Public Service Obligations in the Airline Market:  

Lessons from the Spanish Case

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Abstract

We study the impact of the public service obligations applied in the Spanish airline market during the period 2001-09. Our analysis shows that routes benefiting of price discounts given to island residents exhibit higher prices but similar frequencies than the rest of routes. This can be explained by the effect of discounts on the demand elasticity, the airlines difficulties in acquiring new slots, and the high costs of increasing frequencies. Moreover, we show that price and frequency caps established in intraisland flights lead to lower prices and higher frequencies than in unregulated routes with similar characteristics.

Keywords: Air transportantion; Public Service Obligations; Price and Frequency Caps.

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1 Introduction

Competition has increased importantly in Europe in the last decades as a consequence of liberalization and the successful entry of low-cost carriers in many short-haul routes. However, thin and/or peripheral routes may not benefit of competition and their continuity could be at risk after the privatization of national airlines. Indeed, low-demand routes doesn’t enjoy of density economies and may require the establishment of very high prices.

The traditional way of dealing with this problem has been to subsidize the population leaving in peripheral communities and to establish public service obligations (PSOs) on the airlines exploiting certain routes. The objective of our paper is to analyze the effects on prices and frequencies of protected routes in the Spanish airline market during the period 2001-2009. In particular, we focuss the analysis on the effects of price discounts granted to island residents in domestic routes that have islands as endpoints and on the subsidies offered to airlines that provide intra-island routes and satisfy some price and frequency caps.

To our knowledge, this is the first empirical paper that analyzes the effects of PSOs in the European market. In the last decades, many European countries has set PSOs in domestic routes to regulate market access, prices and frequencies. Nevertheless, to the present date, any study has examined the effects of these regulations. Only Santana (2009) has shown that in the period 1991-2002 PSO have increased the cost of regional airlines in Europe, but not in the US.\footnote{Note that this study uses a completely different approach to ours. While it estimates the airline cost functions, we are mostly interested in the effects of public services obligations at the route level.}

The empirical literature has been quite prolific in analyzing the influence of market structure variables on airline prices at the route level. Some papers that cover this problem are, for example, Borestein (1989), Brander and Zhang (1990, 1993), Berry et. al(1996), Brueckner and Spiller (1994), Dresner et al. (1996, 2002), Evans and Kessides (1993), Fisher and Kamerschen (2003), Fageda (2006), Hofer et al. (2008), Marín (1995), Morrison (2001), Oum et al. (1993). These studies analyze how prices are influenced by features like route competition, airport dominance or the presence of low-cost carriers. However, only Starkie and
Starrs (1984) have considered the prices of thin routes in Australia, and Bitzan and Junkwood (2006) in the US.

The empirical literature about the determinants of airline frequencies includes the contributions by Bilotkach et al. (2009), Borenstein and Netz (1999), Pai (2009), Salvanes et al. (2005), Schipper et al. (2002) and Wei and Hansen (2007). These papers examine the effect of issues such as route distance or aircraft size on the frequencies offered. Most of these studies on prices and frequencies refer to the US due to the higher availability of data.

Our empirical approach is similar to those of the previous studies. We estimate pricing and frequency equations at the route level, focussing on the effects of PSOs. We find that airlines set higher prices in routes between the continent and the Spanish islands but offer similar frequencies. Our interpretation of this result is that price discounts offered to island residents reduce the demand elasticity of this type of passengers and allow airlines to fix higher prices. The interpretation of the frequencies offered is less clear. In principle, residents discounts should increase demand and lead firms to offer higher frequencies. However, airlines may end up not increasing frequencies for two reasons. First, they may find difficult obtaining additional slots. And second, if they increase frequencies they incur in additional fixed. In these two cases, discounts will not increase frequencies but will generate an additional pressure on prices.

We also find that price and frequency caps established in intraisland flights lead to lower prices and higher frequencies than those encountered in unregulated routes with similar features. This result suggest that these caps over-compensate the lack of traffic and competition of protected routes, possibly to achive other policy objectives such as regional development and social cohesion.

The rest of the paper is organized as follows. Section 2 reviews the literature on public service obligations in the airline industry and describes the regulatory design at work in Spain. Section 3 develops a theoretical model that provides the basis for interpreting the empirical results about the effects of PSOs. Section 4 presents the empirical analysis. Finally, section 5 concludes.
2 Literature Review and Public Service Obligations in the Spanish Airline Market

2.1 Literature Review

For many decades, basic services in network industries were provided by public or regulated monopolies and financed through subsidies from the public budget and through cross-subsidies from profitable to unprofitable consumers. For example, in the telecommunications sector the use of uniform prices implied a cross-subsidization from high to low-cost regions and from long distance to local calls. In the postal sector, loss-making public companies received direct transfers from the public budget. In air transportation, high traffic routes subsidized unprofitable remote routes. In recent years, the liberalization of these markets has rendered these financing mechanisms unsustainable, and public authorities has been forced to redefine the basic services guaranteed to the whole population, the selection process of public service operators and the instruments used to finance them. Next, we review the main contributions of the economic literature to these three regulatory problems.

The definition of the basic services that must be guaranteed to all the population is a controversial issue. As Cremer (2009, p. 271) has pointed out, the main problem is to determine when the social benefits generated by the public services obligations are sufficiently important to justify its costs, and more importantly, the restriction in the competition they usually imply. Cremer et al. (2001) and Cremer (2009) identify several economic justifications for facilitating the access to a service. We present those that can be more suitably applied to air transportation: (1) Redistribution of rents: PSOs are an alternative redistribution mechanism to taxes and direct transfers; (2) Network externalities: In the airline sector, when more people is flying more routes are offered and with a higher frequency; (3) Public good. A national network of air transportation can be considered as a public good that enhances social cohesion and equity; and (4) Regional policy. The regulation of prices and frequencies can be used to facilitate regional development.

A number of theoretical papers study the properties of different methods to allocate the
PSO to a firm. Most of them consider the use of auctions (Anton et al. 2002; Chone et al. 2000; Sorana 2000). In the case of air transportation, Williams (2004) analyze the merits of the tendering system used in Norway.

