J Regul Econ
DOI 10.1007/s11149-009-9110-7

ORIGINAL ARTICLE

Privatization, regulation and airport pricing: an empirical analysis for Europe

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Abstract This paper examines factors determining airport charges. Using data for 100 large airports in Europe, we find that they charge higher prices when they move more passengers. Additionally, competition from other transport modes and nearby airports imposes some discipline on the pricing behavior of airports. Low-cost carriers and airlines with a high market share seem to have a stronger countervailing power. We also find that private airports not regulated charge higher prices than public or regulated airports. Finally, the regulation mechanism does not seem to influence substantially the level of airport charges.

Keywords Privatization · Regulation · Pricing · Air transportation · Airports

JEL Classification L33 · L43 · L93

1 Introduction

Airport management is undergoing a major reform process in many countries. Indeed, the privatization of management companies, the changes associated with price regulation and the competition between airports in the same geographical area are all very

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Published online: 10 November 2009

much the current object of discussion. The growing economic importance of airports, the intensity of competition between airlines and the budget restrictions imposed by governments on infrastructure investment explain, to great extent, the reform initiatives in airport policies.

Against this background particular attention should be given to the potential market power of airport operators, bearing in mind that the extent to which they choose to exploit their market power will depend on the specific characteristics of each airport (Starkie 2002; Gillen 2008). Thus, it is to be expected that airports with the heaviest volume of traffic (particularly if congested) will be most susceptible to fix high prices to the airline operators. Likewise, it is to be expected that those airports that serve as a hub for an airline network are more likely to fix high prices.

Furthermore, airports with a high volume of long distance traffic and those located on islands are less vulnerable to competition from other modes of transport such as roads or high speed trains. The absence of competition may also derive from the absence of any neighboring airports with a different management company. In such instances, it is more probable that the airport operator will exploit its market power.

Finally, privately managed airports will have greater incentives to fix higher prices than their publicly owned counterparts, although price regulation can always be used to restrict the behavior of the airport operator.

In this study we conduct an empirical analysis of the determinants of the prices charged by airports to the airlines using a sample comprising the 100 European airports with the highest volumes of air traffic.[1] The great diversity of airports making up this sample in terms of their ownership and regulation, the potential competition from other modes of transport and other airports, and the type of airlines that operate out of them, allows us to evaluate the impact of such factors as the volume and type of traffic, the distributive conflict between airlines and airports, competition, regulation mechanisms and private ownership in the absence of any regulation.

While many studies have analyzed the determinants of the prices that airlines charge passengers, there are virtually no empirical analyses looking at the factors influencing the prices that the airports charge the airlines. The only study to look at this issue, as far as we are aware, is that published by Van Dender (2007), which analyses the determinants of airport revenues for US airports. Our study seeks to contribute to this literature by examining the determinants of the prices charged by airports in a broad sample of European airports, whose institutional framework differs markedly from that which prevails in the US, especially as regards the relationship between airlines and airports. Of even greater relevance is the fact that, in addition to some similar variables previously employed by Van Dender (2007), our study comprehensively considers the influence on prices of factors related to the type of airlines that are predominant at the airport, regulation mechanisms and ownership structure.

Note that generally the elasticity of demand of the airlines to the prices that the airports charge has been considered to be very small, since the former have invested a large volume of sunk costs which prevents them from moving to other airports. However, and while a number of recent relevant studies question the fact that those

[1] The airports' revenue includes aeronautical charges as well as charges for concessions to exploit commercial activities within the terminal buildings. Here, we focus on aeronautical charges.

elasticities are so low (Fu et al. 2006; Van Dender 2007; Basso 2008), there can be no doubt as to the importance of the process of fixing the prices charged by the airports to the airlines. First, these prices greatly condition the volume of revenue of the airport operator. Second, these prices have an impact on the competition between airlines. According to the International Air Transport Association—IATA (2007), airlines and their users pay 42 billion dollars each year to the airports, which represent 11% of the global income of the airlines. Further, increases in the unit rate charged to users can have a direct impact on the levels of profitability of particular flight routes. Finally, the prices have an impact on investment decisions and, in general, on the level of congestion that an airport might suffer.

The remainder of the paper is structured as follows. In Sect. 2, we review the most recently published literature examining airport pricing and regulation. Then, we describe the data used in the empirical analysis. In Sects. 4 and 5, we describe the empirical model and the results of the estimation. The final section examines the main conclusions to be drawn from the study.

2 Market power and airport regulation

Airports have traditionally been managed by public firms or administrative bodies dependent on the public sector. Since the middle of the 1980s, countries in all regions of the world have privatized some of the airports handling the greatest volumes of traffic. Often (though not always) this privatization process has been accompanied by price regulation with varying degrees of strictness. The widespread use of public ownership or private ownership subject to regulation in the management of airports is in line with the idea that the airports might have market power, particularly as regards their aeronautical activities.

Here, it should be borne in mind that although an airport operator fixes high prices, this is not necessarily related to monopoly rents derived from operating in industries with falling average costs,[2] but rather it might be the result of scarcity rents derived from being located in geographical areas that are highly attractive and where there is little availability of land (Starkie 2001). In any case, the need to regulate aeronautical activities will be determined by the airport's capacity to charge high prices, and the extent to which these high prices are transferred to the airline company or to the passengers.

