jit}) \ln(y_{lit}) + D_{ï} + (v_{it} - u_{it}) \tag{4}$$

The efficiency scores obtained from the stochastic frontier analysis are used as the dependent variable in the regression. The explanatory factors are related to the tourism demand and supply within the specific region where airports are located. These factors are proxies of tourism attractiveness assuming enhancing tourists to travel to certain cities in detriment of others. Therefore, airports' technical inefficiencies may be affected.

Note that since the first stage model uses different inputs and outputs, the fixed effects are referred to capacity singularities (usually airports' infrastructure) potentially related to the level of traffic. On this basis, not all the airports are considered having fixed effects. The fixed-effects model controls for all time-invariant differences between units (airports). Therefore, the fixed-effects coefficients are unlikely to be biased because omitted time-invariant characteristics. With this regard, although airports' geographical location could be a fixed effect (i.e. certain airports may have more passengers due to their location), this feature is controlled in the first analysis. In the same way, tourism indicators are considered being independent of fixed effects. This also assures avoiding potential endogeneity problems when performing the second stage regression.

4. Data description

The stochastic frontier analysis has been applied to 48 airports for a period of five years (2009–2013). It has not been possible to study a longer period. The Spanish government has not published individual financial statements beyond those years. In this study, airports are considered since commercial policies are centrally decided by the airports' operator (AENA). These are usually not in accordance with the quality of the service provided (CNMC, 2014). Consequently, airports are not differentiated in service or price, and the decision of an airline to operate in a specific airport may not be a consequence of price differentiation.

The divergence shown in terms of traffic and regulation such as general aviation (Madrid cuatro-vientos; Madrid-Torrejon[3]; Sabadell and Son Bonet) or heliports (Algeciras and Ceuta) has been tested through a sensitivity analysis. Son Bonet is not finally enclosed due to missing information. Following Ripoll-Zarraga and Mar-Molinero (2017) the network is classified in terms of passengers (Table 1).

The summary statistics for the 49 airports managed by AENA are shown in Table 2 (GDP deflator, base Spain 2010).[4]

The variability shown by the statistics suggests a divergence in terms of infrastructure (capacity) as well as in traffic, for example when comparing passengers and cargo. Airports with a significant cargo have overall lower number of passengers and vice versa. Aeronautical revenues are accounted in the value of passengers; air traffic movements and cargo. Commercial revenues refer to income earned from non-aeronautical activities. Labour is the AENA employees' costs, excluding navigation services. AENA does not provide information regarding the number and type of employees (permanent versus part-time). Therefore, labour prices are also unknown.

All the data have been extracted from the annual reports of AENA except for the depreciation since it is highly correlated with operating costs (Ripoll-Zarraga & Mar-Molinero, 2017). The International Accounting Standards (IAS 16) states that although depreciation is an accounting policy to mean that companies decide the method of depreciation, this must be in accordance to how the future inflows will be earned. Meetings with airports' managers have confirmed excessive annual charges applied by AENA (Ripoll-Zarraga & Mar-Molinero, 2017). Consequently, AENA's depreciation may not be in accordance with how revenues are generated potentially breaching the accruals and matching conventions. New depreciation measures were estimated for both airside and landside assets (Ashford, Stanton, & Moore, 1996). The depreciation reported by AENA is significantly higher compared to the new values estimated (Ripoll-Zarraga & Mar-Molinero, 2017). The literature shows a divergence regarding the inputs used and essentially when including measures of cost of capital (airports physical area, Tovar & Martin-Cejas, 2009, 2010, and Martin et al., 2011; the number of runways and terminal buildings, Martin-Cejas, 2002; amortization of fixed assets, Martin & Roman, 2001; Martin, Roman, & Voltes-Dorta, 2009; Martin et al., 2011 or book value Murillo-Melchor, 1999, Martin et al., 2009 and Coto-Millan et al., 2014; Coto-Millan, Inglada, Fernandez, Inglada-Perez, & Pesquera, 2016). After reviewing the literature and assess the reliability of the data the following inputs are used: labour costs; operating costs and depreciation of airside and landside assets. Airside assets are directly related to the aeronautical activity compared to landside assets. In the output side the number of passengers; air traffic movements; cargo and commercial revenues.

In terms of capacity constraints, except for Barcelona, the rest of airports do not have a demand exceeding their actual capacities. Therefore, there is no requirement for expansions at least during the period of study that involves the financial crisis and a slight recuperation. Some airports may suffer from season effect in a specific period of times of the year, but this may be revealed in the efficiency scores and second stage. Additionally, capital investments and expansions are decided centrally by the Spanish government through the airports' operator (AENA).

AENA acts implicitly as the regulator, which is required when monopolistic practices take place. Airport charges should be decided by the same airports depending on the quality of the service provided and commercial policies. Nevertheless, AENA is the one fixing airport prices, as well as decides the airlines operating in the airports, routes, etc. making competition between airports inexistent (CNMC, 2014). All the investments performed are accounted through the estimated depreciation values.

All the airports are government owned and managed potentially treated as public utilities. Therefore, the Spanish government may prioritise social policies (employment or connectivity) rather than industry needs. The labour costs are a significant part of the

[3] Madrid-Torrejon is a military base used as support to Madrid-Barajas until the end of January 2013.

[4] Algeciras is under construction in 2009; Madrid Torrejon is assumed to have zero depreciation in 2009 and 2010 for both types of assets: there is no information of initial investments and improvements (Ripoll-Zarraga & Mar-Molinero, 2017).

Table 1
Airports size in terms of passengers per year.
(Source AENA 2013 in Ripoll-Zarraga & Mar-Molinero, 2017)

Airports	Size	Min PAX	Max PAX
Alicante; Barcelona; Bilbao; Fuerteventura; Gran Canaria; Ibiza; Lanzarote; Madrid Barajas; Malaga; Palma de Mallorca; Sevilla; Tenerife-North; Tenerife-South; Valencia	> 3,500,000	3,524,470	39,735,618
A Coruña; Almeria; Asturias; Girona; Granada; Jerez; La Palma; Menorca; Murcia; Reus; Santander; Santiago; Vigo	≤ 3,500,000 > 750,000	638,288	2,736,867
Albacete; Algeciras; Badajoz; Burgos; Ceuta; Cordoba; El Hierro; Huesca-Pirineos; La Gomera; Leon; Logroño; Madrid 4 vientos; Madrid-Torrejon; Melilla; Pamplona; Sabadell; Salamanca; San Sebastian; Son Bonet; Valladolid; Vitoria; Zaragoza	≤ 750,000	273	457,595

