CAN AIRPORTS' INEFFICIENCY BE DETERMINED BY TOURISM VARIABLES?

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Can airports' inefficiency be determined by tourism variables?*

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Abstract

The Spanish airports are managed centrally by a government owned company named AENA. The excessive public investments; airports managers' inability to decide commercial policies and lack of competition end in uncongested regional areas with more than one airport in an amenity distance. Most of the airports become highly inefficient when treating all the airports under a centralized management. Airports' managerial decisions should acknowledge regional needs. The geographical location of airports and specialization should be questioned as drivers of airports' efficiency. In this study, following Battese and Coelli (1992) a stochastic frontier analysis is applied to estimate the technical inefficiency of the Spanish airports. A new approach is used enclosing firm fixed effects (Greene, 2003) within the production function to control special features that may be affecting airports' individual efficiency. A second stage regression is performed with tourism indicators of the areas where airports are located. The first stage shows that part of the inefficiency is caused by the management (AENA). Additionally, airports' special features are relevant to avoid model misspecifications and mistaken managerial decisions regarding inputs and outputs. In terms of tourism regional aspects, the type of accommodation is a relevant factor affecting airports' efficiency in popular touristic areas. The existence of camp sites in comparison with number of hotels becomes a negative externality for airports' efficiency. In areas that are not usually chosen as tourist destination, the inefficiency is mostly caused by the management. The conclusions refer to airports' differentiation to attract more passengers and airlines.

Keywords: *Airports Inefficiency; Stochastic Frontier Analysis (SFA)***;** *Fixed Effects; Touristic Areas; AENA*

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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 to international places at more competitive prices. The aviation sector becomes then a core driver of economic growth, jobs, trade and mobility for the European Union. 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 seems not committed starting for not allowing competition between airports[1]. Additionally, the Spanish airports are managed by a central authority named AENA, a government owned company. Airports within the same regional areas frequently suffer from low traffic since these are not differentiated in terms of quality of the services provided. The airports charges are also decided by AENA rather than by the airports´ individual managers. Consequently, areas are usually overcrowded with more than one regional airport, but without enough routes and connection options for passengers.

The relevance in making the Spanish airport system attractive 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 et al., 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 has driven the usage of secondary regional airports used due to the low congestion and lower marginal costs (Barbot, 2006). In fact, the LCC business model is based on the usage of secondary airports (Doganis, 2006). LCC airports choices depend on several factors, but overall economic reasons (Warnock-Smith and Potter, 2005; Dziedzic and Warnock-Smith, 2016). Airports enhance economic regional development, but the adequate market conditions must be provided. A centralized management treating all the airports as a whole seems not to address the needs of the city and region where regional airports are located. It is important to increase the awareness of differences across airports and to make decisions according to regional needs.

One of the key aspects is to seek the reason for some airports having less operational activity (traffic) in detriment of others. On this basis, benchmarking allows comparing airports performance to confirm which aspects affect some airports' operational efficiency against other airports. Airports benchmarking has an extensive literature including several methodological approaches. Most of the studies in the airport industry use data development analysis (DEA) (for example, Gillen and Lall 1997, 2001; Pels et al., 2001; Adler and Berechman, 2001; Martin and Roman, 2001; Yoshida and Fujimoto, 2004; Yoshida 2004; Lin and Hong, 2006; Barros, 2008). Few studies use parametric methods such as stochastic frontier analysis (Pels et al., 2001; Martin-Cejas, 2002; Barros, 2008a, 2008b) and stochastic frontier based on a

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

Bayesian approach (Assaf 2008, 2010a, 2010b). Differentiating by airports' homogeneity in the data (Pels et al., 2003) compared to heterogeneity (Barros 2008a; Assaf, 2010b). Overall the literature in the Spanish airport system does not investigate the reasons for differences in efficiency, except for the number of passengers (see Ripoll-Zarraga and Mar-Molinero, 2017). This also happens in tourism literature at micro and macro levels (tourism industry). The studies using DEA represent a 74% of the total (Assaf and 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 to improvement in efficiency. Otherwise, Yu (2004) pointed out the importance of the development of tourism to explain 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 overall conclusions refer to the requirement of analysing the determinants of efficiency from frontier studies (Assaf and Josiassen, 2015). This may be related to controllable factors such as inputs and outputs, but also due to operational barriers such as the population density in the airport catchment area and environmental aspects (weather) As far as our knowledge is concerned literature has not investigated the role of individual tourism variables as determinants of airports' inefficiency. In a first stage we use stochastic frontier analysis under Battese and Coelli (1992) specification of the inefficiency term. Following Greene (2003) fixed effects are also enclosed 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 methodological approach since 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 potentially 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 potentially affected by the airports' geographical location. Based on the fully centralized management, the first inefficiency is considered fully controllable including firm effects since investments decisions are decided by the Spanish government through AENA.