Finally, a third group of papers focus on the economic distortions generated by the PSO’s financing mechanisms (Valletti et al., 2002; Calzada, 2009; Mirabel el al., 2009). In the particular case of air transportation, Nolan et al. (2005) examine the social welfare implications of different schemes to guarantee the service in thin markets; direct subsidies, protected route packages and revenue guarantees. In general, these works distinguish two main forms of financing the PSO. The first one are cross-subsidies from one group of consumers to another. For example, in the telecommunications and electricity sectors regulators impose the use of uniform prices that are applied nationwide. The second financing mechanism are direct subsidies to the public service operator. This option is considered by the literature more efficient and transparent. Subsidies can be financed through the public budget, but it is also possible to create a universal service fund financed by all the operators that are not subject to PSOs.

Very few attention has received the optimal design of the PSO’s financing mechanisms. Mirabel et al (2009) show that a mix of unit and lump-sum subsidies can be used to mitigate the inefficiencies created by uniform prices. Billete de Villemeur (2004) analyzes a monopoly airline that exploits a single origin-destination pair and shows that optimal allocations of price and frequency can be reached by means of a price-cap constraint that depends on the frequency of the service. Our theoretical framework closely follows this model. However, while this paper determines the optimal mechanisms to regulate a private airline, our objective is to analyze the impact of different PSOs that are frequently used in the sector.
2.2 Public Service Obligations in the Spanish Airline Market

In the European Union, member states can impose public service obligations on routes serving peripheral or developing regions and on other thin routes that are considered essential for the development of a region. Williams (2004) reports that subsidized routes must satisfy two requirements to be eligible: the annual seating capacity should be below 30,000; and no other forms of transport can ensure an adequate and uninterrupted service. However, the author claims that in practice many subsidized routes don’t satisfy these requirements.

The obligations imposed on airlines also varies greatly. Usually, subsidized routes must offer a minimum daily service frequency and/or satisfy specific timetabling obligations. In many occasions, governments also define the maximum fares that can be imposed, and in France, Italy, Portugal and Spain island residents are given a price discount.

Williams (2004) explains that in Europe the amount of subsidy given per one-way journey varies widely between routes. For example, in 2003 the range of the subsidies granted in Ireland varied from 53 euros (Dublin-Galway) to 290 euros (Dublin-Knock).

In Spain, several measures are used to promote the mobility of residents in Canary and Balearic islands. Next, we summarize those that affect air transportation:

Island resident’s price discounts.- Residents of Canary and Balearic islands enjoyed a 33 % discount from 2001 to 2004. From 2004 to 2007 this discount progressively increased to 50 %.

Subsidies in the airport fees.- Airport fees in domestic routes that link the continent with an island are about 40 % lower than in the rest of domestic routes. In addition, airport fees in intraisland routes are almost five times cheaper than in the rest of domestic routes.

Subsidies of inter-island flights.- Airlines that connect the islands in Balearic and Canary Islands benefit from subsidies if they meet certain frequency and price restrictions. In November 2003, the Spanish Ministry of Economics and Finance established the following conditions for subsidizing intra-Balearic routes:

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2Council Regulation (ECC) No 2408/92 on Access for Community Air Carriers to Intra-Community Air Routes.
1. The airline must guarantee the provision of the service from 7h to 9h in the morning. The return at night must also be provided.

2. At least four daily flights must be offered in the winter season and five daily flights in the summer season.

3. The airline must offer a minimum capacity in the route. This limit ranges from 64,000 to 110,000 seats per season (6 months), depending on the route and the season.

4. Fares must not exceed 82 euros for each round of the trip. Since 2003, these fares has been updated each year according to the Retail Price Index and the adjustment in airport fees. Airlines are allowed to offer discounts when the load factor achieved is higher than 75 per cent.

In April of 2008, the Spanish Government modified the pricing regime to promote the entry of new carriers in subsidized routes. In the new regulation, maximum fares were substituted by reference fares. This implies that airlines can now fix a price above 82 euros for some passengers if the average price is not higher than 82 euros.

An additional particularity of the Spanish regime is that PSOs for intra-island flights are not imposed on a single airline, as it is usually the case in other European countries. All airlines that meet the PSOs receive a subsidy. Obviously, the concurrence of several operators in the same route increases their costs, but in practice, Air Nostrum, regional airline owned by Iberia, concentrates many of the flights for intra-Balearic routes. Another airline with a smaller presence in these routes is Air Berlin.

3 Theoretical framework

Imagine an airline that connects an island and the continent. The airline transport island residents \( (i = 1) \) and tourists \( (i = 2) \). The proportion of island residents over all passengers transported by the airline is \( \alpha \), and the proportion of tourists is \( 1 - \alpha \).

The demand of air-transportation depends on the ticket price \( p \) and on the flight frequency \( f \). Following Billette de Villemeur (2004), we consider that consumer preferences on departure
time are uniformly distributed over the time and that the expected schedule delay cost is $v < 0$. Therefore, consumers average waiting-time cost is $v/2f$. Consider that $0 \leq d_i \leq 1$ is the price discount given to passengers. Assuming the consumer’s gross surplus generated by a fly is $S(X_i)$, the demand function of type $i$ passengers takes the following form:

$$X_i(p, f) = \arg\max_{X} \{S(X_i) - (p(1 - d_i) + \frac{v}{2f})X\}.$$  \hspace{1cm} (1)

Taking this into account, $X = X_1 + X_2$ is the total demand of the airline. The airline faces a cost $C(K)$ for each flight, where $K$ is the capacity of the aircraft. This cost can be reduced by a subsidy $s \geq 0$. The airline also has a fixed cost $F$, which is independent of the aircraft size. Using this information, the airline sets $p$ and $f$ to maximize the following profit function:

$$\Pi(p, f) = pX(p, f) - f[C(K/f) - s] - F.$$  \hspace{1cm} (2)

We assume that in the long run the airline adjust the aircraft’s capacity to the total traffic and therefore it is satisfied that $X = Kf$. In the short run, however, total transportation capacity may not be enough to absorb all the traffic. For example, the airline might be unable to obtain more slots to exploit a route. In order to reflect this situation, we impose the restriction that in the short run the total number of passengers can not be greater than the transportation capacity, $X < Kf$, where $Kf$ is the existing transportation capacity.