Various theoretical and empirical studies have analyzed the suitability of different methods for price regulation (i.e. price-caps or rate of return).[3] In general, it is believed that price-cap regulation acts as an incentive for cost reduction, although it is not entirely clear that it does not operate in detriment to the incentives appropriate

[2] Results on scale economies in airports are not unanimous. Gillen and Lall (1997) and Pels et al. (2003) find that airports operate under constant returns of scale regarding movements of planes, and under increasing returns to scale regarding movement of passengers. Economies of scale for passengers diminish as long as traffic volume increases and, eventually, decreasing returns of scale set in at large volumes of traffic. Instead, Bazargan and Vasigh (2003) find that diseconomies of scale characterize the airport sector.

[3] Gillen and Niemeier (2008) provide an excellent overview of the strengths and weaknesses of the various methods of regulation.

to invest in capacity. However, Starkie (2004) suggests that, in practice, there are not substantial differences between price-cap and rate of return regulation since price-caps usually take into account historic costs of the airport management company.

Here we should mention the debate concerning what the extent of airport regulation should be. The single-till approach, which regulates both aeronautical and non-aeronautical revenues, favors cross subsidies between the two types of sources of revenues. By contrast, the dual-till approach only regulates aeronautical activities, which are most susceptible to the exploitation of market power.

Several theoretical works show that the single-till approach may be optimal in non-congested airports (Czerny 2006; Lu and Pagliari 2004). However, the dual-till approach may have general advantages: It is focused on activities where the airport managers has effectively market power and do not limit the development of commercial activities in the airport site (Gillen and Niemeier 2008).

However, for the purposes of this article it is perhaps of greater pertinence to refer to the arguments that have been forwarded in defense of price deregulation, even in the case where the management company is controlled by a majority of private investors. Indeed, the management company may have incentives to fix prices below the monopoly level.

First, the airlines also have market power that can counter that of the airport manager (Brueckner 2002; Borenstein and Rose 2007). For this reason, we can expect conflicts of interests between airlines and airports as they seek to appropriate for themselves the monopoly rents at the moment of determining the price levels (for aeronautical activities) that are charged by the airport. It should be borne in mind that the negotiating power of the airline with the airport is closely associated to the airline's share of flights in that particular airport, to the complexity of its network of routes, and to the contribution of connecting passengers that the airline offers to the airport.

Second, the threat of re-regulation can in itself be an element of dissuasion. In Australia a program of deregulation was implemented at the beginning of the present decade using a system of monitoring that included the threat of re-regulation. According to Forsyth (2008), the threat of re-regulation has helped mitigate the potential exploitation of market power by the managers of the airports, which are in the majority controlled by private investors.

Finally, the airport operators can have incentives to charge lower prices to attract more traffic, since the greater the number of passengers they attract the greater will be the volume of revenue associated with the commercial activities offered in the airport terminal (Starkie 2001).

It is at congested airports where it is most likely that the manager can make use of his market power, and some kind of regulation might therefore be especially necessary in congested airports. Basso (2008) presents a theoretical model in which he shows that deregulation can lead to congested private airports fixing higher prices, while it is unclear as to whether they have greater incentives than a regulated airport to invest in their capacity to alleviate this congestion.

Likewise, Fu et al. (2006) forward arguments in favor of a certain degree of regulation, since airport charges can have a marked impact on competition between airlines. Fu et al. analyze the effects of an increase in the prices that the airports charge the airlines in a context where low cost airlines compete against network airlines. The results of their analysis show that the effect is much more prejudicial for the former, which reduce their prices and quantities more. Finally, Oum et al. (2004) provide another argument in favor of regulation: Their empirical analysis shows that price-cap regulation (with a dual-till approach) is a more adequate scenario in comparison to deregulation for the incentives in setting prices, investments and cost reductions.

In short, several studies present arguments for identifying the extent to which an airport has market power and the extent to which it is necessary to regulate prices. But the sole study to analyze empirically pricing determinants is that undertaken by Van Dender (2007), who examines the determinants of airport revenues for a sample of 55 large US airports between 1998 and 2002. Among the explanatory variables, he includes the degree of competition between airlines, the hub-status of some of the airports for some of the large airlines, the share of international traffic, competition from nearby airports and, finally, the existence of restrictions in the allocation of new slots.

Van Dender (2007) finds evidence to suggest that the revenues from aeronautical activities are lower when there is potential competition between airports in the same geographical area, and that they are greater when there are constraints on the allocation of new slots. Moreover, a greater concentration among airlines implies higher prices for the aeronautical activities, which according to Van Dender can be explained by the appropriation by the airport of part of the extraordinary rents that the airlines obtain with their market power. The revenues from aeronautical activities fall as the number of flights operated at the airport increases, while they rise with an increase in the share of international traffic. Thus, international passengers entail both higher costs and higher revenues, while the negative relation between traffic and prices can be explained by the exploitation of scale economies by the airports with the highest volumes of traffic.

However, it should be borne in mind that Van Dender's study refers to the US where the airport operators adhere to very different regulations to those in place in other countries. In the US, the airlines play a key role in the management and financing of airport installations, which means that the charges they have to pay to the airports are fixed according to the conditions established in the contract signed between the two parties. In most countries, the airports are much less influenced by the airline companies when it comes to fixing the operational charges for their installations; if at all, the limits are imposed by the corresponding public authority.

3 Data

The empirical analysis is applied to European airports that generate a high volume of traffic: the sample comprises the 100 airports in the European Union, Switzerland and Norway with most passenger traffic in 2007. It is a fairly homogeneous area in economic terms and it is an area for which the information required for a study of this nature is available. Table A1 in the Appendix lists the airports used in this empirical analysis.

The two main aeronautical charges paid by airline companies are landing fees for the use the airplanes make of the airfield's installations, and charges for the use the passengers make of the terminal building. The sum charged for landing fees is usually based on a unit ratio relative to the plane's maximum take-off weight, while the sum charged for using the terminal building depends on whether the flight is a domestic, from within or outside the European Union.