Table 2
Summary statistics.
(Source: AENA except for depreciation airside-landside, 2009–2013)

Variable	Observations	Mean	Standard Dev.	Minimum	Maximum
PAX (th)	245	3944.68	8529.97	0	49,900
ATM (th)	245	41.41	71.74	0.24	435.19
Cargo (th tones)	245	13,000	52,400	0	394,000
Commercial (th €)	245	12,964.27	30,737.92	0	186,824.96
Labour (th €)	245	8001.23	11,249.05	119.23	81,826.47
Operating (th €)	245	21,064.86	55,077.53	367.62	350,817.64
Depreciation AENA (th €)	245	15,945.98	43,428.97	200.00	291,837.15
Depreciation airside (th €)	240	4351.96	12,473.72	34.19	84,888.71
Depreciation landside (th €)	240	5540.09	16,008.27	0	128,729.05

overall airports' costs since employees are a fixed cost.[5] With this regard is of interest to analyse the complementary or substitute effect of the rest of the inputs (operating costs, and depreciation of the airports' infrastructure) and outputs (passengers, movements, cargo, and commercial revenues) in the overall labour costs. The relevance of including depreciation rather than physical measures corresponds to being a fair reflection of the use of airports' infrastructure in the operational activity. The depreciation policy should follow the accruals and matching conventions accounting for a relation between the cost and income earned. Since AENA's depreciation is not used, there is not a risk of over-depreciating: accruing more expenses compared to the traffic generated. Potential outliers (e.g. Barcelona and Madrid) were removed from the sample for a sensitivity analysis. Additionally, general aviation and heliports since these may have a different production function compared to others. No significant results were found when removing these airports from the sample.

The data are deflated by the Spanish gross domestic product deflator (base Spain, 2010) and standardized by the respective geometric mean, which allows estimating elasticities at sample means (Cuesta, Lovell, & Zofio, 2009). This means that the first-order distance elasticities serve as partial elasticity, to measure output-productivity (resource), of resource consumption (production) for the outputs (inputs).

Table 3 shows the descriptive of the variables used in the second stage.

The tourism factors refer to supply and demand in order to address the potential relationship between the city attractiveness and the airport chosen as the final destination. The arrivals represent the number of visitors per city and year and the length the number of days spent at destination. A range of type of accommodation in quality and price or the concentration of touristic services could affect specific destinations (Butler, 1980). With this regard, three types of accommodation are considered: number of hotels, number of campsites and apartments. The higher number of apartments compared to hotels or campsites is due to a change in the tourism behaviour pattern since the financial crisis started (Tussyadiah & Pesonen, 2016). The expenditure is the euros spent per day of stay per person. A higher daily budget could imply to spend more days at the destination. The labour force is the number of employees working in the touristic sector. The price index represents the cost of labour working in services. The price and employees have been obtained from official statistics provided by the National Institute of Statistics (INE). The data are at provincial level due to inability to access municipalities. In some cases, there is more than one different sized-airport in the same province. With this regard, the tourism attractiveness indicator has been relaxed (Juaneda, Raya, & Sastre, 2011). The accommodation and employees have been standardized by the province number of inhabitants. The final data refers to 189 observations due to missing information.

Ideally, following Battese and Coelli (1995) a translog accounting for the inefficiency term (u_{it}) as a function of tourism variables would be used. Nevertheless, environmental variables require as many observations as possible. On this occasion, there are missing data for different airports in size (Lanzarote; La Palma; Ceuta; Huesca-Pirineos; La Gomera and Melilla). Previous research includes accessibility and the geographical location influencing airports' inefficiency accounted simultaneously within the stochastic frontier (Ripoll-Zarraga, 2017).

[5] Cargo is usually an outsourced activity. Hence it is not enclosed in employees' costs.

Table 3
Summary statistics (2009–2013).

Variable	Observations	Mean	Standard dev.	Minimum	Maximum
Technical efficiency	189	0.722	0.081	0.513	0.919
Hotels (th)	189	0.474	0.314	0.131	1.118
Campsites (th)	189	0.090	0.102	0.003	0.456
Apartments (th)	189	11.14	15.46	0.272	59.55
Expenditure (€/day-person)	189	86.418	33.48	20	163
Length (days)	189	3.402	1.953	1.4	8
Arrivals (mill)	189	6.286	14.052	0.144	14.32
Labour force (mill)	189	0.259	0.225	0.010	1.143
Price index	189	98.06	1.496	94	101

5. Results

First-stage estimation

The results of the stochastic frontier analysis are shown in Table 4. The first column corresponds to the conventional model following Battese and Coelli (1992). The second column shows the results when including airports with special features (fixed effects) in the production function. The fixed effects initial regression for all the airports, resampling and sensitivity analysis has revealed six airports with significant fixed effects (three of them with absolute values between 2 and 4). Firm-effects are evidenced in large airports (Barcelona; Madrid; Palma de Mallorca and Malaga), but also in small airports (Huesca-Pirineos and Vitoria, a cargo-oriented airport). The maximum likelihood technique is employed to the estimates of the variable coefficients and the parameters of the two error components.

The results of both models show high values of likelihood estimator with a clear improvement when considering fixed-effects. The respective high values support the low-level of noise compared to inefficiency explained. As previously discussed, the distributional assumptions of the two components of the error term are identically and independently distributed.

Table 4 shows all the individual effects, the significant iterations and borderlines between the inputs and outputs. The null

Table 4
Translog distance functions.

	Coefficients	SFA_1 (1992)	SFA_2 *FE* (1992)
β_0	Constant	1.0072*	0.7626
β_4	LnCommercial	−0.1137*	−0.0852[1]
β_5	LnPAX	−0.1975*	−0.2367*
β_6	LnATM	−0.2600*	−0.1503*
β_7	LnCargo	−0.0456*	−0.0389*
β_1	LnOperating	0.4213*	0.4458*
β_2	LnDepreciation Airside	0.0045	0.0071
β_3	LnDepreciation Landside	−0.0115	−0.0050
β'_4	½LnCommercial^2	0.0435*	0.0619*
β'_6	½LnATM^2	0.0381	0.1034[1]
β'_7	½LnCargo^2	−0.0062[1]	0.0006
β'_3	½LnDepreciation Landside^2	−0.0017[1]	−0.0011
β_{45}	½LnCom·LnPAX	−0.0887*	−0.1137*
β_{47}	½LnCom·LnCargo	−0.0339*	−0.0311*
β_{56}	½LnPAX·LnATM	0.0771*	0.0566*
β_{13}	½LnOperating·LnDepreciation Landside	0.0244[1]	0.0238[1]
β_{14}	LnOperating·LnCommercial	0.0550	0.0638[1]
D_1	Barcelona	n/a	−1.0149*
D_2	Madrid-Barajas	n/a	−1.2943*
D_3	Malaga	n/a	−0.4784*
D_4	Palma de Mallorca	n/a	−0.4346*
D_5	Huesca-Pirineos	n/a	0.3785*
D_6	Vitoria	n/a	−0.6384*
	mu (**μ**)	0.6394*	0.3876*
	lnsigma^2	−2.9755*	−3.2800*
	ilgtgamma	0.6113[1]	0.1624
	eta	−0.0467*	−0.0788*
	Log Likelihood	89.39	105.73