### 3.1 Consumer discounts and airline subsidies

We start our analysis of the air-transportation public service obligations by considering the effect of resident discounts and cost airline subsidies on the equilibrium prices and frequencies. Afterwards we assess the effects of price and frequency caps.

In order to show the main mechanism at work, we focus on the case where $d_1 > 0$ and $d_2 = 0$. Denoting as $\lambda \geq 0$ the Lagrangian multiplier associated to the transportation capacity constraint, we can write the first order conditions of the airline maximization problem as follows:
\[ \frac{\partial L}{\partial p} = X + (p - C'(K)) \frac{\partial X}{\partial p} - \lambda \frac{\partial X}{\partial p} = 0; \]  
\[ \frac{\partial L}{\partial f} = (p - C'(K)) \frac{\partial X}{\partial f} - C(K) + s + \frac{X}{f} C'(K) - \lambda \frac{\partial X}{\partial f} = 0. \]

From equation (1) these conditions can be simplified by using the fact that \( \frac{\partial X_i(p, f)}{\partial f} = \frac{-v}{2f^2(1-d_i)} \frac{\partial X_i(p, f)}{\partial p} \). Moreover, considering the definition of demand elasticity \( \varepsilon_i = -\frac{p}{X_i(p, f)} \frac{\partial X_i(p, f)}{\partial p} \) we obtain:

\[ \frac{p - C'(K) - \lambda}{p} = \frac{X}{\alpha X_1 \varepsilon_1 + (1 - \alpha) X_2 \varepsilon_2}; \]

\[ \frac{v}{2f} \left[ \frac{\alpha \frac{\partial X_1}{\partial p} + (1 - \alpha) \frac{\partial X_2}{\partial p}}{\alpha \frac{\partial X_1}{\partial p} + (1 - \alpha) \frac{\partial X_2}{\partial p}} \right] = \frac{C(K) - s}{K} - C'(K). \]

The first expression indicates that the price mark-up set by the airline is inversely related to the weighted sum of the price-elasticities of island residents and tourists. When \( d_1 > 0 \) and \( \alpha > 0 \) the airline sets a higher price because the discount make more inelastic the demand of residents. Indeed, in this case the same price increase produces a smaller reduction of demand in the island residents than in the tourists.

The price mark-up also reflects the airline’s capacity restriction. When the transportation capacity is not enough to absorb all the traffic, the capacity restriction is binding \( (\lambda > 0) \) and the airline increases the price to adjust its transportation capacity to the demand. By contrast, if the airline can react to an increase of demand by increasing its transportation capacity, then the restriction is not binding \( (\lambda = 0) \).

Equation (6) shows that the airline increases its frequency until the average waiting time corrected by the effect of the discount is equal to the average cost (which incorporates the subsidy) minus the marginal cost. The airline sets \( f \) taking into account the price discount because it affects the demand effect of a change in \( f \). With the discount, an increase of \( f \) produces a higher increase of the demand.

In the airline industry, a higher frequency implies additional fixed costs (landing fees, renting gates, etc) and reduces the opportunity of exploiting density economies which, in the case of airlines, arise from the use of bigger aircraft at high load factors. In our model, the
idea that higher cost reduce the frequencies offered is obtained by assuming that \( c(K)/K \) is decreasing in \( K \). In this context, subsidies to the airline operations increase frequency because they reduce the average cost.

In section 4 we will assess the PSOs used in the Spanish airline market. We show that routes that receive subsidies for airline operations and offer discounts to island-residents exhibit higher prices than the rest of routes. However, we don’t find that these policies create any change in the frequency offered. Therefore, the higher prices in island routes might be explained both by the lower elasticity of demand of resident passengers due to the discounts and by the presence of capacity restrictions that make difficult to increase the frequency of flights.

### 3.2 Price and frequency caps

Routes with thin demand don’t generate competition and allow airlines to offer higher prices and lower frequencies. Regulators can increase social welfare in these routes by setting price and frequency caps to the airlines. Under this type of regulation, the airline can freely determine the price and the frequency levels with the only requirement of satisfying the caps.

In order to analyze the effects of this regulation, imagine a monopolist that maximizes its profits subject to a price constraint, \( p \leq \bar{p} \), and a frequency constraint, \( \frac{v}{2f} \leq \bar{f} \). We can simplify the analysis by assuming that all consumers are residents (\( \alpha = 1 \)) and that there aren’t capacity constraints.

The first-order maximization conditions of the airline are now:

\[
\frac{\partial L}{\partial p} = X + (p - C'(K)) \frac{\partial X}{\partial p} - \lambda_1 = 0; \\
\frac{\partial L}{\partial f} = (p - C'(K)) \frac{\partial X}{\partial f} - (C(K) - s) + \frac{X}{f} C'(K) + \lambda_2 \frac{v}{2f^2} = 0.
\]

where \( \lambda_1 \) and \( \lambda_2 \) are the Lagrange multipliers associated to the price and frequency caps, respectively. Simplifying the above conditions we obtain:
\[
\frac{p - C'(K)}{p} = \left(1 - \frac{\lambda_1}{X}\right) \frac{1}{\varepsilon_1};
\]

\[
\frac{\left(\frac{X - \lambda_1}{X}\right)(\frac{1}{1 - d_i} + \frac{\lambda_2}{X})}{2f} \frac{v}{K} = \frac{C(K) - s}{K} - C'(K).
\]

First note that when the caps are not binding \((\lambda_1 = 0 \text{ and } \lambda_2 = 0)\) the price and the frequency are determined as in the standard case: the airline establishes a mark-up over the price that is inversely related to the elasticity of the demand and the frequency is increased to the point where the average waiting time corrected by the price discount is equal to the average cost minus the marginal cost.

When the price constraint is binding, \(\lambda_1\) is the value of the multiplier that allows to satisfy \(p = \overline{p}\). In addition, the presence of \(\lambda_1\) in the frequency equation reflects that when the price is constrained the airline has incentives to reduce its frequency. In our model, this effect is compensated with the frequency cap the price discount and the cost subsidies. By contrast, if the regulator fixes \(\lambda_1 = \lambda_2\) then we obtain again the standard equation for frequency in (6).