The data gathered include the different rates that airports charge the airlines based on information provided by http://Airportcharges.com for 2008. The prices used have been fixed with reference to an A-320 aircraft with an occupancy factor of 70% (105 passengers). The price is for the whole A-320 but we can argue that we are dealing with rates per passenger since a constant occupancy factor is assumed. Our price variable includes the following charges: landing fees, rights to approach and park aircraft, charges for using the terminal, noise and safety surcharges (where applicable). In general, the prices for domestic and EU traffic are identical or very similar, while those for international traffic are higher.

Total traffic data and by geographical area (domestic, intra-EU, international) up to 2007 are available on the Eurostat web page, while market share data for the airlines that operate at the respective airports for 2007 are taken from information supplied by the Official Airlines Guide (OAG).

We also use data describing the economic and demographic characteristics of the geographical areas in which the airports are located, including population, GDP per capita, and intensity of tourism. The region of reference is understood to be the geographical area equivalent to the statistical definition used by Eurostat of NUTS 2. The information source here is the *European Regional Prospects* database, published by Cambridge Econometrics. The NUTS classification divides up the economic territory of the Member States. The objective is to harmonize the statistical system of geographical areas across European Union countries. Hence, NUTS 2 should refer to areas with a range of population between 800,000 and 3,000,000 inhabitants. In practice, the statistical territorial units are defined in terms of the existing administrative units in the Member States and do not necessarily meet that population range. For example, NUTS 2 are "Regierungsbezirke" in Germany, "Comunidades Autónomas" in Spain, "Régions" in France, or "Provincies" in Netherlands.

Finally, we gathered information about the ownership structure of the management companies at all the airports, and of the main characteristics of the price regulation practiced. The sources of information regarding ownership and regulation were the web pages of the airports and the civil aviation authorities and the following studies: Oum et al. (2004), Cunha Marques and Brochado (2008) and Gillen and Niemeier (2008).

Of the 100 airports in the sample, 26 are managed by companies in which the majority share is held by a private firm, and in 11 of these the management company is partially controlled by private investors. Moreover, 26 of the airports are not subject to any economic regulation, including among this number several airports that are fully or partially controlled by private firms.

Concerning regulated airports, rate of return regulation with a single-till approach is the most common regulation mechanism. Price-caps with a single-till approach are implemented in Budapest, Dublin, Gatwick, Heathrow, Manchester (until recently), Stockholm, Stansted and Vienna, while price-caps are also applied in Copenhagen, Frankfurt, Hamburg, and Malta with a dual-till approach.

Table 1 Data about prices, traffic and competition in sample airports

Country	Total number airports	Mean traffic (000 passengers)	Variation coef. traffic	Mean prices (Euro)	Variation coef. prices	Num airp. with at least other nearby airport
Total	100	11,648	1.11	2,076	0.37	39
United Kingdom	17	13,312	1.26	2,821	0.31	15
Spain	16	11,798	1.13	1,451	0.02	0
Italy	14	7,798	1.04	1,299	0.12	8
Germany	11	15,791	0.97	2,110	0.29	3
France	8	15,297	1.27	2,207	0.19	5
Norway	4	7,572	1.01	2,344	0	0
Greece	4	7,439	0.82	1,703	0.40	0
Ireland	3	10,000	1.15	1,838	0.02	1
Switzerland	3	11,686	0.75	2,496	0.33	3
Portugal	3	7,575	0.69	2,181	0.02	0
Poland	2	6,182	0.71	2,524	0.22	0
Sweden	2	11,215	0.86	2,051	0.08	0
Belgium	2	10,188	1.08	1,722	1.05	2

Note: In this table, we are just considering countries with more than one airport in the sample. In Greece, all airports charge the same price except in the case of Athens where prices are much higher. In Norway, there are no differences in prices when considering national and European traffic but prices are lower for Oslo when considering traffic to other continents
Source: http://Airportcharges.com and Eurostat

There is a general consensus in the literature that price fixing at each airport should be undertaken on an individual basis (Starkie 2004; Gillen 2008; Gillen and Niemeier 2008). But cases still occur where price-fixing systems are used, so that several airports with markedly distinct characteristics charge airlines the same prices. From the sample of airports analyzed in this study, this system approach is used in Spain, Greece (except Athens), and Norway.

Table 1 shows the country variation in traffic and prices. It can be seen that in the United Kingdom, Germany, and to a lesser extent in France, there is a large difference in prices between airports, even though their prices are higher than the EU average. This suggest that differences in market conditions at the airports might be more clearly reflected in these countries, a feature which is captured, albeit somewhat approximately, in the table by the variations in traffic. By contrast, in Italy and especially in Spain, the very small variations in prices between airports do not correspond to the heterogeneity that exists between these airports, which in addition to the traffic includes other aspects such as the type of airlines that operate there and the dominant traffic type (business, tourism).