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 main 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' 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 and Mar-Molinero, 2017). The need of the Spanish airport-system's financial sustainability has made seeking new sources of income, but still requires the implementation of strategies to reduce costs including the financial costs due to borrowings used to finance the investments made in the past years. 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 and Mar-Molinero, 2017).

One of the consequences of the centralised management is that the Spanish airports do not compete. There are several geographical areas with more than one airport within an amenity distance serving the same areas. Consequently, these are not congested becoming cost inefficient (Martin et al., 2011). The network contains a significant number of small and medium airports not used for aeronautical purposes. Previous studies in the Spanish airport system analyse the relation between infrastructure and traffic within the same catchment area and the geographical location (Martin and Roman, 2001 and 2006; Tapiador et al., 2008). The findings conclude airports' location affecting efficiency and large and small airports being more geographical efficient. A review of previous studies in the Spanish airport system and main findings are summarized in Ripoll-Zarraga and Mar-Molinero (2017)

The question to be addressed is if part of this traffic could be explained by geographical characteristics of airports and more specifically tourism variables rather than the inputs and outputs.

Figure 1: The Spanish Airport System (Source: AENA, 2013)

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 degrees, 2,451 hours of sunshine, which is equivalent to 6.7 hours of daily sun. It boasts 8,000 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 clearly reflect different conditions under the Spanish airports operate. This is known as unobserved heterogeneity and since it is not controlled by airports' operator, creates inefficiency. Unobserved heterogeneity may be caused by economic cycles or market levels characteristics as well as low transfer capacity of inputs (Bottaso and Conti, 2010). The relevance of accounting for heterogeneity is to avoid biasing the estimated efficiency levels. Examples of unobserved heterogeneity are demographic characteristics where airports are located (e.g. population and weather) or even structural characteristics of airports such as longer runways, etc. Overall, these externalities could cause a significant season effect restricting the traffic to specific period of times during the year. Finally, other externalities regarding the regulatory framework; government policy and ownership forms could also generate inefficiency. These are particularly relevant in the Spanish airport system since airports' managers do not have decision making power. In the first stage the regulatory impact is implicitly captured by accounting for firm effects related to infrastructure characteristics since airports' investments are fully decided by AENA. With this regard and in this context the unobserved heterogeneity could be discussed to be controlled by the centralized management. This is identified as airports' time-invariant singularities and enclosed in the production function. In the second stage the unobserved characteristics are related to the airports' specific geographical location. Therefore, these are considered not to be under AENA´s control. These correspond to region specific effects classified as touristic and no-touristic areas that can variate across time.

3. Methodology

The first stage consists on applying stochastic frontier analysis (SFA). A main advantage of the stochastic frontier approach over DEA is that it isolates the influence of factors other than inefficient behavior. The model specification follows Battese and Coelli (1992), but accounting for entity fixed effects (Greene, 2003) in the production function. The model is a translog distance function being the most adequate framework since airports are multi- output firms

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

(Coelli and Perelman, 1999; Kumbhakar and Lovell, 2000). Following Greene (2003) fixed effects are considered within the model to account for singularities of certain airports that remain constant over time (unobserved heterogeneity). The assumption made is that these fixed effects may 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 characteristics of the same unit.

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. Assuming m outputs and k inputs; choosing arbitrary one of the inputs as the $ϛ-th$ input for normalising purposes ($k=\frac{1}{x_{ϛit}}$) and normalising the rest of the k -1 inputs by k, the translog distance function follows,

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

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

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

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 Pitt 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 $vi{\sim}N^{+}(0,\ \sigma_v^2)$

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

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 frontier function is estimated by the maximum likelihood method, as the inefficiency is estimated 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 et al., 1982). Robust stochastic frontier analysis has been applied in order to test heteroscedasticity.