Billette the Villemeus (2004) shows that this case appears when the regulator fixes a general "price-and-frequency" cap with the form \(p + \frac{v}{2f} \leq \overline{p}\). This author demonstrate that by using this mechanism regulars will be able to set the second-best allocations for \(p\) and \(f\).

Our empirical model of section 4 analyzes the effect of the price and frequency caps imposed to intra-island flights in the Spanish Balearic Island. We explain that these regulations seem to have been effective in reducing the prices and in increasing the frequency, relative to other non-regulated routes.

\footnote{Billette de Villemeur (2004) shows that a conveniently designed "price-and-frequency" cap constraint can implement the second-best optimum. In this work we simply analyze the effects of imposing a separate price and frequency cap to the airline to identify the main effects of the Spanish regulatory regime.}
4 Empirical model

In this section we develop an empirical model to analyze the effects of public service obligations in the Spanish airline market during the period 2001-2009. For this objective, we estimate price and frequency equations at the route level to assess the impact of price discounts and price and frequency caps.

4.1 The data

First, we describe the variables used in the price and frequency equations and explain the sources of this information. The frequency of the data is semi-annual. Thus, we differentiate between the summer and winter seasons in a time period that goes from the summer season of 2001 to the winter season of 2008-2009.

Price ($P$): We consider as price the lowest mean round trip price charged by airlines present in a route weighted by their corresponding market share. Information has been obtained from airlines websites following an homogeneous process in a sample week for each period. Price data refers to the city pair link that has as its origin in the city with the largest airport. Data has been collected one month before travelling, the price refers to the first trip of the week, and the return is on Sunday. We impose these conditions in all data collection for all airlines and routes, taking into account that our empirical analysis exploits the variability across routes.

Frequency ($FQ$): This variable shows the weekly total frequency offered by airlines in each route. Data of frequencies by airlines operating in each route has been obtained from the website of Official Airlines Guide (OAG). Data collection for frequencies refers to the same sample week of data for prices.

Demand ($Q$): Total number of passengers carried by airlines in the route, including direct and connecting traffic. Information has been obtained from the website of the Spanish Airports and Air Navigation (AENA) agency.

Population: ($Pop$): Mean population in the route’s origin and destination provinces (NUTS
3). Data has been obtained from the National Statistics Institute (INE). We consider more appropriate to use data for population at NUTS 3 level instead that at NUTS 2 level, because the size of the urban agglomeration close to the airport is more accurately captured.

Gross domestic product per capita (\(GDPc\)): Mean gross domestic product per capita in the route’s origin and destination regions (NUTS 2). Data has been obtained from the National Statistics Institute (INE). We use this variable at the regional level because the information is not available at the province level for the recent years of the period considered.

Tourism (\(Tour\)): Number of tourists per capita in the destination region (NUTS 2). Data has been obtained from the Institute of Tourist Studies (IET). We use this variable at the regional level because the information is not available at the province level.

Distance (\(Dist\)): Number of kilometers that separate the route’s origin and destination airport. Data has been collected from WebFlyer site.

Route concentration (\(HHI\)): Index of Herfindahl-Hirschman at the route level. The index is computed as the sum of the market shares squares of airlines operating in the route in terms of airlines’ departures. Data on departures of each airline in each route have been obtained from Official Airlines Guide (OAG) website.

Concentration at the airport level (\(HHI_{airport}\)): This index is computed as the sum of the market shares squares of airlines operating in the route in terms of total national departures both in the origin and destination airports of the route. Data on the percentage of departures of each airline in origin and destination airports have been obtained from the Spanish Airports and Air Navigation (AENA) agency. Decisions at the airport level involve several routes so that we expect any endogeneity bias due to a simultaneous determination of prices and airlines’ shares will be reduced by using airport concentration as instrument for route concentration.

The analysis also considers two dummy variables that are the focus of our analysis: First, a dummy variable that takes the value 1 in routes with an island as an endpoint (\(Disland\)). And second, a dummy variable that takes the value of 1 in intraisland flights (\(DPSO\)) since the summer of 2004. Concerning intraisland flights, we only have available information for
the Balearic Islands and we can’t analyze intraisland flights in Canary Islands. To summarize, our analysis considers 74 domestic routes in the Spanish market, of which 24 have an island as an endpoint and 2 are intraisland.

Finally, we also consider other dummy variables as explanatory variables. A dummy variable that takes the value 1 in routes with origin in Madrid airport ($D_{hub}$); and a dummy variable that takes the value 1 in the Summer Season ($D_{Summer}$).

Table 1 shows the descriptive statistics of the variables used in the empirical analysis. There is a high degree of variability in all the variables that are continuous and the only dummy variable with few observations with value 1, as expected, is the dummy variable for public services obligations.

<table>
<thead>
<tr>
<th>Continuous Variable</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Minimum Value</th>
<th>Maximum Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prices (euros)</td>
<td>193.43</td>
<td>101.25</td>
<td>45</td>
<td>829.67</td>
</tr>
<tr>
<td>frequency (weekly number of flights)</td>
<td>45.88</td>
<td>56.25</td>
<td>2</td>
<td>559</td>
</tr>
<tr>
<td>Demand (number passengers)</td>
<td>214,617.6</td>
<td>306,571.9</td>
<td>1,361</td>
<td>2,514,338</td>
</tr>
<tr>
<td>distance (kilometres)</td>
<td>645.56</td>
<td>483.16</td>
<td>131</td>
<td>2,190</td>
</tr>
<tr>
<td>$H_{HHI_{route}}$ (Hirschman-Herfindahl index)</td>
<td>0.71</td>
<td>0.28</td>
<td>0.21</td>
<td>1</td>
</tr>
<tr>
<td>Population (inhabitants)</td>
<td>2,826,917</td>
<td>925,605.9</td>
<td>841.668</td>
<td>5,766,091</td>
</tr>
<tr>
<td>GDP per capita (euros)</td>
<td>22,018.96</td>
<td>3,163.71</td>
<td>13,888</td>
<td>30,435</td>
</tr>
<tr>
<td>Tourism per capita (number tourists per capita)</td>
<td>2.53</td>
<td>3.38</td>
<td>0.11</td>
<td>11.34</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Discrete Variables</th>
<th>Number of observations (= 1)</th>
<th>Number of observations (= 0)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$D_{island}$ (1: islands as endpoint)</td>
<td>359</td>
<td>741</td>
</tr>
<tr>
<td>$D_{pspo}$ (1: routes with public service obligations)</td>
<td>20</td>
<td>1080</td>
</tr>
<tr>
<td>$D_{hub}$ (1: routes with origin in Madrid airport)</td>
<td>478</td>
<td>622</td>
</tr>
<tr>
<td>$D_{Summer}$ (1: Summer season)</td>
<td>574</td>
<td>526</td>
</tr>
</tbody>
</table>

