Discounts and Public Service Obligations in the Airline Market: Lessons from Spain[*]

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Abstract

We study the impact of the universal service obligations applied in the Spanish airline market during the period 2001-09. Our analysis shows that routes benefiting from price discounts given to island residents present higher prices than the rest of domestic routes, but similar flight frequencies. This can be explained by the effect of discounts on demand elasticity, the airlines' difficulties in acquiring new slots, and the high costs of increasing frequencies. Moreover, we show that intra-island routes regulated with price caps and frequency floors have lower prices and higher frequencies than unregulated routes of similar characteristics. These results suggest that, in Spain, residents' discounts subsidize airlines on unregulated routes, and guarantee the viability of routes protected by public service obligations.

Keywords: Air Transportation; Residents Discounts; Price Caps; Frequency Floors.

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1 Introduction

Competition in European air travel has increased significantly in recent 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 from these changes, and in some cases their continuity is at risk after the privatization of national airlines. When demand is very low airlines cannot take advantage of density economies, and it is unclear if they can find profitable entering the market.

The traditional way of dealing with this problem in the European Union has been to subsidize the population living in peripheral communities and/or to establish public service obligations (PSOs) on the airlines exploiting protected routes.[1] In recent years the inconsistency of these policies has been widely criticized. First, in the EU there is no clear definition of which routes should be protected. As pointed out by Williams and Pagliari (2004), "in many cases the line between PSO and non-PSO designation is arbitrary and often the product of how successful lobby groups have been at influencing national policy". And second, the regulatory instruments used to finance thin routes and the mobility of citizens vary significantly across countries.

The objective of this paper is to analyze the universal service policies applied in the Spanish airline market during the period 2001-2009. In particular, we analyze the effects of price discounts granted to island residents on domestic routes which have islands as endpoints and the effectiveness of price caps and frequency floors established for intra-island routes. To our knowledge, this is the first empirical paper to study the impact of these regulations in Europe. Recently, Santana (2009) analyzed the effect of PSOs on the productive efficiency of European airlines for the period 1991-2002, but our paper is the first to consider the effect of these policies on prices and frequencies at the route level.[2]

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[1] National governments are responsible for administering these policies in the Irish Republic, Norway, Portugal, Spain and Sweden, while regional authorities are in charge of them in France, Germany and Italy.

[2] Santana (2009) estimates the cost functions of European and US airlines and assesses the effect of PSOs in each of these regions. In our paper, however, we are mostly interested in the effects of price discounts and PSOs 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. Papers that explore this problem are, for example, Borenstein (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), and Oum et al. (1993). These studies estimate 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 analyzed the prices of thin routes in Australia, and Bitzan and Junkwood (2006) in the US.

The empirical literature on the determinants of airline frequencies includes the contributions by Bilotkach et al. (2010), Borenstein and Netz (1999), Brueckner and Pai (2009), Pai (2010), 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 approach is similar to those of the previous studies. We estimate pricing and frequency equations at the route level, focusing on the effects of residents' discounts and PSOs. We find that airlines set higher prices in routes that connect the Spanish mainland and the Canary and Balearic islands, where island residents benefit from a 50 % price discount. However, price discounts do not have an impact on frequencies. Our interpretation of these results is that discounts reduce the demand elasticity of island residents, thus allowing airlines to set higher prices. Moreover, airlines have great difficulty obtaining additional slots in these routes, and, perhaps more importantly, the additional demand generated by the discounts do not compensate for the cost of increasing the number of flights. As a result, discounts do not increase frequencies, but create more pressure on prices.

We also find that the price caps and frequency floors established in intra-island flights lead to lower prices and higher frequencies than those encountered in unregulated domestic routes of similar characteristics. Therefore, these instruments might be over-compensating for the lack of traffic and competition of protected routes, possibly in order to achieve 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 universal service obligations in the airline industry and describes the regulatory design in place in Spain. Section 3 develops a theoretical model that provides the basis for interpreting the empirical results. Section 4 presents the empirical analysis. Finally, section 5 concludes.

2 Literature review and Spanish regulation

2.1 Literature review

Before the liberalization reform initiated in the nineties, 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, uniform prices involved 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, however, competition has rendered these financing mechanisms unsustainable and public authorities have been forced to implement universal service policies to compensate for the adverse effects of the reform in some groups of consumers and regions. Governments define the basic services that must be guaranteed to the whole population, select the public service operators, and choose the instruments to finance them. Below, we briefly review the main contributions of the economic literature to the study of these three regulatory problems.