* Significant different from zero at least at 5% [1]SFA_1**:** The results with the robust model are similar in terms of significance except for ½LnCargo^2 $P > |z| = 0.117$; ½LnDepreciationLandside^2 $P > |z| = 0.218$; ilgtgamma $P > |z| = 0.082$ SFA_2**:** ditto except for LnCommercial $P > |z| = 0.066$; ½LnATM^2 $P > |z| = 0.083$; LnOperating·LnDepreciation Landside $P > |z| = 0.204$; LnOperating·LnCommercial $P > |z| = 0.177$.

hypothesis of the no-existence of inefficiency is rejected in the first model since the expected inefficiency is significantly different from zero (μ). When fixed effects are considered the expected value of the inefficiency is significantly lower (39%) compared to when these are not identified (64%). With this regard, the second model has more explanatory power compared to the first one, potentially biased. The significant drop in the overall inefficiency of the system confirms that the fixed effects enclosed capture satisfactorily special features (unobserved heterogeneity). Consequently, if these are not taken into account the results could lead to model misspecifications. It is important to bear on mind that the part of the inefficiency within the production function is due to the management (AENA). This means that the inefficiency can be reduced if the right decisions among inputs and outputs are made. If fixed effects were not considered, the model would reveal a 64% of inefficiency caused by AENA. Nevertheless, this is not entirely robust as shown by the results when including fixed effects (39%). Gamma $\left(\gamma = \frac{\sigma_u^2}{\sigma_u^2 + \sigma_v^2}\right)$ is an indicator of the explanatory power of the model ($0 \leq \gamma \geq 1$). When gamma is close to zero, the model has a significant presence of noise. When gamma is close to the unity, the technical inefficiency explains overall the dependent variable. The optimization is parametrised in terms of the inverse logit of gamma (ilgtgamma). The low-level of noise supports the adequacy of stochastic frontier analysis in the first model. The fact that ilgtgamma is not significant, essentially when including fixed effects, reveals that there is further variability to be explained.

Regarding the individual effects, the results show the coefficients of the basic variables with the expected signs. There is relevance for the passengers and movements effects compared to commercial revenues. The depreciation of assets is not significant evidencing that there is not a relation between airports' infrastructure and labour costs. The vast majority of airports suffer from over-capacity since traffic has not increased accordingly to the excessive investments made (European Court of Auditors, 2014) Investments are a long-term strategy, but the required increase in demand of air traffic will not happen unless airports work independently in a competitive market. Cargo although significant does not have a major impact as shown in previous studies (Ripoll-Zarraga & Lozano, 2019; Ripoll-Zarraga & Mar-Molinero, 2017; Ripoll-Zarraga, Portillo, & Mar-Molinero, 2017).[6]

The fixed effects model shows similar results regarding both, significance and value of parameters, except for commercial revenues with a trade-off between the first and the second model. The fixed effects model reveal the requirement of commercial revenues co-existing with the number of passengers ($\beta_{45} = -0.1137$). The model also shows the relevance of large and hub airports in generating financial resources ($D_1 = -1.0149; D_2 = -1.2943$) compared to small airports. Airports not having enough traffic become a burden for the system ($D_5 = +0.3785$). The results also show that airports' specialization contributes positively from a financial perspective ($D_6 = -0.6384$). Finally, there is a clear season effect when airports are located in touristic areas: Malaga ($D_3 = -0.4784$) and Palma de Mallorca ($D_4 = -0.4346$) are usual tourists' destinations in specific periods of the year. These airports do not contribute consistently to finance the overall labour costs in comparison to other consistent destinations during the whole year (e.g. Barcelona)

Table 5 shows the average of technical efficiencies for each airport in both models. The fact that an airport is technologically efficient does not imply that it is allocative efficient. The fixed effects model provides higher values compared to the standard model (Battese & Coelli, 1992). These results confirm that the presence of environmental factors (unobserved heterogeneity) affects airports operational performance independently of the level of traffic. Therefore, it is important to control them. The efficiencies are significantly lower when entity fixed effects are not identified. These results confirm the requirement of identifying fixed effects to avoid misspecifications. As previously stated these singularities are assumed not to change-over-time. In order to understand the scope of the efficiencies and the number of airports located nearby, Figs. 2 and 3 shows the location of each airport in terms of catchment areas. A catchment area is defined as the influence area from a city with an airport and within 150 km (Ripoll-Zarraga & Mar-Molinero, 2017). The efficiency level has been ranked within three groups: airports with low technical efficiency, with efficiency scores between 1% and 59%; medium between 60% and 75% and highly efficient with > 75% of efficiency. Note than Gran Canaria is classified as medium-efficient since obtains an efficiency higher than 59%. Apart from the inefficiency caused by the management (AENA) when not considering fixed effects, the maps reveal that somehow the location and the number of airports located in the regional area could also contribute to the overall inefficiency of the system. The next stage includes touristic factors related to the airports' specific environment.

Second-stage estimation

Although a potential assumption could be made regarding a spatial econometric model-driven approach, there is no evidence that special patterns exist in the sample (Anselin, 2003), neither local nor global. The difference in regression coefficient between special and non-spatial is unpredictable (Beale, Lennon, Yearsley, Brewer, & Elston, 2010). Therefore, the theoretical assumption of spatial autocorrelation must be confronted with the data.

Table 6 reports the estimates of the three regression models with the technical efficiency levels obtained from the fixed effects model as dependent variable. The first column presents the results for the total sample without differentiating airports' geographical location. The second and third columns correspond to touristic and no-touristic areas respectively. The tourism specialization index is used to identify these areas.[7] Six cities revealed a tourism specialization index higher than 0.40 indicating substantial tourism.[8] These are traditional touristic destinations such as Alicante and Barcelona, but also cities with small airports such as Burgos, Huesca-Pirineos and Pamplona located in the mid-northern area and Sabadell, in the same catchment area than Barcelona. The Balearic and

[6] There are two cargo-oriented airports: Vitoria and Zaragoza.