Figure 1: Descriptive statistics of the variables used in the empirical analysis (N= 1100)

Table 2 presents the matrix of correlations between variables. It shows a strong relationship between demand and frequency and as strong correlation between islands and tourism. Furthermore, we can see that distance is the major determinant of prices.
### 4.2 Estimation strategy

We follow a similar methodological approach than the previous literature about the determinants of prices and frequencies at the route level. The pricing equation considers distance and traffic density as variables that reflect the costs and route competition to reflect the mark-ups over costs. In a similar vein, the frequency equation considers as explanatory variables demand shifters at the route level such as distance and route competition. However, our interest is focussed on the variables that allow identifying the effects of PSOs. Next we present the explanatory variables considered in our pricing and frequency equations and the expected sign of the coefficient associated to these variables.

**Pricing equation.** We consider that the price of route $k$ at period $t$ can be explained by the following equation:

\[
P_{kt} = b_0 + b_1 Q_{kt} + b_2 Dist_{kt} + b_3 HH_{kt} + b_4 Dist_{land} + b_5 D_{pso_{kt}} \\
+ b_6 D_{hub_{kt}} + b_7 D_{summer_t} + b_8 TimeTrend_t + e_{kt}. \tag{11}
\]

The expected influence of the explanatory variables is the following:

**Demand ($Q$):** The expected sign of the coefficient of this variable is ambiguous. Intense traffic allows exploiting density economies, as the airline can use bigger planes at higher load factors...
and optimizes the use of the planes and the crew. In a competitive environment this should lead to lower prices, but in a monopolistic market or when capacity constraints are present more traffic leads to higher mark-ups over costs.

Note that at the route level prices and demand can be determined simultaneously. In order to avoid any endogeneity bias in the price equation we include as instruments for the demand the mean population in the route’s origin and destination provinces ($Pop$), Gross Domestic Product per capita ($GDPc$), and Tourism ($Tour$) at the region level.

Distance ($Dist$): Distance is a major determinant of the costs faced by airlines and we expect that the coefficient of this variable positive and lower than one. We justify this because we expect that costs increase less than proportionally with an increase of kilometers flown. Long-haul routes involve higher average speeds, less intense consumption of fuel, and lower charges per kilometer.$^4$

Route concentration ($HHI$): This variable reflects the effects of competition at the route level on the price. The coefficient associated to this variable should be positive, since less competition implies higher prices.

As in the case of the demand, prices and route concentration can be determined simultaneously, and therefore we must take into account a possible bias due to the endogeneity of the variable for concentration. We deal with this problem by using two alternative instruments for concentration at the route level: 1) Market concentration at the airport level ($HHI_{airport}$) and 2) The first lag of the concentration at the route level (e.g. the instrument of route concentration in the summer of 2004 would be route concentration in the summer of 2003). The advantage of the first instrument is that we don’t lose observations for two periods (summer of 2001 and winter of 2001-2002). However, we can still not be sure that this variable is not endogenous. Hence, we use both instruments in separate regressions.

$^4$The estimation of the price equation using prices per kilometre offers almost identical results as those obtained when using prices as dependent variable. When using prices per kilometre, the coefficient associated to the variable distance is negative, but this result should be interpreted in the same line as a positive sign and coefficient lower than one in the regression that uses prices as dependent variable.
Dummy for island flights ($D_{island}$): Dummy variable that takes value 1 for routes with an island as endpoint. Recall that residents from Canary and Balearic Islands have a discount in the price of domestic routes that have an island as endpoint. In Section 3 we have shown that the expected effect of this measure is a price increase since with the discount the demand of island residents is less elastic. The presence of the discount should also increase the traffic of the route, but this effect should be captured by the variable of demand. Thus, we expect a positive sign for the coefficient associated to this variable.

The magnitude of the effect of discounts could be distorted by the fact that the flights to the islands do not compete with other transportation modes like trains or cars. In order to reflect the role of intermodal competition in the price setting, we repeat the estimation of equation (11) excluding routes from the peninsula with a lower distance than 500 kilometers. That is, we compare routes with islands as endpoints and long-haul routes from the peninsula. In both cases, intermodal competition should not be strong.

Recall also that domestic routes that have islands as endpoints benefit from lower airport fees. This cost reduction might favor lower prices.

Dummy for intra-island flights ($D_{pso}$): Dummy variable that takes value 1 for routes with public services obligations. Since the end of 2003, airlines that provide intra-island flights in Balearic Islands benefit of lump-sum subsidy from the Central government if they offer a minimum frequency and satisfy a price cap.

If this price cap was set to equal the prices of non-regulated routes we should expect the coefficient of this dummy to be non significant. However, a priori the cap can be higher or lower than the prices set elsewhere.

Dummy for departure airport ($D_{hub}$): Dummy variable that takes value 1 in routes with origin in Madrid airport. Madrid airport is the hub of the largest Spanish airline, Iberia and is the Spanish airport with the highest amount of connecting passengers. A priori, we don’t have a clear expectation of what the sign for the coefficient associated to this variable should be. Iberia could set higher prices for flights departing from Madrid due to the hub premium effect, which is well documented in the literature since the seminal paper of Borenstein (1989).
However, Iberia could also benefit from density economies that generate its hub-and-spoke operations.

Seasonality \((D_{\text{summer}})\): Dummy variable that takes value 1 for the summer season, that goes from April 26th to October 26th. We include this dummy variable in these price equation to account for differences across seasons.

Time trend \((\text{TimeTrend})\): A time trend is also included in the model to account for changes along time in several of the variables considered in the empirical model.