Defining the basic services that must be made available to all citizens 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 service obligations are sufficiently important to justify their costs and, more importantly, the restriction in competition they usually entail. Cremer et al. (2001) and Cremer (2009) identify several economic justifications for facilitating access to a service. Here we summarize the ones that are most closely related to air transportation:

(1) Redistribution of income: PSOs are an alternative redistributive mechanism to taxes and direct transfers; (2) Network externalities: by subsidizing some passengers, others might enjoy additional frequencies, and by subsidizing some routes others might receive more traffic and become profitable; (3) The public good: A national network of air transportation enhances social cohesion and equity; and (4) Regional policy: prices and frequencies can be regulated to facilitate regional development.

A number of theoretical papers study the properties of several methods for allocating the PSOs to a firm. Most consider the use of auctions (Anton et al., 1998; Chone et al., 2000; Sorana, 2000, Calzada et al., 2010). In the case of air transportation, Williams (2005) analyze the merits of the tendering system used in Norway.

Finally, a third group of theoretical papers focus on the economic distortions generated by the PSO financing mechanisms (Armstrong, 2001; Calzada, 2009; Mirabel el al., 2009; Valletti et al., 2002). For the particular case of air transportation, Nolan et al. (2005) examine the social welfare implications of different schemes that can be used in thin markets: direct subsidies, protected route packages, and revenue guarantees. In general, these papers distinguish two main forms of financing the public service operator: cross-subsidies from one group of consumers to another, and direct subsidies to the operator. The second option is considered by the literature to be 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 operators. In contrast to these works, our paper examines the effects of the price discounts applied in air transportation to island residents. We show that in Spain residents' discounts can be considered as an indirect mechanism for financing the universal service operator, as operators take advantage of them to increase prices.

Very little attention has been paid to finding the optimal universal service 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. Billette 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, although we focus on the particular price and frequency regulations that are currently used in Spain.

2.2 Universal service obligations in the Spanish airline market

In the EU, member states use universal service policies to promote the mobility of the population in remote and peripheral areas. France, Italy, Portugal, Spain and the UK establish discount schemes that cover the residents of selected islands and regions. For example, residents of Madeira and Azores in Portugal and Sardinia in Italy benefit from price discounts. Some countries complement this direct social aid with public service obligations imposed on air carriers serving peripheral or developing regions and other thin routes. The European regulation stipulates that subsidized routes must satisfy two requirements to be eligible[3]: the annual seating capacity should be below 30,000; and no other forms of transport can ensure adequate, uninterrupted service. However, some authors such as Williams and Pagliari (2004) and Williams (2005) claim that on many occasions PSOs are the result of local political pressure and bear little relation to issues affecting the periphery, economic development, and the availability of alternative transportation services.

There is considerable variation in the application of PSOs. Countries such as France, Irish Republic and Norway have made extensive use of this policy, but other member states like the UK have been much less interventionist. Usually, protected routes must offer a minimum daily service frequency and/or satisfy specific timetable obligations. On many occasions, governments also define the maximum fares that can be imposed. As a result, the amount of subsidy given per one-way journey varies widely both between and within countries (Williams and Pagliari, 2004).

In Spain, in recent decades the government has established several measures to promote the mobility of island residents and the residents of the cities of Ceuta and Melilla. Here we

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[3] Council Regulation (ECC) No 2408/92 on Access for Community Air Carriers to Intra-Community Air Routes. Article 4.1 of this regulation allows member states to impose PSOs in air transportation. In 2008, this legislation was modified by Regulation (ECC) No 1008/08 of the European Parliament and the Council of 24 September, on common rules for the operation of air services in the Community.

summarize those that affect air transportation:

Residents discount scheme.- Between 2001 and 2004 residents of Canary and Balearic islands and the cities of Ceuta and Melilla enjoyed a 33 % discount, financed by public funds. From 2004 to 2007 the discount increased progressively from 33 % to 50 %.[4]

Subsidies of airport fees.- Airport fees on domestic routes that link the mainland and the islands are about 40 % lower than on the rest of domestic routes. Moreover, airport fees on intra-island routes are almost five times cheaper than on the rest of domestic routes.