[7] The tourism specialization index is the second homes per first home ratio, which measures the concentration of non-principal homes.

[8] The value of the tourism specialization index equal to the unity indicates a touristic area for municipality data (Juaneda et al., 2011). As we have province data (various municipalities), we have relaxed this threshold.

Table 5
Technical efficiency (2009–2013).

	Size	SFA_1 (1992)	SFA_2 *FE* (1992)		Size	SFA_1 (1992)	SFA_2 *FE* (1992)
A Coruña	Medium	55.75%	75.69%	Logroño	Small	42.70%	58.10%
Albacete	Small	51.97%	62.99%	Madrid 4 vientos	Small	53.16%	66.31%
Algeciras	Small	87.48%	89.91%	Madrid Barajas	Large	48.06%	73.37%
Alicante	Large	58.39%	66.64%	Madrid Torrejon	Small	53.52%	71.74%
Almeria	Medium	45.99%	64.27%	Malaga	Large	48.85%	70.88%
Asturias	Medium	55.63%	75.14%	Melilla	Small	44.11%	58.43%
Badajoz	Small	69.78%	90.46%	Menorca	Medium	56.28%	72.62%
Barcelona	Large	48.39%	74.13%	Murcia	Medium	56.03%	73.39%
Bilbao	Large	64.97%	76.26%	Palma de Mallorca	Large	52.12%	74.22%
Burgos	Small	72.40%	90.51%	Pamplona	Small	42.67%	70.49%
Ceuta	Small	70.89%	86.25%	Reus	Medium	52.74%	69.81%
Cordoba	Small	49.56%	70.72%	Sabadell	Small	62.04%	82.25%
El Hierro	Small	64.99%	81.50%	Salamanca	Small	49.18%	67.54%
Fuerteventura	Large	58.66%	70.54%	San Sebastian	Small	61.64%	80.93%
Girona	Medium	64.31%	82.93%	Santander	Medium	49.97%	67.62%
Gran Canaria	Large	59.42%	62.37%	Santiago	Medium	50.05%	65.92%
Granada-Jaen	Medium	46.88%	65.04%	Sevilla	Large	64.85%	77.09%
Huesca-Pirineos	Small	68.58%	70.38%	Tenerife North	Large	60.45%	71.83%
Ibiza	Large	60.92%	74.07%	Tenerife South	Large	54.15%	66.45%
Jerez	Medium	52.77%	66.45%	Valencia	Large	65.21%	68.06%
La Gomera	Small	50.05%	64.38%	Valladolid	Small	53.82%	70.90%
La Palma	Medium	49.99%	66.23%	Vigo	Medium	50.27%	67.66%
Lanzarote	Large	63.60%	75.93%	Vitoria	Small	44.86%	71.03%
Leon	Small	51.81%	67.38%	Zaragoza	Small	72.23%	82.94%

	SFA_1 (1992)	SFA_2 *FE* (1992)
Mean	56.37%	71.96%
Maximum	88.29%	91.88%
Minimum	39.26%	53.06%
Standard deviation	0.0919	0.0832

Canary Islands are not considered tourist areas since having a significant number of households compared to second home residences (or even empty residences).

With no distinction between areas, the number of hotels and the length of the stay are the only variables affecting airports' efficiency levels. A higher number of hotels increase airports' efficiency by 10% while a higher length diminishes them at −2.9%. Cities with a higher number of hotels are usually nearby an airport, attracting more visitors compared to other locations with a different type of accommodation. At the same time, cities with few hotels will imply lower traffic for the respective airports (number of routes and passengers). Evidence suggests that competitive and efficient aviation services attract a larger number of tourists. LCCs attract more passengers due to lower fares (Windle & Dresner, 1999) and other aspects such as passenger friendly attitude (Gillen & Lall, 2004; Heskett & Schlesinger, 1994). Nevertheless, in terms of product differentiation, the Spanish regulatory framework is not flexible. Spanish' airports not only do not compete, but they are unable to diversify by price and quality of the services provided. AENA applies a fully centralised management to the extent of deciding airports' charges. Apart from airfares, the other airport choice determinants are accessibility and flight frequencies (Hess & Polak, 2006; Ishii, Jun, & Van Dender, 2009; Pels et al., 2003; Suzuki, 2007; Windle & Dresner, 1995). Again, these are managerial decisions under AENA's control. Consequently, the Spanish airports do not enhance traffic by providing a better service or price, but due to their geographical location. These results exclude potential endogeneity issues in the causality between tourism and airport traffic volume. Finally, in 2011 and 2012 the technical efficiency decreased by 7.3% and 13.3% respectively. The highest significant decrease in efficiency happens from 2011 to 2012 for all the areas overall and slightly higher for the touristic areas (−6.7%). This is that according to the trend, the efficiency decreases in the cruder crisis years. This result was also observed by Coto-Millan et al. (2014) for the Spanish airports experimenting a dramatic productivity regress due to the economic crisis. Previous findings confirm the relevance of airports' efficiency in terms of passengers between 2010 and 2011 due to the financial crisis also (Ripoll-Zarraga et al., 2017)

The results show that for touristic areas, the type of accommodation is a relevant factor affecting airports' technical efficiency.[9] The touristic product is a complex experience enclosing multiple services used by visitors such as transportation; accommodation and attraction services (Gunn, 1988). Thus, a higher number of hotels increase significantly the efficiency for airports located in those areas. In particular, every hotel per 1000 inhabitants increases the efficiency in 171 percentage points (0.17% per inhabitant). This effect is 1.6 times higher compared to not differentiating between touristic and non-touristic areas. However, every campsite per

[9] Similar results were obtained using coastal locations instead of the specialization index. The only difference is the insignificant effect for the apartments.