Table 1 also offers information about potential competition between airports located in nearby zones. In this regard, note the case of the United Kingdom where most of airports have to face potential competition from other airports located in nearby zones. By contrast, none of the airports in Spain faces competition from other airports located

Table 2 Data for the sample airports according to the dominant airline

Dominant airline	Number airports	Traffic (000 passengers)	Mean price (Euros)	Share dominant airline	HHI	Share airlines in alliances
Ryanair	10	7,752	1,394	0.66	0.53	0.07
easyJet	9	6,486	2,636	0.42	0.27	0.18
Iberia	9	14,315	1,455	0.46	0.28	0.64
Lufthansa	9	17,426	2,279	0.38	0.21	0.62
Air France	8	19,981	2,378	0.61	0.40	0.77
SAS	7	10,588	2,278	0.45	0.27	0.58
British Airways	6	25,519	2,568	0.32	0.16	0.53
Alitalia	4	16,544	1,308	0.39	0.23	0.53
Binter Canarias	4	5,945	1,459	0.42	0.22	0.13
Olympic Airlines	3	8,529	1,816	0.51	0.38	0.06
TAP	2	8,655	2,187	0.40	0.25	0.57
Air One	2	4,200	1,247	0.24	0.14	0.31
LOT	2	6,182	2,524	0.44	0.27	0.67
Meridiana	2	2,830	1,161	0.40	0.27	0.23
Other Airlines	22	8,002	2,351	0.37	0.23	0.36

Note: Data about traffic, prices, and airlines share make reference to the mean value for the corresponding sub-sample of routes
Source: Eurostat, http://Airportcharges.com, OAG

in nearby zones due to their integrated management In Italy and France, several airports are exposed to potential competition from nearby airports, while in Germany few airports faces any potential competition from other airports.

In the context of the debate regarding the relative market power of the airports and airlines, it is interesting to refer to data describing the market structure of the 100 airports in the sample in terms of the volume of traffic of the various airlines that operate out of them. Thus, Table 2 shows that two low cost airlines, Ryanair and easyJet, are dominant in the greatest number of airports included in the sample. Ryanair, which is the only airline in the sample that dominates airports in more than one country, appears to enjoy considerable negotiating capacity with the airports, given that the prices fixed for the company are much lower than in the majority of the airports in the sample.[4] Exposure to the competition of the low cost airlines is particularly important in the case of British Airways and Alitalia. Several airports in their respective countries of origin are controlled by low cost airlines, and in which they are leaders, the share of traffic controlled by airlines integrated in alliances is less than in that of other network airlines.

[4] This might also be influenced by the fact that Ryanair is usually based in regional airports with a small amount of traffic.

4 The empirical model

In this section, we estimate the determinants of the prices charged by the airports to the airlines. Particular attention is given to questions concerning market power. Indeed, it is expected that the greater an airport's market power, the higher the prices that airport will charge those airlines that operate from its installations. Thus, we estimate the following pricing equation charged by airport a to the airlines that operate from its installations:

$$\begin{aligned} PR_a = \alpha &+ \beta_1 Total\_Traffic_a + \beta_2 \%National\_Traffic_a \\ &+\beta_3 Number\_nearby\_airports_a + \beta_4 HHI_a + \beta_5 \%Airline\_alliance\_traffic \\ &+\beta_6 Private\_Non\text{-}Regulated_a + \beta_7 \mathrm{D}_a^{\mathrm{island}} + \beta_8 \mathrm{D}_a^{\mathrm{system}} + \varepsilon \end{aligned} \tag{1}$$

where the variable to be determined are the prices charged by the airports to airlines for traffic within the EU, PR_a. European Union traffic is used as the reference, since prices for domestic and EU traffic are generally identical or very similar, while in most of the airports in the sample there are no flights involving traffic from outside the EU, or where there are its volume is very low. Furthermore, the A-320 aircraft is typically used on medium-distance routes. However, our results remain unaltered when taking domestic traffic as reference. The explanatory variables in Eq. 1 are:

(1) The airport's total volume of traffic, $Total\_Traffic_a$. The coefficient associated with this variable is expected to present a positive sign. In other words, the greater the volume of traffic is, the higher the prices that will be charged by the corresponding airport. Here, higher prices may refer either to the greater monopoly or the scarcity rents. However, the effect in terms of costs of the number of passengers channeled from the corresponding airport is unknown. These costs will depend on the degree of use of the airport's capacity.[5] If this use is high, the airport can exploit the scale economies derived from the sharing of fixed costs among a greater number of output units. But, in turn, a high use of its capacity can also give rise to higher costs due to greater congestion.

Note that we can expect a simultaneous determination of the price and demand levels of an airport. Therefore, in order to avoid the problem of endogeneity in the estimation of the pricing equation, we need to include demand instruments within this estimation. As instruments, we use the following variables: the market potential of the region of reference of the airport (NUTS 2) which is constructed as the sum of the GDP of all the regions of all the airports in the sample (a') weighted by the distance to the region of airport a: $\sum \mathrm{PIB}_{a'}/\mathrm{Dist}_{aa'}$. We also include as instruments income per capita and the population of the region of reference and, finally, the rate of employment in hotels and restaurants as a percentage of overall employment in the region in which the airport is located as an indicator of the intensity of tourism there.

[5] Gillen and Lall (1997) claim that we should speak of density economies rather than of economies of scale in relation to the airports' cost structures. Thus, the airports operate in an environment of economies of density that are derived from the greater use of indivisible assets. By contrast, doubling the number of runways will not necessarily reduce average costs, while doubling the number of terminals can even mean falling returns due to the increased complexity involved in their management.

(2) Domestic traffic as a percentage of the airport's total traffic, *%National_Traffic*$_a$. The coefficient associated with this variable is expected to present a negative sign, since the greater the proportion of domestic traffic, the lower the airport's market power should be, owing to greater competition from other modes of transport. Furthermore, the airport policy might favor lower prices should the importance of domestic traffic be relatively higher.[6]

(3) The number of airports that lie fewer than 100 km from airport a, and which are managed by different operators, $Number\_nearby\_airports_a$. We only consider airports with passenger traffic greater than 150,000 individuals. This traffic threshold is the same as that used by Eurostat for differentiating between main and small commercial airports. The coefficient associated with this variable is expected to present a negative sign, since the higher the number of nearby airports with commercial traffic, the lower will be the airport's market power due to possible competition among airports seeking to attract the traffic that a shared geographical area generates.