The specific airports' characteristics (fixed effects) are introduced as dummies ($D_{ï}$) in the production function. Each dummy represents one airport ï identified for containing special features compared to others. Airport-specific effects are assumed to be correlated with the regressors. Therefore, the equation (1) becomes,

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

$D_{ï} \in i = 1, \dots n$

In the second stage a regression is performed. The efficiency scores obtained from the first analysis (SFA) are used as dependent variable. 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. The next section describes the tourism variables used in the second stage. Several models tested including exogenous variables (environmental variables) as function of the inefficiency term (Battese and Coelli, 1995), have identified few explanatory causes of the overall inefficiency of the network (see Ripoll-Zarraga and Adler, 2018). This may be consequence of the particularities of the Spanish airport system that cannot be extrapolated to other countries. On this basis, we apply a different methodology approach based on SFA with the inclusion of fixed effects in a first phase and an independent regression in a second phase.

4. Data Description

The stochastic frontier analysis has been applied to 48 airports for a period of five years (2009-2013). Individual financial information before 2009 is not released. The Spanish regulatory framework based on a fully centralised management without airports' operators flexibility to apply commercial policies, justifies using airports and not airlines. The number; type of airlines and routes are extremely conditioned to the Spanish market not being liberalised factually. There is a clear increment of additional passenger when airports decide freely the fares (price differentiation). The Spanish efficiency literature shows most of the studies based on airports rather than airlines (see Ripoll-Zarraga and Mar-Molinero, 2017). Additionally, the few studies considering airlines are usually focused on the impact of low costs carriers and hubs (e.g. Castillo-Manzano et al., 2017; Marti et al., 2015).

The divergence shown in terms of traffic and regulation regarding civilian airports compared to general aviation (Madrid cuatro-vientos; Madrid-Torrejon[3]; Sabadell and Son Bonet) and heliports (Algeciras and Ceuta) have been tested through a sensitivity analysis. Finally, all the airports have been enclosed in the final analysis except Son Bonet due to missing regarding infrastructure (depreciation). Following Ripoll-Zarraga and Mar-Molinero (2017) the network is classified in terms of passengers containing 14 large airports (i.e. more than 3.5 million of passengers per year); 13 medium and 22 small-sized airports (with less than 750,000 passengers per year).

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

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-Costa Brava; 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 Sebastián; Son Bonet; Valladolid; Vitoria; Zaragoza	≤ 750,000	273	457,595

Table 1: Airports Size in terms of Passengers per year (Source AENA 2013 in Ripoll-Zarraga and Mar-Molinero, 2017)

The summary statistics for the 49 airports managed by AENA are shown in Table 2[4].

Variable	Observations	Mean	Standard Dev.	Minimum	Maximum
PAX (th)	245	3,944.68	8,529.97	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	11.71	27.83	0	169.51
Labour (th €)	245	7.23	10.19	0.11	74.24
Operating (th €)	245	19.03	49.86	0.24	318.30
Depreciation AENA (th €)	245	14.40	39.31	0.18	264.45
Depreciation Airside (th €)	240	4.16	11.08	0	79.80
Depreciation Landside (th €)	240	1.09	2.22	0	11.94

Table 2: Summary Statistics (Source: AENA except for Depreciation Airside-Landside, 2009-2013)

The statistics show relevant variability suggesting a divergence in terms of infrastructure (capacity) as well as in traffic for example, comparing passengers and cargo. Overall airports with a significant cargo level have a low number of passengers and vice versa. Aeronautical revenues are accounted in the value of passengers; air traffic movements and cargo. The aeronautical income is clearly more relevant compared to commercial revenues. Nevertheless, commercial revenues are also an important source of income (ICAO, 2013). Labour refers to the cost of AENA's employees working in the airports. These are an indicator of the overall

[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 and Mar-Molinero, 2017)

Spanish airport system fixed costs. AENA does not provide information regarding number and type of employees (permanent; fix; full and part-time). The depreciation reported by AENA is significantly high compared to the new values estimated. Meetings with managers have confirmed the excessive annual charges applied by AENA (Ripoll-Zarraga and Mar-Molinero, 2017). Consequently, AENA´s depreciation may not be in accordance with how revenues are generated. The literature shows a divergence regarding the inputs used and essentially when including measures of cost of capital (for example airports physical area, Tovar and Martin-Cejas, 2009 and 2010 and Martin et al. 2011; the number of runways and terminal buildings, Martin-Cejas, 2002; amortization of fixed assets, Martin et al., 2001, 2009, 2011 or book value Murillo-Melchor 1999, Salazar de la Cruz 1999, Pestana and Sampaio, 2004, Martin et al., 2009 and Coto-Millan et al., 2014, 2016).