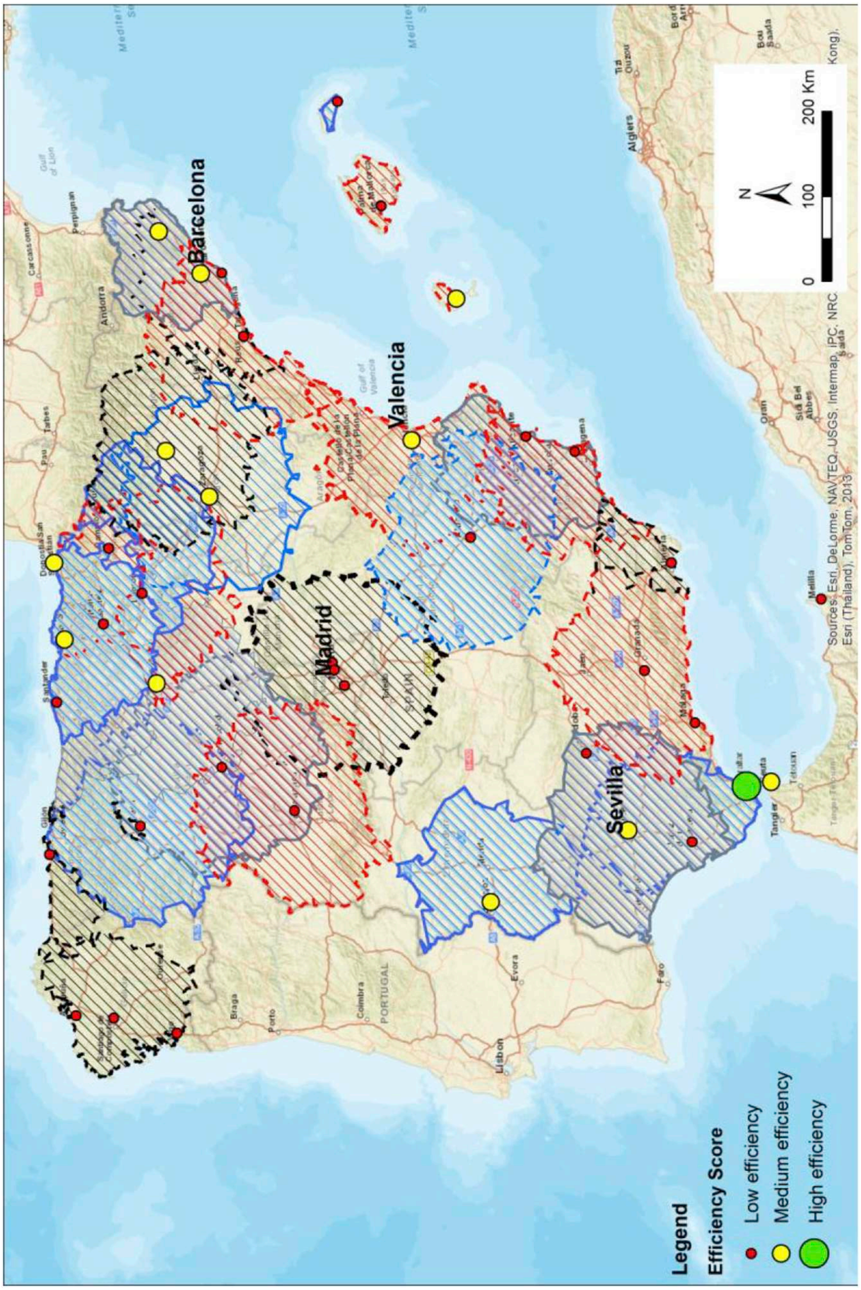

Fig. 2. Average technical efficiency mainland (SFA_1).

Fig. 3. Average technical efficiency islands (SFA_1).

Table 6
Results regression models.

Variable	Total	Touristic area	No-touristic area
Hotels	0.101**	1.708**	−0.060
Campsites	0.003	−2.566*	−0.003
Apartments	−0.002	−0.025***	−0.007
Expenditure	0.001	0.003**	0.001
Length	−0.029**	−0.13**	0.019
Arrivals	0.0001	0.0001*	0.0001
Labour force	−0.0002	0.004	−0.007
Price index	−0.001	−0.006	0.005
Year (reference 2013)			
2009	0.007	0.001	0.005
2010	−0.009	0.0050	−0.02
2011	−0.073***	−0.013**	−0.078***
2012	−0.133***	−0.080**	−0.141***
Intercept	0.963***	2.174**	0.320*
R-squared	0.32	0.94	0.28
Observations	193	24	169

If a p-value is less than 0.05, it is flagged with one star (*). If a p-value is less than 0.01, it is flagged with two stars (**). If a p-value is less than 0.001, it is flagged with three stars (***).

1000 inhabitants reduces the efficiency score by 257%. The apartments also reduce the efficiency of the airports in touristic areas, but with lower impact (−2.5%). The role of the type of accommodation (i.e. international hotel chains) and popular tourists' destinations are (among others) key factors to choose the travel destination product (Mo, Howard, & Havitz, 1993).

Every incoming tourist slightly increases the efficiency (0.01%) and for each euro spent the efficiency increases by just 0.3%. A higher number of tourists' arrivals by plane would be expected to improve airports' efficiency. Nevertheless, the low impact of arrivals may imply that the majority of tourists are using alternative types of transport to reach touristic destinations. These results suggest that the Spanish airports do not benefit from the number of passengers (tourist arrivals) neither from the tourists' purchases unless these take place within the airports' premises: commercial revenues are an important source of income (ICAO, 2013). With this regard, tourists arriving by plane may contribute to the financial aspect of the airports and, at the same time, to airports' efficiency. Nevertheless, this cannot happen without airports' differentiation in terms of commercial policies to make airports attractive to airlines and passengers (CNMC, 2014). The fact that a passenger stays one additional day at the destination decreases the efficiency by 13%. This loss in efficiency represents the opportunity cost: visitors use the airport to land (arrival) and take-off (leaving) independently on the number of days spent in a city. For every additional day remaining at the destination, the airport is losing a passenger per day (take-off). On the other hand, tourists arriving by alternative travel modes rather than by air transport will increase airports' inefficiency due to not having passengers neither landing or taking off. With this regard, tourists visiting Spain may choose the destinations based on other factors rather than lower airfares or availability of LCCs as suggested in literature. Although differential pricing could attract LCCs to airports (Barrett, 2004; Gillen & Lall, 2004), AENA's centralised management makes marketing strategies and airport differentiation unrealistic.