Public Service Obligations.- 13 intra-island routes in Canary islands and 3 intra-island routes in Balearic islands are subject to public service obligations that guarantee the continuity, frequency, capacity, quality and affordability of the service. In November 2003, the Spanish Government established the following conditions for operating these routes:[5]

1. Timetable requirements. Airlines must guarantee the provision of the service from 7h to 9h in the morning. The return at night must be provided from 20h to 22h, depending on the route.

2. Frequency floors. Each route must operate several flights per day. For example, between Mallorca and Menorca at least four daily flights must be offered in the winter and five daily flights in the summer. Between Gran Canaria and Tenerife, at least 12 daily flights must be offered in the winter and at least 14 in the summer.

3. Seating capacity. Airlines must offer minimum levels of seating capacity. For example, on the Mallorca-Menorca route the minimum level of seating capacity is 63,000 seats in winter, and on the Gran Canaria-Tenerife route the minimum seat capacity in winter is 295,000.

4. Price caps. Fares must not exceed 82 euros for each round of the trip between Mallorca and Ibiza and Mallorca and Menorca. On the Canary routes, fares in the 13 routes

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[4] See Real Decreto 1316/2001, of November 30th and Real Decreto 1340/2007, of October 11th.

[5] The regulation of PSOs is based on legislation passed in 1997 concerning tax measures, government and social order.

> protected vary from 56 euros between Gran Canaria and Tenerife to 94 euros between La Palma and Lanzarote. Since 2003, these fares have been updated each year in accordance with 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 %.[6]

An additional feature of the Spanish regime is that routes subject to PSOs are not granted exclusively to one airline. In spite of this, protected routes are usually dominated by one operator. In the Balearics, Air Nostrum, a regional airline owned by Iberia, operates most of the flights. In the Canaries, the main operator is Binter, an airline that specializes in intra-island flights.

3 Theoretical framework

In this section, we follow Billette de Villemeur's model (2004) to analyze the strategy of an airline that connects an island and the mainland. This model is specially useful for our objective of analyzing price discounts because it considers that demand is elastic.[7] Users of the airline are island residents ($i = 1$) and mainland residents ($i = 2$). The proportion of island residents over all passengers is α, and the proportion of mainland residents is $1 - \alpha$.

The airline's demand depends on the ticket price p and on the flight frequency f. Consider that consumers preferences on departure times are uniformly distributed over the time and their expected schedule delay cost is $v > 0$. Therefore, consumers' average waiting-time cost is $v/2f$.[8] Consider that $0 \leq d_i \leq 1$ is the price discount granted by the government to type i passengers and that the discount is financed with public funds. Assuming that the consumer's gross surplus generated by a flight is $S(X_i)$, the demand function of type i passengers takes

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[6] In 2008, the Spanish government modified the pricing regime to promote the entry of new carriers on subsidized routes. In the new regulation, for at most 50 % of the seats occupied the maximum fares are 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 this figure. See Ministry of Fomento, FOM/1085/2008, April 7th .

[7] Brueckner (2010) analyzes how airlines set the prices and frequencies in a competing environment. He extends Brueckner (2004) and Brueckner and Flores-Fillol (2007) to assume that demand is elastic.

[8] The schedule delay cost is the difference between the preferred and the actual time of the flight which can have an important influence on business passengers. Frequency is a key variable to reduce it.

the following form:

$$X_i(p,f) = argmax_{X_i}\{S(X_i) - (p(1-d_i) + \frac{v}{2f})X_i\}. \tag{1}$$

Taking this into account, $X = X_1 + X_2$ is the airline's total demand. The airline faces a cost $C(K)$ for each flight, where K is the capacity of the aircraft (number of seats). We consider that in the long run the airline adjust the aircraft's capacity to the total number of passengers and therefore the condition that $X = Kf$ is satisfied. The firm's costs can be reduced with a subsidy $s \geq 0$ that is also financed by public funds. Moreover, the airline has a fixed cost F, which is independent of aircraft capacity. Using this information, the airline sets p and f to maximize the following profit function:

$$\Pi(p,f) = pX - f[C(X/f) - s] - F. \tag{2}$$

3.1 Residents' discounts and airline subsidies

We start our analysis of the air-transportation universal service policies by considering the effect of residents' discounts and subsidies on the airline's equilibrium prices and frequencies. We then assess the effects of price caps and frequency floors.