The limited information provided by AENA requires using the following inputs: labour costs; operating costs and depreciation of assets. In the output side the number of passengers; air traffic movements; cargo and commercial revenues (e.g. passengers, Murillo-Melchor, 1999, Salazar de la Cruz, 1999 and Tovar and Martin-Cejas, 2010; air traffic movements and cargo, Martin and Roman, 2001, Lozano and Gutierrez, 2011, Lozano et al., 2013 and Coto-Millan et al., 2014 and 2016; aeronautical and commercial revenues, Salazar de la Cruz, 1999, Tovar and Martin-Cejas, 2009, 2010 and Martin et al., 2011).

The dependent variable in the translog distance function is the labour costs (input distance function). The idea is to test if there is a relation between airports infrastructure (depreciation) and operational activity (operating costs and traffic) with the labour employed by AENA. Since all the airports are government owned and managed, the Spanish government may treat the Spanish airports as public utilities prioritising social policies (employment or connectivity) rather than industry needs. 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 and Mar-Molinero, 2017[5]). The airports' infrastructure refers to airside and landside assets (Ashford et al., 1996) Airside assets is infrastructure directly related to the aeronautical activity. Landside assets refer to other assets not strictly necessary for air transport purposes. Examples of airside assets include aviation terminals; aprons; taxiway; runways; air traffic control and visualisation systems (beacon). Landside assets accounts for passengers and cargo terminals; parking; emergency services buildings and other investments including recycling system and access roads. The relevance of including depreciation rather than physical measures such as the number or extension of runways; number of terminals, etc. correspond to being a reflection of the usage of airports' infrastructure in the operational activity. The depreciation policy should follow the accruals and matching conventions accounting for a relation between usage (cost) and income earned. In this case since AENA depreciation is not used, a risk of over-depreciating does not occur: accruing more expenses compared to the traffic generated (income earned).

The data has been deflated by the Spanish gross domestic product deflator (base Spain, 2010) and standardized by the respective geometric mean, which allows to estimate elasticities at sample means (Cuesta et al., 2009) Table 3 shows the descriptive of the variables used in the second stage.

[5] The new depreciation shows a significant lower correlation coefficients with the operating costs (Ripoll-Zarraga and Mar-Molinero, 2017)

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
Camp Sites (th)	189	0.090	0.102	0.003	0.456
Apartments (th)	189	11.14	15.46	0.272	59.55
Expenditure (€)	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

Table 3: Summary Statistics (2009-2013)

For the second- step tourism variables refer to accommodation supply and demand. The inclusion of these variables addresses the potential relation between the tourism attractiveness of a city and the passengers' choice of the city airport as final destination. A range of type of accommodation in quality and price or the concentration of touristic services in specific areas could explain the reasons because some destinations are preferred in detriment of others (Butler, 1980). From an initial sample of 240 airports (48 airports from 2009 to 2013), the final data refers to 189 observations due to missing in tourism variables. The technical efficiency scores correspond to the results obtained in the first analysis following Battese and Coelli (1992) accounting for fixed effects (see table 5). The tourism data statistics reveal a significance in the number of apartments compared to hotels or campsites. This is evidence for a change in the tourism behaviour pattern since the financial crisis started (Tussyadiah and Pesonen, 2016) Tourists tend to rent apartments based on lower cost per day compared to hotels. With this regard, tourists have a higher daily budget potentially enhancing more number of days to spend at the destination. The labour force is the number of employees working in the touristic sector. The price and employees have been obtained from official statistics provided by the National Institute of Statistics (INE). It has not been possible to obtain more disaggregate data except at provincial level. We are aware that this may create a bias as there is more than one different sized-airport usually within the same province. The type of accommodation and the employees have been standardized by the number of inhabitants of the province.