The results show that tourism variables do not affect airports' efficiency in areas perceived as non-touristic. These results suggest that when a city is a popular tourist destination, this becomes a decisional variable to decide the airport destination (Gunn, 1988). In touristic areas the higher number of campsites versus hotels the more negative impact in the airports' efficiency located nearby. Airports located in unpopular destinations are unfairly labelled as inefficient from a pure technical efficiency perspective. This is based on the airports' resources in relation to the income generated. Nevertheless, the results confirm that part of this inefficiency is due to the geographical location of these airports. These cities are less attractive for visitors who may also have different typologies in terms of sociodemographic characteristics; motivations; tourist activities; travel experiences; lifestyles and values (Cohen, 1984; Pitts & Woodside, 1986). On this basis, they may choose a different destination or even the same city as other visitors, but using a different transport modal. Consequently, some airports suffer from a lower number of passengers compared to other airports located in popular destinations (heterogeneity unobserved). At the same time, airports located in touristic areas with fewer hotels, but alternative types of accommodation will also have much lower passengers. Visitors prefer other cities with a specific type of hotels or tourist infrastructure (Gunn, 1988). It is clear that situational factors may influence the final decision in terms of city destination (e.g. health; travelling with children and relatives; financial crisis, etc.). Nevertheless, travel behavior could be predicted. Recent travel experiences may determine future travel intentions (Mazursky, 1989). Airports located in popular touristic areas will gain from having more passengers subject to having a good travel experience including accommodation (hotels) and leisure activities. Airports located in other areas will have to make an effort to attract airlines and passengers through price differentiation and quality of the service provided by the airports.

6. Conclusions

The results obtained are of major interest for not only the Spanish airports' management (AENA) but also for tourism authorities. The overall results highlight the relation between airports' operations and the geographical location of airports. Furthermore, the type of accommodation is a driver to attract passengers with a potential differentiation of travelers (business versus leisure). These results are relevant to be considered essentially in a strong centralised management background with a lack of managerial flexibility of airports' managers. In the first stage, the results show the passengers and movements as the main explanatory factors of the airports' technical efficiency, and with less relevance cargo. Commercial revenues become a significant source of income with more relevance in airports with a higher number of passengers. The cost of capital (depreciation) is not significant, suggesting that the Spanish airport-system suffers from over-capacity. Adequate managerial decisions must be taken to increase traffic. It is clear that airports' specialization and the airports' location in the seaside help the financing aspect of the system. Nevertheless, not all the inefficiency is due to decisions on inputs (airports' resources) and outputs (traffic). Although potential visitors may be willing to choose a specific destination, the Spanish market is not currently attractive to airlines and passengers. It is essential to enhance the aeronautical aspect of the airports allowing diversify and to differentiate on the quality of the service provided and price. This is only possible if managers are granted with the flexibility to decide commercial policies rather than being decided centralised by AENA. Individual airports' managers are potentially more focused on the regional needs where airports are located. Marketing efforts and price differentiation will also attract more LCCs and airports will be benefiting from a higher volume of passengers (product destination).

Provided the current regulatory framework the first analysis concludes that inefficiency is overall caused by how airports are managed (i.e. decisions among inputs and outputs). The standardisation of procedures implies a very low flexible decision-making process affecting the principal stakeholders (airlines, cargo companies, regional authorities, commercial bodies). Regardless of airports being government-owned and managed, it is essential to allow airports' service differentiation. Airports are different businesses based on derived demand and geographical location (e.g., regional needs, location, population). Decentralised management will assure the right decision for each airport which may imply airports' specialization to be more efficient (Ripoll-Zarraga & Lozano, 2019). Additionally, part of the network inefficiency is affected by the airports' geographical location. With this regulatory background where airports are not differentiated and are not competing to attract airlines and passengers, Spain visitors seem to decide first the destination and secondly the travel modal (airport). Further research is required considering not only the number of arrivals, but tourists travel modes. Tourist behavioral attitude depends on different circumstantial factors (financial crisis; family, etc.), but it is a complex process that goes beyond the destination choice (transport; accommodation and attraction services). Additionally, an integral part of the tourism experience relays on previous experiences regarding the airport chosen and the services provided (e.g., services in check-in, Rendeiro, 2006; food and beverage, Del Chiappa, Martin, & Roman, 2016). With this regard, airports identified in touristic areas are becoming more efficient since attracting more visitors in cities with a higher number of hotels compared to campsites or apartments. Cities with campsites are reached by alternative transport choices such as roads and railways. Consequently, airports are more technically inefficient in these latest cities. Airports located in touristic areas are more sensitive to the decisions made by potential visitors regarding the type of accommodation; the number of days staying and budget. The touristic pattern in the years of the study (2009–2013) reflects that is preferably having visitors spending fewer days in the destination (where the airport is located). The type of accommodation is an essential part of the destination product becoming a driver of airports' efficiency in touristic areas.

Apart from the trend, no significant effects are observed in non-touristic areas showing a higher decrease in efficiency compared to touristic areas (−7.8% in 2011 and 14.1% in 2012). Due to the financial crisis airports have fewer passengers. Visitors use alternative travel choices potentially travelling to less popular, but cheaper destinations. Therefore, the results conclude that airports' inefficiency in no-touristic areas is mainly caused by airports' management (inputs and outputs). This inefficiency is significantly reduced when considering the different peculiarities of certain airports of the system (fixed effects). With this regard, airports located in no popular destinations may be unfairly treated by AENA by applying similar policies across the network and other airports within the catchment area. The Spanish government requires keeping a significant number of small regional airports with alternative transport choices. Nevertheless, the absence of competition does not help these smallest airports increasing and attracting traffic. It is essential to consider airports' impact on local economies: as drivers of regional development and economic growth. Competition between airports located in the same geographic areas is essential with more relevance for not popular tourist destinations since visitors enhance airports' financial and efficiency aspects.

One of the main contributions of the study is the insights learned from the methodology approach used in an empirical case and demonstrating the change in the inefficiency explained by the airports' resources and the overall traffic generated when including fixed effects. Without considering the specific firm effects, firstly airports would be unfairly treated as technical inefficient, as well as the management (AENA) since the overall inefficiency is significantly higher for the traditional model. But, secondly, wrong managerial decisions would be made since the model assumes that all the inefficiency is caused by the decisions regarding inputs and outputs. Limitations are highlighted such as the inaccessibility to touristic municipality data, but province data. Finally, it is essential to question the consistency of these results if airports were individually managed rather than by the same authority. Future research will involve other European airports with similar structure and government ownership forms, but with different degree of centralisation of management (i.e., Norway and Poland).