(4) The Hirschman-Herfindalh index of concentration at the airport in terms of the number of flights offered by the airlines operating out of it, *HHI*$_a$. The greater the concentration among the airlines that operate out of the airport, the lower the market power that airport should have, because the airlines with the greatest market share will enjoy greater negotiating power.

(5) The percentage of traffic channeled by the airlines integrated within intercontinental airline alliances; Oneworld, Star Alliance and SkyTeam, *%Airline_alliance_traffic*$_a$. The coefficient associated with this variable is expected to present a positive sign, given that the network airlines should have a lower capacity to negotiate than the low cost airlines. The network airlines channel their traffic by exploiting connecting traffic, which involves a complex structuring of routes and a heavy dependence on its *hub* airports.[7] It is more expensive and difficult for the network airlines than it is for the low cost airlines to make significant changes in the airports that they use as the base of their operations. Low cost airlines, with their simpler point to point route structures as opposed to hub-and-spoke network of routes, have a greater margin to delocalize their operations to other airports.

(6) A variable that is the result of the interaction between the percentage of private property owned by the management company and a dummy variable that takes a value of 1 for those airports not subject to regulation, *Private_Non-regulated*. As such, this variable takes a value of 0 for airports managed by public firms or by private firms subject to regulation, while it takes a value equivalent to the percentage of the firm's capital that is in the hands of private firms in the case of private airports free of regulation.

The coefficient associated with this variable is expected to present a positive sign, so that the higher the percentage of private property of management companies not

6 Bel and Fageda (2009) report evidence of airport investment policies that include cross subsidies from international users to domestic users.

7 However, and for airports with a high volume of traffic channeled by airlines integrated in alliances, the greater the share of connecting traffic (that is, traffic whose final destination is not the airport in question) the greater the airline's negotiating power. The lack of data on connecting traffic, however, prevents us from testing this hypothesis.

subject to regulation the higher the prices charged by the airport. Indeed, the typical behavior of private firms is to maximize profits, while that of public firms or institutions is guided more by social and political objectives. Therefore, prices can be expected to be higher in airports controlled by private investors if they are not subject to any regulation, although it is not clear whether this is prejudicial to the airlines, to the passengers or to both.

(7) A dummy variable for airports with an island location, D^{island}. The coefficient associated with this variable is expected to present a positive sign, since the market power of airports located on islands should be high because of the fewer opportunities for intermodal competition. An additional explanation of higher charges for airports located on islands could be higher costs due to a more expensive supply of fuel.

(8) A dummy variable for airports in countries that operate a price-fixing system, D^{system}. Such countries are considered as being those that operate a centralized management system in which the airports charge identical prices; Spain—based on three traffic categories, Greece—except Athens, and Norway. In these countries, price fixing by each individual airport might be distorted, but it is not clear what the sign of the coefficient associated with this variable should be, nor whether this variable should be significant. Indeed, the prices in some of these airports controlled by a system of this kind can be higher than those that would be applied in an individual pricing scheme while in other airports in the system they might be lower.

It should be pointed out that the differences in the institutional and regulatory policy frameworks of the airports in the various countries will influence the results of the empirical analysis. For example, in countries such as Spain and Greece, various airports charge the same prices even though their characteristics might be very different in terms of their geographical location, type of traffic and the airlines that operate there, etc. This could distort the testing of some of the hypotheses stated. Moreover, the extraordinary economic and social importance of the airports located on islands means there is a need to consider the significant differences that might exist between the decision-taking procedures of airport management companies in continental Europe with respect to those located on islands.

Therefore, we performed three estimations of Eq. 1 based on the sample of airports considered here. First, we estimated the pricing equation by taking into consideration all the airports in the sample. Second, we estimated the equation excluding the airports from the same country that charged the same prices (Spain—according to three categories of traffic, Greece –except Athens, and Norway). Finally, we estimated the pricing equation excluding both those airports in countries that adhere to a price-fixing system and those airports located on islands. Note that this last estimation allows us to consider the most homogenous sample of airports possible, namely the airports of continental Europe where price fixing is carried out independently of all the other airports in the country.

In addition to this, we also estimate the following pricing equation just for regulated airports (and also excluding airports from countries with a price-fixing system):

$$\begin{aligned} PR_a = \alpha &+ \beta_1 Total\_Traffic_a + \beta_2 \%National\_Traffic_a \\ &+ \beta_3 Number\_nearby\_airports_a + \beta_4 HHI_a + \beta_5 \%Airline\_alliance\_traffic \\ &+ \beta_6 \mathrm{D}_a^{\mathrm{island}} + \beta_7 \mathrm{D}^{\mathrm{pricecap}} + \beta_8 \mathrm{D}^{\mathrm{dualtill}} + \varepsilon \end{aligned} \quad (2)$$

In this equation, we add the sample explanatory variables as in Eq. 1 except the dummy variable for airports in countries that operate a price-fixing system. And we add the following explanatory variables:

(1) A dummy variable for airports where prices are regulated by price-caps, $D^{pricecap}$. The relation between the regulation mechanism (price-caps or rate of return regulation) and prices is a priori ambiguous regardless of the incentives that these regulation mechanisms imply to reduce costs and invest in capacity. Note that price-caps in European airports are usually not pure because historical capital costs are taken into account. Hence, differences between price-cap regulation and rate-of-return regulation may be small in practice (Starkie 2004).