Frequency equation. The estimation of the frequency equation for the route \(k\) at period \(t\) takes the following form:

\[
F_{Q_{kt}} = c_0 + c_1 Population_{kt} + c_2 GDP_{\text{per capita}}_{kt} + c_3 Dist_{kt} + c_4 HHI_{kt} + c_5 Disland_k + c_6 D_{\text{pop}}_{kt} + c_7 D_{\text{hub}}_{kt} + c_8 D_{\text{summer}} t + c_9 \text{TimeTrend}_t + e_{kt}, \tag{12}
\]

Next we explain the expected influence of the explanatory variables included in this equation:

Demand \((Q)\): For the frequency equation we follow a different empirical strategy in relation to the variable of demand. An estimation that regress frequency against demand displays a \(R^2\) above 0.90, which might reflect an over-identification of the model that will distort the individual interpretation of the other explanatory variables. As this over-identification is due to the very high relevance of just one explanatory variable it will likely not be corrected by an instrumental variables procedure. Thus, in the frequency equation we prefer to use the instruments of the demand (population and GDP per capita) rather than the estimated variable of demand.\(^5\) We expect a positive sign of the coefficient of these variables.

Distance \((\text{Dist})\): We expect a negative relationship between frequency and distance in a

\(^5\)The high correlation between the dummy variable for islands and tourism intensity at the destination region makes advisable not to include the variable tourism as explanatory variable in equation (12). Hence, the dummy variable for islands can also capture the demand effect generated by tourist activities. Including tourism per capita at the destination region as explanatory variable does not increase the \(R^2\) obtained from the regression.
route. Airlines may find profitable to reduce frequencies in longer routes where they can exploit density economies by using bigger planes at high load factors. In addition, intermodal competition is soft in long-haul routes so that airlines may not require to offer high frequencies to compete with cars and trains there.

Route concentration ($HHI$): Airlines compete both in prices and frequencies. Hence, flight frequency should be higher in less concentrated routes. Bearing this in mind, the sign of the coefficient associated to this variable should be negative.

As in the pricing equation, we use two different instruments to deal with the possible endogeneity bias due to a simultaneous determination of the dependent variable and market concentration. 1) The concentration at the airport level ($HHI_{airport}$); and 2) The first lag of the concentration at the route level.

Dummy for island flights ($D_{island}$): Frequency may be lower in routes with islands as endpoints. Airlines do not suffer from intermodal competition in these routes and they have higher proportion of tourists, which are less time-sensitive than business passengers. On the other hand, there are also important reasons that favor a higher frequency in these routes: First, islands routes benefit of more demand due to tourist activities. And second, island benefit of public service obligations such as price discounts to residents that increase the demand and therefore the profitability of higher frequencies. Taking all these influences into account, it is not clear what the sign of the coefficient associated to this variable should be.

As in the pricing equation, we account for the role of intermodal competition by estimating equation (12) excluding routes from the peninsula with a distance lower than 500 kilometers. Therefore, in this sub-sample we compare routes with islands as endpoints and long-haul routes from the peninsula. In both cases, intermodal competition should not be strong.

Dummy for intra-island flights ($D_{intra}$): Airlines that operate intra-islands routes obtain subsidies from the Government if they offer a minimum frequency of service. The Government can ask airlines to offer a higher or lower frequency than the unregulated domestic routes.

---

6A very important cost for business is the schedule delay cost, which is the difference between the preferred and the actual time of the flight. Frequency of service is a key variable to reduce this schedule delay cost.
Dummy for departure airport ($D_{hub}$): Frequencies should be higher in routes with origin in Madrid airport since hub-and-spoke operations may require a higher frequency of service than point-to-point operations. Hence, we expect a positive sign in the coefficient associated to this variable.

Seasonality ($D_{summer}$): This variable accounts for differences in the frequencies of flights across seasons. We expect higher frequency in the summer season due to the influence of tourism.

Time trend ($TimeTrend$): A time trend is also included in the model to account for changes along time in the variables of the empirical model.

### 4.3 Results and discussion

We estimate the pricing equation using the Two-Stage Least Square estimator (2SLS-IV) since demand and route concentration may be endogenous. Indeed, prices and demand may be determined simultaneously and the price charged in each route can influence airlines entry patterns.

The frequency equation is also estimated using 2SL-IV, but only the variable of route concentration is considered endogenous. As we mention above, the simultaneous determination of frequency and demand may be particularly high, so we use the instruments of demand as explanatory variables instead of assuming that demand is endogenous as we do for the pricing equation. Note also that we compute standard errors robust to any bias from heteroskedasticity.

Our estimation procedure does not take into account the panel data nature of the sample. The use of a fixed-effects model is not appropriate in our context since this technique drops anything that is time-invariant from the model, such as route distance or being an island. A random-effects model is not appropriate because the individual effects related to routes are likely correlated with the error term, as indicated by Hausman test. Finally, the Hausman-Taylor estimator is not appropriate either since it assumes that all explanatory variables are exogenous.
Tables 3 and 4 show the results of the estimates of the pricing and frequency equation, respectively. Both equations are estimated using three samples:

1. The whole sample of routes.

2. A sub-sample that excludes routes from the peninsula shorter than 500 kilometers. The estimation for this subsample allows to compare differences between island routes and routes from the peninsula where intermodal competition should be soft.\(^7\)

3. A sub-sample that only includes routes with islands as endpoints. All routes in this sub-sample benefit from discounts to island residents. As a result, this helps us to more accurately differentiate the effects of price and frequency caps from the effects created by discounts.

Pricing equation: The overall significance of the model for the pricing equation is reasonably good since the \(R^2\) is about 0.40-0.50. It seems that the more appropriate instrument for concentration at the route level is the lag of this variable rather than concentration at the airport level. The partial \(R^2\) is quite similar for both instruments, but the Hansen J-test does not always accept the null hypothesis of exogeneity of all instruments when using as instrument concentration at the airport level.