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References

Aigner, D., Lovell, K. C. A., & Schmidt, P. (1977). Formulation and estimation of stochastic frontier production function models. *Journal of Econometrics, 6*, 21–37.
Anselin, L. (2003). Spatial externalities, spatial multipliers and spatial econometrics. *International Regional Science Review, 26*(2), 153–166.
Ashford, N., Stanton, H., & Moore, C. (1996). *Airport operations* (2nd ed.). New York: McGraw-Hill Education.
Assaf, A. (2008). Accounting for size in efficiency comparisons of airports. *Journal of Air Transport Management, 15*(5), 256–258.
Assaf, A. (2010). The cost efficiency of Australian airports post privatisation: A Bayesian methodology. *Tourism Management, 31*(2), 267–273.
Assaf, A., & Josiassen, A. (2015). Frontier analysis: A state-of-the-art review and meta-analysis. *Journal of Travel Research,* 1–16.
Barbot, C. (2006). Low-cost airlines, secondary airports and state aid: An economic assessment of the Ryanair-Charleroi airport agreement. *Journal of Air Transport Management, 12*, 197–203.
Barrett, S. D. (2004). How do the demands for airport services differ between full-service carriers and low-cost carriers? *Journal of Air Transport Management, 10*(1), 33–39.
Barros, C. P. (2008). Airports in Argentina: Technical efficiency in the context of an economic crisis. *Journal of Air Transport Management, 14*(6), 315–319.
Barros, C. P. (2008a). Technical efficiency of UK airports. *Journal of Transport Management, 14*(4), 175–178 Technical efficiency of UK airports'. *Journal of Air Transport* Barros, C.P. (2008a).
Barros, C. P. (2008b). Technical change and productivity growth in airports: A case study. *Transportation Research Part A: Policy and Practice, 42*(5), 818–832.
Battese, G. E., & Coelli, T. J. (1992). Frontier production functions, technical efficiency and panel data: With application to paddy farmers in India. *Journal of Productivity Analysis, 3*, 153–169.
Battese, G. E., & Coelli, T. J. (1995). A model for technical inefficiency effects in a stochastic frontier production function for panel data. *Empirical Economics, 20*, 325–332.
Beale, C. M., Lennon, J. J., Yearsley, J. M., Brewer, M. J., & Elston, D. A. (2010). Regression analysis of spatial data. *Ecology Letters, 13*(2), 246–264.
Bottaso, A., & Conti, M. (2010). An assessment on the cost structure of the UK airport industry: Ownership outcomes and long run cost economies. *Working paper. Vol. 13*University of Torino.
Brümmer, B., Glauben, T. G., & Lu, W. (2006). Policy reform and productivity change in Chinese agriculture: A distance function approach. *Journal of Development Economics, 81*, 61–79.
Brümmer, B., Glauben, T. G., & Thijssen, G. (2002). Decomposition of productivity growth distance functions: The case of dairy farms in three European countries. *American Journal of Agricultural Economics, 84*(3), 628–644.
Butler, R. W. (1980). The concept of a tourist area cycle of evolution: Implications for management of resources. *The Canadian Geographer, 24*(1), 5–12.
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*(15) (1967-197).
Coelli, T., Rao, D. S. P., O'Donnell, C. J., & Battese, G. E. (2005). *An introduction to efficiency and productivity analysis* (2nd ed.). New York: Springer.
Cohen, E. (1984). The sociology of tourism: Approaches, issues and findings. *Annual Review of Sociology, 10*, 373–392.
Comisión Nacional de los Mercados y la Competencia (2014). *El Sector Aeroportuario en España: Situación Actual y Recomendaciones de Liberalización.* CNMC, July.
Coto-Millan, P., Casares-Hontañon, P., Inglada, V., Agüeros, M., Pesquera, M. A., & Badiola, A. (2014). Small is beautiful? The impact of economic crisis, low cost carriers, and size on efficiency in Spanish airports (2009–2011). *Journal of Air Transport Management, 40*, 34–41.
Coto-Millan, P., Inglada, V., Fernandez, X. L., Inglada-Perez, L., & Pesquera, M. A. (2016). The effect procargo on technical and scale efficiency at airports: The case of Spanish airports (2009–2011). *Utilities Policy, 39*, 29–35.
Cuesta, R. A., Lovell, C. A. K., & Zofio, J. L. (2009). Environmental efficiency measurement with translog distance functions: A parametric approach. *Ecological Economics, 68*, 2232–2242.
Del Chiappa, G., Martin, J., & Roman, C. (2016). Service quality of airports' food and beverage retailers: A fuzzy approach. *Journal of Air Transport Management, 53*, 105–113.
European Commission European Court of Auditors (2014). *EU-funded airport infrastructures: poor value for money.* December, Special Report, 21 http://www.politico.eu/article/eu-wasted-money-on-new-airports-say-auditors/.
Flightpath 2050 Europe's vision for aviation' (c, March 2011) doi: 10.2777/50266 EUR 098 EN https://ec.europa.eu › sites › files › modes › air › doc
Färe, R. (1988). *Fundamentals of production theory.* Switzerland: Springer Nature.
Färe, R., & Primont, D. (1995). *Multi-output production and duality: Theory and applications.* Boston: Kluwer Academic Publishers.
Gillen, D., & Lall, A. (1997). Non-parametric measures of efficiency of US airports. *International Journal of Transport Economics, 28*, 283–306.
Gillen, D., & Lall, A. (2004). Competitive advantage of low-cost carriers: Some implications for airports. *Journal of Air Transport Management, 10*(1), 41–50.
Goetz, A. R. (1992). Air passenger transportation and growth in the US urban system, 1950–1987. *Growth and Change, 23*, 218–242.
Greene, W. (2003). *Econometric analysis* (5th ed.). Englewood Cliffs: Prentice Hall.
Grosskopf, S., Margaritas, D., & Valdemanis, V. (1995). Estimating output substitutability of hospital services: A distance function approach. *European Journal of Operational Research, 80*, 575–587.
Gunn, C. (1988). *Tourism planning.* New York: Taylor and Francis.
Heskett, J. L., & Schlesinger, L. (1994). Putting the service-profit chain to work. *Harvard Business Review, 72*(2), 164–174.
Hess, S., & Polak, J. W. (2006). Exploring the potential for cross-nesting structures in airport-choice analysis: A case-study of the greater London area. *Transportation Research Part E: Logistics and Transportation Review, 42*(2), 63–81.
International Civil Aviation Organization (2013). *Worldwide Air Transport Conference (ATCONF) Sixth meeting: Airport Competition.* March.
Ishii, J., Jun, S., & Van Dender, K. (2009). Air travel choices in multi-airport markets. *Journal of Urban Economics, 65*(2), 216–227.
Jondrow, J., Lovell, C. A. K., Materov, I. S., & Schmidt, P. (1982). On the estimation of technical inefficiency in stochastic frontier production function model. *Journal of Econometrics, 19*(2–3), 233–238.
Juaneda, C., Raya, J. M., & Sastre, F. (2011). Pricing the time and location of a stay at a hotel or apartment. *Tourism Economics, 17*(2), 321–338.
Kumbhakar, S. C., & Lovell, C. A. K. (2000). *Stochastic frontier analysis.* Cambridge, United Kingdom: Cambridge University Press.
Lovell, C. A. K., Richardson, S., Travers, P., & Wood, L. L. (1994). Resources and functioning: a new view of inequality in Australia' in Models and measurement of welfare and inequality. In W. Eichhorn (Ed.). Berlin: Springer.
Martin, J. C., & Roman, C. (2001). An application of DEA to measure the efficiency of Spanish airports prior to privatization. *Journal of Air Transport Management, 7*(3), 149–157.
Martin, J. C., Roman, C., & Voltes-Dorta, A. (2009). A stochastic frontier analysis to estimate the relative efficiency of the Spanish airports. *Journal of Productivity Analysis, 31*(3), 163–176.
Martin, J. C., Roman, C., & Voltes-Dorta, A. (2011). Scale economies and marginal costs in Spanish airports. *Transportation Research Part E: Logistics and Transportation Review, 47*, 238–248.
Martin-Cejas, R. R. (2002). An approximation to the productive efficiency of the Spanish airports network through a deterministic cost frontier. *Journal of Air Transport Management, 8*(4), 233–238.
Mazursky, D. (1989). Past experience and future tourism decisions. *Annals of Tourism Research, 16*, 333–344.
Meeusen, W., & van den Broeck, J. (1977). Efficiency Estimation from Cobb-Douglas Production Functions with Composed Error. *International Economic Review, 18*, 435–444.
Mo, C., Howard, D., & Havitz, M. (1993). Testing an international tourist role typology. *Annals of Tourism Research, 20*(2), 319–335.
Murillo-Melchor, C. (1999). An analysis of technical efficiency and productivity changes in Spanish airports using the Malmquist index. *International Journal of Transport Economics, 26*(2), 271–292.