(2) A dummy variable for airports where prices are regulated with a dual-till approach, $D^{dualtill}$. We should expect that prices may be higher in airports subject to regulations following the dual-till approach because this approach does not allow cross-subsidization between aeronautical and non-aeronautical revenues.

This latter estimation will allow us to measure the influence of the different regulation mechanisms and the impact of several factors on market power in a context in which regulation should limit it.

5 Estimation and results

Table 3 shows the descriptive statistics of the variables used in the empirical analysis where the high degree of variability in all the variables that are continuous is evident. Table 4 shows the correlation matrix between variables.

The estimation was made using the estimator of Instrumental Variables (two-stage least squares regression—2SLS), which considers the possible endogeneity of the variable relative to total airport traffic to the extent that there might be a simultaneous determination of the price and demand variables. The instrument suitability tests, the partial R^2 of the first stage regression and Hansen's J test of the possible endogeneity

Table 3 Descriptive statistics of the continous variables used in the empirical analysis

Variable	Mean	Standard deviation	Minimum value	Maximum value
PR (Euros)	2076.40	760.12	441	4310.23
Total traffic (000 passengers)	11648.15	12937.78	2420.71	68279.36
%National_Traffic	0.31	0.24	0	0.95
Number_nearby_airports	0.67	1.005	0	5
HHI	0.28	0.17	0.07	0.93
%Traffic_airlines_alliances	0.43	0.28	0	0.90
Private_NoRegulated	0.13	0.33	0	1
Market potential (Euros)	103453	95619.58	9975	487957
GDP per capita (100 = EU27)	119.29	37.74	47	236
Tourism_Intensity (%)	0.06	0.04	0.01	0.21

Table 4 Matrix of correlations of the continous variables used in the empirical analysis

Variable	PR	Total Traffic	%National	Tourism Int.	Nearby airports	HHI	%Alliances	Priv	MP	GDPc
PR	1									
Total traffic	0.29	1								
%National_Traffic	−0.29	−0.22	1							
Tourism antensity	−0.20	−0.05	0.03	1						
Nearby airports	0.19	0.03	−0.18	−0.11	1					
HHI	−0.12	−0.09	−0.06	0.02	0.08	1				
%Traffic_alliances	0.24	0.42	0.14	−0.20	−0.20	−0.15	1			
Private_NoRegulated (Priv)	0.35	−0.13	0.006	0.04	0.41	0.11	−0.28	1		
Market potential (MP)	0.22	0.53	−0.05	−0.20	0.38	0.05	0.16	0.06	1	
GDP per capita (GDPc)	0.27	0.45	−0.20	−0.13	0.27	0.13	0.25	0.07	0.45	1

of the instruments show a high correlation between the variable of demand and the instruments and the exogeneity of the latter.

It is also necessary to bear in mind the common factors that might affect the airports in the same country. Therefore, the estimation takes into account the possible correlation between the standard errors of airports that belong to the same country by considering clusters for each country. Finally, the standard errors can be corrected for a possible problem of heteroscedasticity derived from a non-constant variance between very different observations.

Tables 5 and 6 show the results of the estimation that considers the determinants of the prices that the airports charge the airlines. The joint significance of the equation estimated is reasonable considering the high degree of heterogeneity of the airports making up the sample. In this regard, the R^2 is much higher in the estimation that excludes airports in countries that adhere to a price-fixing system and those airports located on islands. The sign of the coefficients of the explanatory variables is as expected although some of these coefficients are not statistically significant in all the estimations made.

We confirm that prices are higher in airports with the greatest volumes of traffic, be it because of their greater scarcity or monopoly rents, or their higher costs. However, the total traffic variable is no longer significant in the estimation that excludes airports in countries that adhere to a price-fixing system as well as those located on islands.

Table 5 Estimates of the pricing equation (IV-2SLS)

Explanatory variable: PR	All sample	We exclude airports with a system approach	We exclude airports with a system approach and islands
Total_Traffic	0.013 (0.005)***	0.012 (0.004)***	0.008 (0.006)
%National_Traffic	−777.97 (381.66)**	−1210.39 (298.35)***	−1181.51 (344.38)***
Number_nearby_airports	−42.00 (37.55)	−61.89 (40.13)	−137.96 (65.41)**
HHI	−479.49 (415.87)	−692.40 (494.92)	−902.29 (530.29)*
%Traffic_airlines_alliances	869.84 (310.50)***	1123.92 (317.23)***	1432.95 (202.70)***
Private_NoRegulated	10.87 (1.74)***	10.40 (1.06)***	13.66 (2.40)***
D^{island}	134.45 (135.91)	357.36 (93.90)***	–
D^{System}	−284.67 (286.19)	–	–
Intercept	1828.45 (180.33)***	1871.49 (215.25)***	1853.54 (218.09)***
N	100	77	55
R^2	0.44	0.47	0.58
F (Joint significance)	77.64***	59.51***	86.06***
Tests of instruments			
R^2 parcial	0.39	0.43	0.54
Hansen J	3.44	2.85	1.78

Note: Standard errors in parenthesis (robust to heteroscedasticity and adjusted for correlation between airports of a same country). Statistical significance at 1% (***), 5% (**), 10% (*). Instruments for the demand variable (Total_Traffic) are the following: Market potential, GDP per capita, population and tourism intensity

Table 6 Elasticities evaluated at sample means

Dependent variable: PR	All sample	We exclude airports with a system approach	We exclude airports with a system approach and islands
Total_Traffic	0.08***	0.07***	0.04
%National_Traffic	−0.12**	−0.14***	−0.14***
Number_nearby_airports	−0.01	−0.03	−0.04**
HHI	−0.07	−0.09	−0.12*
%Traffic_airlines_alliances	0.18***	0.22***	0.35***
Private_NoRegulated	0.07***	0.08***	0.02***
D^{island}	0.02	−0.05***	–
D^{System}	−0.03	–	–

The lack of data concerning flight delays and the capacity available at the airports under consideration means we are unable to define better the relation between prices, monopoly rents and congestion levels. However, the positive effects on prices derived from the higher monopoly rents or from the greater costs due to congestion are more significant than the negative effects that might be derived from a better exploitation of the scale economies. This result contrasts with that reported by Van Dender (2007) for a sample of large US airports where he found evidence of a negative relation between prices and traffic.