The variable of demand is not statistically significant in most cases. A possible explanation is that the negative effect related to the exploitation of density economies is compensated by the positive effect generated by airlines market power and by capacity restrictions. As expected, the variable distance is statistically significant and the sign of the coefficient is positive and lower than one. The coefficient of the variable route concentration is positive and statistically significant, which indicates that prices are higher when competition is softer. No clear inferences can be made in relation to results for the dummy variable for routes with origin in Madrid airport because the coefficient takes a positive value in some regressions and a

\(^7\)Some routes in Spain are served by high-speed trains but none of them cover a distance of more than 500 kilometers in the period considered.
<table>
<thead>
<tr>
<th>Explanatory Variables</th>
<th>All Sample</th>
<th>All sample except routes &lt;500 kms from the peninsula</th>
<th>Routes with an island as endpoint</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>HHI\text{route} as instrument of HHI\text{route}</td>
<td>Lag of HHI\text{route} as instrument of HHI\text{route}</td>
<td>HHI\text{route} as instrument of HHI\text{route}</td>
</tr>
<tr>
<td>demand (Q)</td>
<td>0.000057 (0.000031)***</td>
<td>0.000008 (0.000029)</td>
<td>-0.000082 (0.000059)</td>
</tr>
<tr>
<td>distance ( autonom)</td>
<td>0.11 (0.008)***</td>
<td>0.10 (0.008)***</td>
<td>0.10 (0.008)***</td>
</tr>
<tr>
<td>HHI\text{route}</td>
<td>217.27 (38.45)***</td>
<td>136.38 (33.02)***</td>
<td>120.34 (47.72)***</td>
</tr>
<tr>
<td>D\text{isln}</td>
<td>58.13 (9.70)***</td>
<td>43.96 (8.39)***</td>
<td>32.79 (10.39)***</td>
</tr>
<tr>
<td>D\text{hub}</td>
<td>64.20 (15.18)***</td>
<td>49.73 (13.29)***</td>
<td>-46.43 (17.60)***</td>
</tr>
<tr>
<td>D\text{Summer}</td>
<td>62.12 (4.91)***</td>
<td>62.43 (5.07)***</td>
<td>93.49 (6.68)***</td>
</tr>
<tr>
<td>Time Trend (T)</td>
<td>0.21 (1.37)</td>
<td>-0.66 (1.52)</td>
<td>0.33 (1.92)</td>
</tr>
<tr>
<td>Intercept</td>
<td>95.55 (44.42)***</td>
<td>-36.12 (35.77)</td>
<td>0.64 (52.56)</td>
</tr>
<tr>
<td>F (Joint Significance)</td>
<td>1100 (66.71)***</td>
<td>974 (57.86)***</td>
<td>637 (58.54)***</td>
</tr>
<tr>
<td>Tests of instruments:</td>
<td>0.36 (0.37)</td>
<td>0.33 (0.38)</td>
<td>0.38 (0.35)</td>
</tr>
<tr>
<td>Partial F: HHI\text{route}</td>
<td>0.44 (0.62)</td>
<td>0.49 (0.58)</td>
<td>0.51 (0.63)</td>
</tr>
<tr>
<td>Hansen J (H: Instruments are exogenous)</td>
<td>4.59 (2.69)</td>
<td>8.27**</td>
<td>2.29</td>
</tr>
</tbody>
</table>

Note 1: Standard errors in parenthesis (robust to heteroscedasticity)
Note 2: Statistical significance at 1% (***) , 5% (**), 10% (*)
Note 3: Instruments for the demand variable are the following: GDP per capita, population and tourism per capita.

Figure 3: Pricing equation estimates (2SLS-IV)
<table>
<thead>
<tr>
<th>Explanatory Variables</th>
<th>All Sample</th>
<th>All sample except routes &lt;500 kms from the peninsula</th>
<th>Routes with an island as endpoint</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>HHİpert as instrument of HHİpert</td>
<td>HHİpert as instrument of HHİpert</td>
<td>HHİpert as instrument of HHİpert</td>
</tr>
<tr>
<td></td>
<td>Lag of HHİpert as instrument of HHİpert</td>
<td>Lag of HHİpert as instrument of HHİpert</td>
<td>Lag of HHİpert as instrument of HHİpert</td>
</tr>
<tr>
<td>Population</td>
<td>0.0000024 (3.53ε-06)***</td>
<td>0.0000026 (4.35ε-06)***</td>
<td>0.000012 (1.91ε-06)***</td>
</tr>
<tr>
<td>GDP per capita</td>
<td>0.0012 (0.0005)**</td>
<td>0.0012 (0.00053)**</td>
<td>-0.0002 (0.0005)***</td>
</tr>
<tr>
<td>distance (dist)</td>
<td>-0.03 (0.002)***</td>
<td>-0.03 (0.002)***</td>
<td>-0.02 (0.002)***</td>
</tr>
<tr>
<td>HHIacts</td>
<td>-118.42 (9.81)***</td>
<td>-96.23 (6.26)***</td>
<td>-86.96 (6.56)***</td>
</tr>
<tr>
<td>Dİ</td>
<td>-5.86 (4.37)</td>
<td>1.03 (7.71)</td>
<td>3.40 (3.22)</td>
</tr>
<tr>
<td>Dİ</td>
<td>63.90 (8.06)***</td>
<td>59.43 (7.32)***</td>
<td>40.70 (4.92)***</td>
</tr>
<tr>
<td>Dİ</td>
<td>-2.56 (3.12)</td>
<td>-2.49 (3.49)</td>
<td>5.74 (3.54)***</td>
</tr>
<tr>
<td>Dİ</td>
<td>-0.48 (2.63)</td>
<td>-0.49 (2.75)</td>
<td>2.90 (2.04)</td>
</tr>
<tr>
<td>Time Trend (T)</td>
<td>-4.36 (0.96)***</td>
<td>-4.23 (0.96)***</td>
<td>-2.12 (0.71)***</td>
</tr>
<tr>
<td>Intercept</td>
<td>76.88 (11.94)***</td>
<td>53.94 (15.51)***</td>
<td>96.46 (13.13)***</td>
</tr>
<tr>
<td>N</td>
<td>1100</td>
<td>974</td>
<td>637</td>
</tr>
<tr>
<td>F (Joint Significance)</td>
<td>46.35***</td>
<td>57.26***</td>
<td>42.71***</td>
</tr>
</tbody>
</table>

Note 1: Standard errors in parenthesis (robust to heteroscedasticity)
Note 2: Statistical significance at 1% (***) , 5% (**), 10% (*)

Figure 4: Frequency equation estimates (2SLS-IV)

negative value in others. Furthermore, prices are higher in the summer season when tourism is more intense, and no clear time trend appears from our estimation.