Paul, C. J. M., Johnston, W. E., & Frengley, G. A. G. (2000). Efficiency in New Zealand sheep and beef farming: The impacts of regulatory reform. *The Review of Economics and Statistics, 82*(2), 325–337.
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 economies of European airport operations. *Transportation Research Part E: Logistics and Transportation Review, 39*, 341–361.
Pit, M., & Lee, L. (1981). The measurement and sources of technical inefficiency in Indonesian weaving industry. *Journal of Development Economics, 9*, 43–64.
Pitts, R. E., & Woodside, A. G. (1986). Personal values and travel decisions. *Journal of Travel Research, 25*, 20–25.
Rendeiro, R. (2006). Tourism service quality begins at the airport. *Tourism Management, 27*(5), 874–877.
Ripoll-Zarraga, A. E. (2017). The Spanish airport-system: Critical evaluation of the effectiveness of the Spanish Government's management of public resources. *The Publich Sphere Journal of Public Policy*(February 2017) (London School of Economics and Political Science. London).
Ripoll-Zarraga, A. E., & Lozano, S. (2019). **A** centralised DEA approach to resource reallocation in Spanish airports. *Annals of operations research S.I.: Data envelopment analysis: Four decades on* (pp. 1–32). .
Ripoll-Zarraga, A. E., & Mar-Molinero, C. (2017). Spanish airports: A visual study of management efficiency. *Funcas working papers* (pp. 791). September.
Ripoll-Zarraga, A. E., Portillo, F., & Mar-Molinero, C. (2017). The impact of the 2008 economic crisis in the efficiency of Spanish airports: A DEA analysis. *Funcas working papers* (pp. 794). December.
Sarkis, J. (2000). An analysis of the operational efficiency of major airports in the United States. *Journal of Operations Management, 18*, 335–351.
Shepard, R. W. (1970). *Theory of cost and production functions.* Priceton: Princeton University Press.
Suzuki, Y. (2007). Modeling and testing the "two-step" decision process of travellers in airport and airline choices. *Transportation Research Part E: Logistics and Transportation Review, 43*(1), 1–20.
Tapiador, F. J., Mateos, A., & Marti-Henneberg, J. (2008). The geographical efficiency of Spain's regional airports: A quantitative analysis. *Journal of Air Transport Management, 14*(4), 205–212.
Tovar, B., & Martin-Cejas, R. R. (2009). Are outsourcing and non-aeronautical revenues important drivers in the efficiency of Spanish airports? *Journal of Air Transport Management, 15*(5), 217–220.
Tovar, B., & Martin-Cejas, R. R. (2010). Technical efficiency and productivity changes in Spanish airports: A parametric distance functions approach. *Transportation Research Part E, 46*(5), 249–260.
Tussyadiah, I. P., & Pesonen, J. (2016). Impacts of peer-to-peer accommodation use on travel patterns. *Journal of Travel Research, 55*(8), 1022–1040.
Windle, R., & Dresner, M. (1995). Airport choice in multiple-airport regions. *Journal of Transportation Engineering, 121*(4), 332–337.
Windle, R., & Dresner, M. (1999). Competitive responses to low cost carrier entry. *Transportation Research Part E: Logistics and Transportation Review, 35*(1), 59–75.
Yoshida, Y. (2004). Endogenous-weight TFP measurement: Methodology and its application to Japanese-airport benchmarking. *Transportation Research Part E: Logistics and Transportation Review, 40*(2), 151–182.
Yu, M.-M. (2004). Measuring physical efficiency of domestic airports in Taiwan with undesirable outputs and environmental factors. *Journal of Air Transport Management, 10*(5), 295–303.

Reports

Comisión Nacional de los Mercados y la Competencia (CNMC) (July 2014). *El Sector Aeroportuario en España: Situación Actual y Recomendaciones de Liberalización*.
European Commission (2011). European strategies: Mobility and transport white paper. https://ec.europa.eu/transport/themes/strategies/2011_white_paper_en.
European Commission European Court of Auditors (December, 2014). *'EU-funded airport infrastructures: poor value for money' Special Report.* 21. http://www.politico.eu/article/eu-wasted-money-on-new-airports-say-auditors/.
European Commission (December, 2015). An aviation strategy for Europe. https://ec.europa.eu/transport/modes/air/aviation-strategy_en.
European Commission (March, 2017). *Annual analyses related to the EU air transport market 2016. Final report*.
International Civil Aviation Organization ICAO (March, 2013). *Worldwide air transport conference (ATCONF) Sixth meeting: Airport competition*.

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