The share of domestic traffic has a negative influence on the prices charged by the airports and its effect is statistically significant in the three estimations performed. Likewise, the dummy variable for airports located on islands is positive and statistically significant in the estimation that excludes airports operating a price-fixing system. We can therefore confirm that the possible competition from other modes of transport has an impact on the capacity of the airports to fix high prices. In turn, airport policy may favor lower prices in those cases where the percentage of travelers resident in the country is high.

The number of nearby airports has a negative influence on the prices charged by the airports but its effect is only statistically significant in the estimation that excludes airports that adhere to a price-fixing system and those located on islands. Therefore, we find some evidence that the competition derived from the presence of other nearby airports has a negative influence and one that is statistically significant on the prices fixed by airports in the countries of continental Europe that fix their prices individually.

In the case of variables related to the characteristics of the airlines, their negotiating capacity seems to be determined by the type of airline that is predominant at the airport as well as by the levels of concentration. Indeed, the low cost airlines seem to have a greater negotiating capacity than the airlines integrated in alliances and this effect is statistically significant in all three estimations. Moreover, greater levels of concentration seem to be associated with lower prices (in contrast with the findings reported by Van Dender 2007) and, therefore, with a greater airline negotiating capacity with higher market shares. Note that this effect is only statistically significant in the estimation that considers airports in the countries of continental Europe that fix their prices on an individual basis. This might be explained by the greater homogeneity of this particular sample, since the economic impact of concentration is notable in all three estimations when we consider the elasticities evaluated according to the sample mean in Table 6.

Moreover, the prices are higher in the case of non-regulated airports with a greater percentage of private property. This does not necessarily imply the exploitation of market power but rather it can also indicate greater bargaining power on the part of the airports in their conflict with the airlines to obtain extraordinary rents.

Finally, the airports that adopt a price-fixing system appear to fix lower prices than the rest of the airports although the estimated effect is not statistically significant.

Tables 7 and 8 show the results of the estimation that also considers the influence of the different regulation mechanisms on airport charges. As we mention above, this estimation is made for regulated airport that set prices on an individualized basis. The overall explanatory power of this estimation is quite good.

Interestingly, it seems that the regulation mechanism does not influence substantially on the level of prices charged by airports. Neither the type of regulation mechanism (rate of return or price-cap regulation) nor the scope of regulation (single-till or dual-till) is a very relevant factor. What it seems to be relevant is whether some price

Table 7 Estimates of the pricing equation (IV-2SLS)

Explanatory variable: PR	We exclude airports with a system approach and airports no regulated
Total_Traffic	0.016 (0.0047)***
%National_Traffic	−909.75 (262.76)***
Num_nearby_airports	−78.71 (30.64)***
HHI	−899.68 (610.67)$^+$
%Traffic_airlines_alliances	1156.09 (233.56)***
D^{island}	198.05 (198.05)**
$D^{pricecap}$	−26.50 (244.14)
$D^{dualtill}$	136.25 (209.76)
Intercept	1714.78 (267.22)***
N	51
R^2	0.67
F (Joint significance)	31.82***
Instruments tests	
R^2 partial	0.53
Hansen J	1.74

Note: Standard errors in parenthesis (robust to heteroscedasticity and adjusted for correlation between airports of a same country). Statistical significance at 1% (***), 5% (**), 10% (*), 15% ($^+$). Instruments for the demand variable (Total_Traffic) are the following: Market potential, GDP per capita, population and tourism intensity

Table 8 Elasticities evaluated at sample means

Dependent variable: PR	Excluding system approach and airports no regulated
Total_Traffic	0.12***
%National_Traffic	−0.13***
Number_nearby_airports	−0.02**
HHI	−0.12+
%Traffic_airlines_alliances	0.28***
D^{island}	0.01*
$D^{pricecap}$	−0.003
$D^{dualtill}$	0.009

Statistical significance at 1% (***), 5% (**), 10%(*), 15%(+)

regulation is implemented or not. Note also that the sign of the coefficients of the rest of explanatory variables are the same as in previous estimation and most of them are statistically significant.

6 Concluding remarks

Our analysis contributes to this area of the literature by undertaking a study of the determinants of airport pricing in a broad sample of European airports. In addition to the variables employed by Van Dender (2007) for US airports, our study has also given comprehensive consideration to the influence on pricing of factors related to the predominant airline type at the airport, pricing regulation and to ownership structure.

Our empirical analysis suggests that airports with the highest volumes of traffic charge higher prices to airlines. There are two possible explanations for this result; higher extraordinary rents or higher overall costs. We are not able to identify which explanation is more relevant with our current dataset. This could be the subject of future research.

Moreover, the amount of domestic traffic as a proportion of total traffic has a negative influence on airport charges, since this traffic is more vulnerable to competition from other transport modes or to the fact that the country's airport policy might favor lower prices.

At the same time, island-based airports charge the airlines higher prices, which can be accounted for in terms of the fewer opportunities that exist for intermodal competition. An additional explanation of higher charges for island-based airports could be higher costs due to a more expensive supply of fuel.