Note that due to the significant missing data in the second stage, a translog following Battese and Coelli (1995) accounting for the inefficiency term as function of environmental variables has not been possible to be performed. The idea when analyzing the overall inefficiency (u_{it}) as function of environmental variables is to enclose as many airports as possible. On this occasion some airports have missing data for all the years with variability in terms of size (for example, Lanzarote, large airport; a medium-sized, La Palma and small airports, Ceuta; Huesca-Pirineos; La Gomera and Melilla). Further research has been performed considering externalities potentially influencing airports' inefficiency (environmental variables) simultaneously with the stochastic frontier (see Ripoll-Zarraga and Adler, 2018)[6].

5. Results

First-step estimation

The results of the stochastic frontier analysis are shown in Table 4. The first column corresponds to the translog without considering fixed effects. The second column is the model enclosing fixed effects in the production function as dummies. Fixed effects have been identified in large airports (Barcelona; Madrid; Palma de Mallorca and Malaga), but also in small airports such as Huesca-Pirineos and Vitoria (cargo-oriented airport). As stated, these airports are assumed to have time-invariant features.

The maximum likelihood technique is employed to the estimates of the variable coefficients and the parameters of the two error components. Both models show high values of likelihood estimator with a clear improvement when considering entity fixed-effects. The respective high values support the low-level of noise compared to inefficiency explained. The distributional assumptions of the two components of the error term are to be identically and independently distributed as previously discussed.

Due to the extension of the translog function all the individual effects are shown, but only the significant iterations. The null 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). Gamma $(\gamma = \frac{\sigma_u^2}{\sigma_u^2+\sigma_v^2})$ 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. Additional airports may be enclosed within the production function (fixed effects). This is to be performed in future analysis.

Regarding the individual effects, the results show the coefficients of the basic variables with the expected signs. There is a relevance of 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-investments since traffic has not increased accordingly (AENA 2009-2013).

[6] The exogenous variables are the number of competitors within the catchment areas; existence of public service obligation routes (PSOs); train facilities to access directly the airport; capacity of the airport subject to air traffic restrictions and main activity of the airport (Ripoll-Zarraga and Adler, 2018).

Cargo although significant does not have a major impact as it would be expected[7]. The fixed effects model shows similarly results regarding both, significance and value of parameters, except for commercial revenues where there is a clear trade-off between the first and the second model[8]: the fixed effects reveal the requirement of commercial revenues co-existing with the number of passengers ($\beta_{45} = -0.1137$). The fixed effects model also shows the relevance of large and hub airports such Barcelona and Madrid in generating financial resources ($D_1 = -1.0149$; $D_2 = -1.2943$) compared to small airports. Airports not having enough traffic such as Huesca-Pirineos become a burden for the system ($D_5 = +0.3785$). The results also show that airports' specialisation 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 although in specific periods of the year. Therefore, these airports do not contribute consistently to finance the overall labour costs in comparison to other large airports considered popular destinations during the whole year (e.g. Barcelona)

Table 5 shows the average of technical efficiencies for each airport in both models. The fixed effects model provides higher values compared to the standard model (Battese and Coelli, 1992). These results confirm that the presence of externalities (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. 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, figures 2 and 3 shows the location of each airport in terms of catchment areas. A catchment area is defined as the influence area within 150 kilometres (Ripoll-Zarraga and Mar-Molinero, 2017). The efficiency level has been ranked within three groups: low, with efficiency scores between 1% and 59%; medium between 60% and 75% and high for airports with more than 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), the visualisation reveal that somehow the location and the number of airports located in the regional area could also contribute to the inefficiency of the system.

A further analysis is performed regarding other factors potentially explaining the increase in the airports' individual efficiency when including fixed effects. These are related to the airports' specific environment.

[7] This result is initially supported since there are two cargo-oriented airports: Vitoria and Zaragoza.
[8] Commercial revenues are significant in the first model ($\beta_4 = -0.1137$), but not in the fixed effects model. The iteration between commercial revenues and passengers is significant in both models with a significant effect in the second one ($\beta_{45} = -0.1137$)

	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	½LnCommercial²	0.0435*	0.0619*
β'_6	½LnATM²	0.0381	0.1034[1]
β'_7	½LnCargo²	-0.0062[1]	0.0006
β'_1	½LnOperating²	0.0105	0.0754
β'_2	½LnDepreciation Airside²	-0.0014	-0.0012
β'_3	½LnDepreciation Landside²	-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_{57}	½LnPAX·LnCargo	0.0197	0.0029
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

Table 4: Translog distance function (Battese and Coelli, 1992) *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 $P > |z| = 0.117$; ½LnDepreciationLandside² $P > |z| = 0.218$; 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 $P > |z| = 0.177$