The main interest of our analysis is to know if airlines set higher prices in routes with a discount than in the rest of routes. We find that prices of routes with an island as an endpoint are substantially higher than in the rest of domestic routes. Thus, the discounts enjoyed by island residents might be partly compensated by higher prices. This result is also present when we compare routes with islands as endpoints with long-haul routes from the peninsula, although in this case the coefficient of the variable island is smaller. This result shows that the lack of intermodal competition in routes with an island as an endpoint only explains partially the higher prices charged in these routes.

Therefore, our analysis suggest that the higher prices of islands flights can be related with
the discount policy used in these routes. This conclusion is supported by our estimates of
the demand elasticity. Indeed, while the estimated demand elasticity for all the routes in our
sample is -1.17, the estimated elasticity for routes with islands as endpoints is just -0.86. As
we have explained in the theoretical framework of section 3, this difference might respond to
the presence of the discount.8

The second objective of this paper is to determine if the intraisland routes that are
regulated with price caps exhibit different prices than the routes where prices are unrestricted.
The estimates show that prices in intraisland routes are lower than in the rest of domestic
routes. Hence, price-caps seem to over-compensate the lack of demand and competition in
intra-Balearic routes.

Frequency equation: The overall significance of the model for frequency is also reasonably
good since the $R^2$ is about 0.40. The coefficient of the variable Population is positive and
statistically significant as expected. The coefficient of the variable of GDP per capita is
also positive and statistically significant in the regressions that use all routes of the sample,
although it is not significant in the regressions that use sub-samples of routes. As expected,
airlines reduce frequencies in long and concentrated routes. As in the pricing equation, no
clear inferences can be made in relation to the dummy variable for routes with origin in Madrid
airport because the coefficient takes a positive value in some regressions and a negative value
in others. Finally, airlines do not offer higher frequencies in the summer season and there is
a tendency towards a decrease in the number of weekly flights offered by airlines along time
for the period 2001-2009.

The coefficient of the dummy variable for routes with island as endpoint is positive but
it is not statistically significant. Recall that this variable is capturing different effects. On
the one hand, the positive effect due to the higher demand from tourism and the discounts to
island residents. On the other hand, the negative effect associated to the lack of intermodal
competition and the lower proportion of business passengers. In spite of this, when we
compare routes with an island as endpoint with long-haul routes from the peninsula that are

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8Results of the estimates are available upon request from the authors.
not affected by intermodal competition, the coefficient of the variable for islands is still not statistically significant, although the magnitude of the effect increases as expected. Hence, we could conclude that price discounts to island residents have not been enough to spur demand and increase frequencies.

Another interpretation is that airlines have in general few opportunities to increase routes frequencies due to the restrictive system of slot allocation (and sometimes due to airport congestion). In this situation, an increase of demand generated by price discounts is adjusted via price increases. This conclusion is supported in our analysis by the higher prices we find in the flights that have an island as an endpoint.

Finally, another interesting result from the frequency equation is that intraisland routes with PSOs offer higher frequencies, even although airlines set lower prices in these routes than in the rest. In the Spanish market, the losses airlines incur when satisfying price caps and minimum frequency regulations are compensated with lump sum subsidies.

We finish this discussion by showing the magnitude of the effects of PSOs in terms of prices and frequencies variations. Controlling for several factors, Table 5 shows that prices of round trip flights that have an island as endpoint are about 44 euros higher than the prices in the rest of domestic routes. As we have already explained, frequencies doesn’t differ much. If we now compare round trip flights that have an island as endpoint with long-haul routes from the peninsula, we obtain that round trip prices in islands routes are about 26.4 euros higher and airlines offer three flights more per week. Thus, the lack of intermodal competition in islands is just explaining part of differences in prices.

The comparison with intra-Balearic routes gives even more strong results. The prices in Balearic-routes are 36 euros lower than the prices in the other routes with an island as an endpoint. Overall, prices in intra-Balearic routes are around 6 euros lower than in non-island routes. Controlling for several factors, the impact of PSOs on frequencies is also quite important since airlines offer the double of weekly flights in intra-Balearic routes than in the rest of domestic routes.
Public service obligations in airline markets have been applied in several European countries to guarantee the service in thin or peripheral routes. These policies may pursue different political objectives such as the redistribution of rents, the maximization of network effects, the promotion of social cohesion and the enhancing of regional development. Regardless of these objectives, it is important to take into account that PSOs have substantial effects on the prices and frequencies set on a particular route.

In this paper, we have examined the effects of PSOs applied in the Spanish airline market both from a theoretical and empirical point of view. Results of our analysis show that price discounts to island residents have implied higher prices in routes with islands as endpoints in comparison to the rest of routes. By contrast, we have not found a clear effect of discounts on frequencies. The logic behind this result is as follows. Price discounts to island residents increases total demand and the demand of island residents becomes less elastic. These effects seem to be mainly captured by an increase of prices instead of an increase in frequencies. This is because airlines may not find profitable or even possible to increase frequencies when demand increases. Indeed, more frequencies imply more fixed costs and in addition it may be difficult to obtain more slots.

All in all, a part of the benefits of price discounts may be translated to airlines via price
increases, which harms passengers that are not covered by the discounts. In addition, all passengers does not enjoy of a greater frequencies. As a consequence, in part this measure seems to be working like a subsidy to airlines rather than as an effective instrument to achieve other policy goals like social cohesion or regional development.

We have also found that price and frequency caps established in intraisland flights lead to lower prices and higher frequencies than those encountered in unregulated routes with similar features. Therefore, in this case our results suggest that these caps over-compensate the lack of traffic and competition of protected routes.

Finally, we conclude by noting that PSOs have not received too much attention in the previous literature in spite of being a very important part of the air transportation policies. Further research should put the attention in issues like the competition effects of PSOs and on the optimal design of these regulations.


References


[33] Starkie, D. and M. Starrs (1984), Contestability and Sustainability in Regional Airline Markets, Economic Record, 60, 274 - 283