We have also found some evidence to indicate that an airline's negotiating power with the airport is greater the larger the market share this airline enjoys at that particular airport. This negotiating capacity also seems to be greater for low cost airlines, in comparison to that enjoyed by network airlines, since prices are higher the greater the percentage of traffic that is channeled by airlines integrated in alliances.

The competition that might be exercised by other airports located in nearby areas and managed by different companies seems to discipline the behavior of the corresponding airport operator, while the airports controlled by private companies that are not subject to regulation fix higher prices than the airports managed by public firms or private firms subject to regulation.

The specific regulation mechanism adopted does not seem to influence the level of prices charged by airports. Indeed, neither the type of regulation mechanism (rate of return or price-cap regulation) nor the scope of regulation (single-till or dual-till) seems to be a very relevant factor in explaining airport charges. Note that price-caps in European airports usually take into account historical capital costs so that differences between price-cap and rate-of-return regulation may not be high in practice. Future research could examine more thoroughly differences in practice between the single-till versus dual-till approach.

Private sector participation seems set to increase in the next few years, given the pressure exercised by other agents on airport activity. Indeed, the airlines operate today in a highly competitive environment, and demand sufficient capacity from the airports at which they carry out most of their operations. And, often, governments face the need to finance significant investments in airports at a time of major budgetary restrictions.

Privatization grants greater importance to regulation to the extent that private managers might have greater incentives than public managers to set high prices. Our analysis suggests that this is particularly true in certain circumstances, which include the airports' potential to generate traffic, the competition that might be exercised by nearby airports and the degree of dependence on one or more airlines.

Nevertheless, the fixing of high prices by the airports is not necessarily prejudicial in terms of social welfare. Apart from the distributive conflict between airports and airlines, which will have a varying impact on passengers depending on the intensity of competition between airlines, high price fixing by airport operators can also help mitigate congestion problems be it by a rationing of demand or by providing incentives for investment in additional capacity. However, in certain circumstances, such high prices can be prejudicial to the extent that they represent the securing of extraordinary monopoly rents. Our analysis cannot distinguish between the two effects—the congestion effect and monopoly exploitation effect. Nonetheless, very few airports around Europe apply congestion charges so that the monopoly effect on high prices would likely have a more relevant role. Finding more evidence on that will be an issue for future research.

Acknowledgements We have benefited from financial support provided by the Spanish Ministry of Education (SEJ2006-04985), the Spanish Ministry of Science and Innovation (ECO2009-06946), and Fundación de Estudios de Economía Aplicada (FEDEA). We are grateful for comments and suggestions from Toni Brunet, Guillaume Burghouwt, Gustavo Nombela and Jaap de Wit. We have received as well useful comments and suggestions from two anonymous reviewers and the Editor

Appendix

See Table A1.

Table A1 Sample of airports used in the empirical analysis

Airport	Airport	Airport
Aberdeen (ABZ)	Gatwick (LGW)	Nuremberg (NUE)
Alicante (ALC)	Gran Canaria (LPA)	Oslo (OSL)
Arlanda (ARN)	Glasgow (GLA)	Palma de Mallorca (PMI)
Amsterdam (AMS)	Girona (GRO)	Palermo (PMO)
Athens (ATH)	Ginebra (GVA)	Paris-Charles de Gaulle (CDG)
Basel (BSL)	Gotheborg (GOT)	Paris-Orly (ORY)
Barcelona (BCN)	Hahn (HNN)	Porto (OPO)
Belfast (BFS)	Hamburg (HAM)	Praga (PRG)
Bergamo (BGY)	Hannover (HAJ)	Pisa (PSA)
Bergen (BGO)	Helsinki (HEL)	Prestwick (PIK)
Bilbao (BIO)	Heraklion (HER)	Rhodes (RHO)
Birmingham (BHX)	Ibiza (IBZ)	Riga (RIX)
Bologna (BLQ)	Lanzarote (ACE)	Schonefeld (SFX)
Budapest (BUD)	Larnaca (LCA)	Seville (SVQ)
Bucharest (OTP)	Leeds (LBA)	Shannon (SNN)
Bordeaux (BOD)	Linate (LIN)	Sofia (SOF)
Bristol (BRS)	Lisboa (LIS)	Stansted (STN)
Brussels (BRU)	London-Heathrow (LHR)	Stavanger (SVG)
Cagliari (CAG)	London City (LCY)	Stuttgart (STR)
Catania (CTA)	Liverpool (LPL)	Tegel (TXL)
Krakow (KRK)	Luton (LTN)	Tenerife North (TFN)
Copenhaguen (CPH)	Lyon (LYS)	Tenerife South (TFS)
Köln-Bonn (CGN)	Madrid (MAD)	Thessalonica (SKG)
Cork (ORK)	Málaga (AGP)	Tolouse (TLS)
Charleroi (CRL)	Malta (MLA)	Trondheim (TRD)
Ciampino (CIA)	Milan-Malpensa (MXP)	Turin (TRN)
Dublin (DUB)	Manchester (MAN)	Valencia (VLQ)
Dusseldorf (DUS)	Marsella (MRS)	Warsaw (WAW)
East Midlands (EMA)	Menorca (MAH)	Venice (VCE)
Edimburgh (EDI)	Munich (MUC)	Verona (VRN)
Faro (FAO)	Nantes (NTE)	Vienna (VIE)
Fiumicino (FCO)	Naples (NAP)	Zurich (ZRH)
Fuerteventura (FUE)	Newcastle (NCL)	
Frankfurt (FRA)	Nice (NCE)	

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