The average of the individual technical efficiencies for both models follow,

	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

Table 5: Average Technical Efficiency Airports 2009-2013 (Battese and Coelli, 1992)

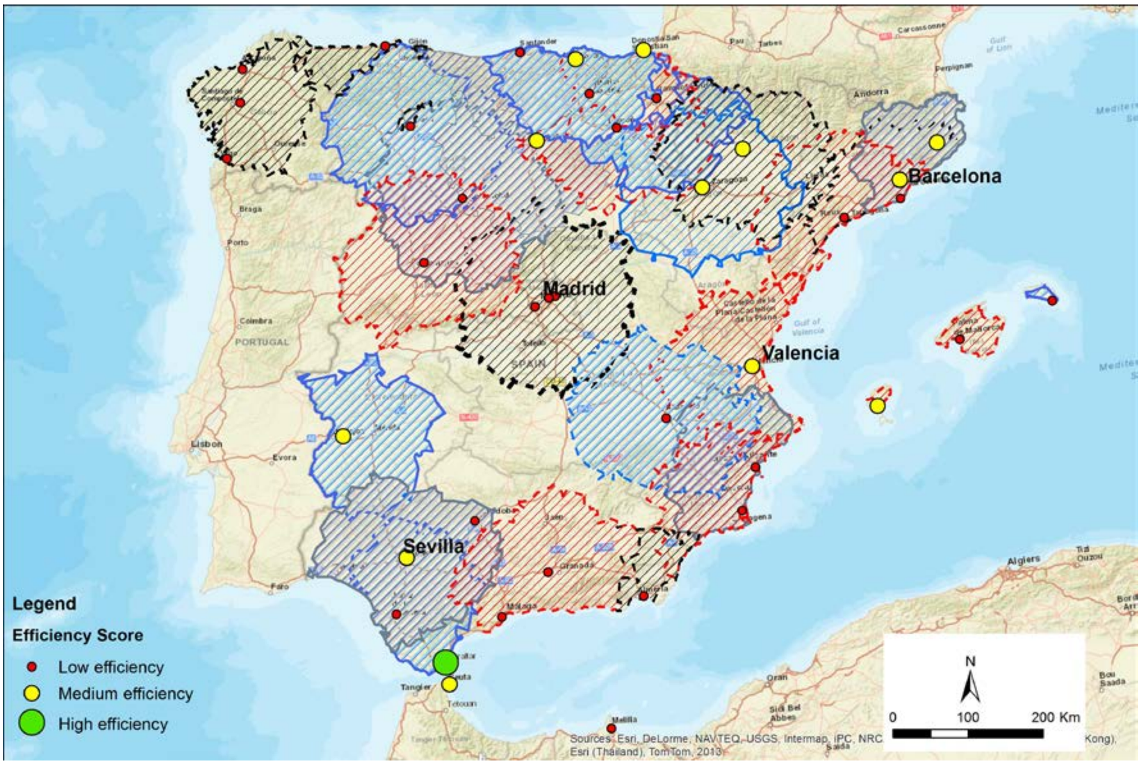

Figure 2: Average Technical Efficiency Mainland (SFA_1)

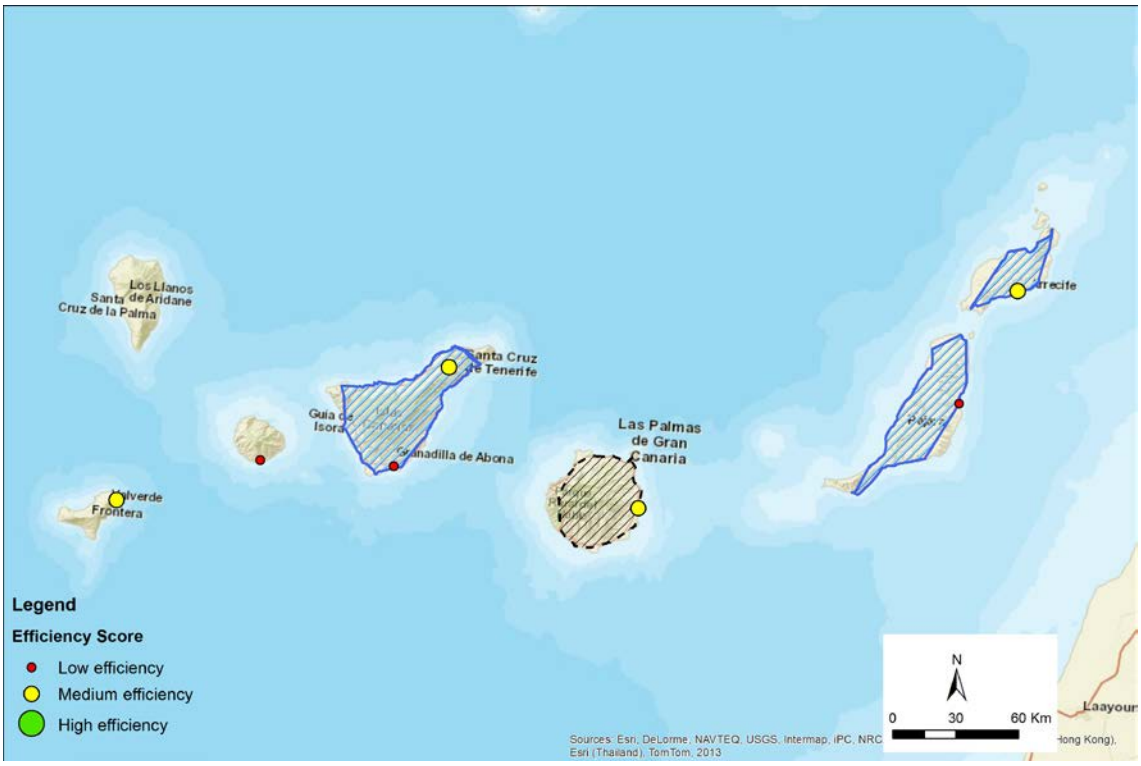

Figure 3: Average Technical Efficiency Islands (SFA_1)

Second-step estimation

Table 6 reports the estimates of the three regression models with the technical efficiency as dependent variable obtained from the SFA model including fixed effects. The first column presents the results for the total sample (i.e. without considering the airports' geographical location). The second and third column differ airports located in areas perceived as touristic and no-touristic.

To divide airports into those located in a touristic (non-touristic) area we use the well-known tourism specialization index[9]. A touristic area is considered if the tourism specialization index is higher than 0.40, indicating substantial tourism[10]. Only seven airports have a tourism specialization index over 0.40 and these are mainly located in coastal areas[11]. Examples of these airports are Girona, Alicante and Ibiza with a potential season effect.

Variable	**Total**	**Touristic Area**	**No-Touristic Area**
Hotels	0.101**	1.708**	-0.060
Camp Sites	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	0.84	0.28
Observations	189	32	157

Table 6: Results Estimated Models

[9] The tourism specialization index is the second homes per first home ratio, which measures the concentration of non-principal homes.
[10] The value of the tourism specialization index equal to the unity indicates a touristic area. Nevertheless this threshold was established using municipality data (Juaneda et al., 2011). As we have province data (an aggregation of various municipalities), we have relaxed this threshold.
[11] Similar results were obtained using coastal locations instead of the specialization index. The only difference is the insignificant effect for the apartments.

When there is no distinction between areas, the number of hotels and the length of the stay are the only variables affecting the airports' efficiency levels. A higher number of hotels increase airports' efficiency in 10% while a higher length diminishes them in -2.9%. Cities with a higher number of hotels are usually cities nearby an airport, enhancing more visitors compared to other locations with a relatively fewer number of hotels, but other type of accommodation (i.e. campsites). 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 larger number of tourists. The presence of low cost carriers helps airports attracting more passengers, but due to their lower fares (Windle and Dresner, 1999) and other aspects such as passenger friendly attitude (Heskett and Schlesinger, 1994; Gillen and Lall, 2004). 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 applying commercial policies (price and quality of the services provided) to make airports attractive to airlines and passengers. AENA applies a fully centralized management even deciding airports' charges. Apart from air fares, the other airport choice determinants are accessibility and flight frequencies (Windle and Dresner, 1995; Pels et al., 2003; Hess and Polak, 2006; Suzuki, 2007; Ishii et al., 2009). Again, these are managerial decisions under the Spanish government control. Consequently, it is not the airport that attracts passengers by providing a better service or price, but the area where the airport is geographically located. This is also confirmed by the existence of several geographical areas with more than one airport and variability of size and very low traffic. Finally, in 2011 and 2012 the technical efficiency decreased in 7.3% and 13.3% respectively. The highest significant decrease in efficiency happens from 2011 to 2012 (-6%).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. Additionally, previous findings highlighting the relevance of airports' efficiency in terms of passengers during 2010 and 2011 due to the financial crisis (Ripoll-Zarraga et al., 2017)

The results show that for touristic areas, the type of accommodation is a relevant factor affecting airports' technical efficiency. 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 1,000 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 camp site per 1,000 inhabitants reduces the efficiency score in 257%. The apartments also reduce the efficiency of the airports in touristic areas, but with lower impact (-2.5%). The role of type of accommodation (i.e. international hotel chains) and popular tourists' destinations are (among others) key factors to choose the travel destination product (Mo et al., 1993).

Every incoming tourist increases slightly the efficiency (0.01%) and for each euro spent the efficiency increases in just 0.3% These results suggest that the Spanish airports do not benefit from the number of passengers (tourist arrivals) and the tourists' purchases, unless these take place within the airports' premises (commercial revenues). In the same way, the fact that a passenger stays one additional day at the destination decreases the efficiency in 13%. These findings confirm that tourists use alternative travel modals to arrive at the destination. With this regard, tourists visiting Spain do not choose the destination based on for example, lower air fares or availability of LCCs as suggested in literature, but other external factors are prioritized (tourism variables) It is demonstrated that differential pricing could attract LCCs to airports (Barrett, 2004; Gillen and Lall, 2004). Consequently, airports could benefit of increasing their passengers even above of the forecast levels settled a priori (Cho et al., 2015). Nevertheless as previously discussed, AENA's centralized management makes marketing strategies and airport differentiation unable for the Spanish airports' managers. In non-touristic areas none of these variables are significant suggesting that a popular tourist destination is a key factor for travelers to decide the airport destination (Gunn, 1988). In touristic areas the higher number of camp sites versus hotels the more negative impact in the airports' efficiency located nearby.

The trend shows a lower decrease in efficiency during the crisis period (1% in 2011 compared to 8% in 2012). For non-touristic areas, no significant effects apart from the trend are observed with a higher decrease in inefficiency compared to touristic areas (-7.8% in 2011 and 14.1% in 2012). Due to the financial crisis although airports have fewer passengers, visitors continue travelling to popular touristic destinations.

The results show that tourism variables do not affect airports' efficiency in areas perceived as non-touristic. Airports located in unpopular destinations are unfairly labelled of inefficient from a pure technical efficiency perspective. This is based on the airports' resources (labour; operating costs incurred and depreciation of infrastructure) in relation with the income generated (passengers; movements; cargo and commercial revenues). 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 and Woodside 1986). On this basis they may choose a different destination or even the same visited city, but using a different transport modal. Consequently, some airports suffer from 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 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. In the first stage the results show the passengers and movements as main explanatory factors of the airports' technical efficiency, and with less relevance cargo. Commercial revenues become a significant source of income with more relevance with 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 help the financing aspect of the system and also the airports located closed to the seaside. Nevertheless, not all the inefficiency is due to decisions in inputs (airports' resources) and outputs (traffic). 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 provide different products and services (i.e. to differentiate on the quality of the service provided and price). This is only possible if managers are granted with flexibility to decide commercial policies rather than being decided centralized 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 low cost carriers (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. in terms of current inputs and outputs). 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 the destination first and secondly the travel modal (airport). 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, 2016; food and beverage, Del Chiappa et al., 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 camp sites or apartments. Cities having camp sites are reached by alternative travel modals such as roads and railways. Consequently, airports are more technically inefficient in these latest cities. Airports located in touristic areas are clearly more sensitive to the decisions made by potential visitors in terms of type of accommodation; number of staying days 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 clearly an essential part of the destination product becoming a driver of airports' efficiency in touristic areas.

The results conclude that the inefficiency of airports located in no-touristic areas is mainly caused by the 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 these airports may be treated unfairly 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 travel modals. Nevertheless, the fact that airports do not compete does not help these smallest airports increasing and attracting traffic. It is essential to consider airports' impact in local economies: as drivers of regional development and economic growth. It is required to enhance competition between airports located in the same geographic areas, but essentially when airports are not located in popular tourist destinations since visitors help the efficiency and financial aspect of the airports.

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