In order to show the main mechanism at work, we focus on the case where $d_1 > 0$ and $d_2 = 0$. The first order conditions of the airline maximization problem are then as follows:

$$\begin{aligned} \frac{\partial \Pi}{\partial p} &= X + (p - C'(K))\frac{\partial X}{\partial p} = 0; && (3) \\ \frac{\partial \Pi}{\partial f} &= (p - C'(K))\frac{\partial X}{\partial f} - C(K) + s + \frac{X}{f}C'(K) = 0. && (4) \end{aligned}$$

From equation (1) these conditions can be simplified by using the fact that $\frac{\partial X_i}{\partial f} = \frac{-v}{2f^2(1-d_i)}\frac{\partial X_i}{\partial p}$. Note that as the discount reduces the price of the service but not consumers' average waiting-time cost, the impact on demand of a change in the frequency is higher with a discount. Denoting by $\varepsilon_i = -\frac{p}{X_i}\frac{\partial X_i}{\partial p}$ the price-elasticity of demand we obtain:

$$\frac{p - C'(K)}{p} = \frac{X}{\alpha X_1 \varepsilon_1 + (1-\alpha) X_2 \varepsilon_2}; \tag{5}$$

$$\frac{v}{2f}\left[\frac{\frac{\alpha}{1-d_1}\frac{\partial X_1}{\partial p} + (1-\alpha)\frac{\partial X_2}{\partial p}}{\alpha\frac{\partial X_1}{\partial p} + (1-\alpha)\frac{\partial X_2}{\partial p}}\right] = \frac{C(K) - s}{K} - C'(K). \tag{6}$$

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 the two groups of passengers. When $d_1 > 0$ the presence of island residents increases the price mark-up because the discount makes their demand more inelastic than that of mainland residents. Indeed, for the same price increase the island residents' consumption decreases less than that of mainland residents.

Equation (6) shows that the airline increases its frequency until the average waiting time corrected by the impact of the discount is equal to the average cost (after incorporating the subsidy) minus the marginal cost. The left-hand side of the equation shows that with the discount the firm offers a higher frequency because the demand responds more strongly to a change in f. This change depends on the proportion of island residents that benefit from the discount.

In the airline industry, a higher frequency implies additional fixed costs (landing fees, gate renting, etc.) and reduces the opportunity of exploiting density economies through the use of larger aircrafts with higher load factors. In our model, the idea that higher costs reduce the frequency is obtained by assuming that $C(K)/K$ is decreasing in K. Taking this into account, the right-hand side of equation (6) shows that when the average cost per flight decreases due to a higher K the airline offers more frequencies. Moreover, it shows that the government can promote an increase in frequencies by giving subsidies to the airline.

Finally, we consider the case where the airline cannot increase its supply to absorb all the demand. For example, in many routes airlines are unable to acquire more slots when demand increases. In order to reflect this situation, we assume that the aircraft's capacity and the frequency are fixed and that the total number of passengers attended cannot be greater than the existing transportation capacity, $X < \overline{X}$. Denoting the Lagrangian multiplier associated to this capacity constraint as $\lambda \geq 0$ we obtain the following first order condition for the price:

$$\frac{\partial L}{\partial p} = X + (p - C'(K))\frac{\partial X}{\partial p} - \lambda\frac{\partial X}{\partial p} = 0. \tag{7}$$

Rearranging this equation yields:

$$\frac{p - C'(K) - \lambda}{p} = \frac{X}{\alpha X_1\varepsilon_1 + (1-\alpha)X_2\varepsilon_2}. \tag{8}$$

This result shows that when the capacity restriction is binding ($\lambda > 0$) the airline increases the price to adjust the number of passengers to its capacity. In other words, if the demand increase generated by the discount cannot be satisfied with the existing capacity, the airline increases its price.

In section 4 we analyze the effects of the universal service policy applied in the Spanish airline market. We show that routes benefiting from subsidies and price discounts exhibit higher prices than the rest of domestic routes. However, we do not find evidence that these measures have increased the frequency offered by airlines. It is possible that airlines compensate for the scarcity of new slots by using bigger aircrafts and higher load factors. However, we argue that the most likely explanation for this result is that the main part of the demand increase generated by the discounts is absorbed via an increase in prices.

3.2 Public service obligations: price caps and frequency floors

Airlines may want to secure the profitability of routes with thin demand by setting high prices and low frequencies. This strategy can be favored by the absence of competition. As we have explained in Section 2, many countries have tackled this situation by establishing public service obligations (PSOs) on the airline operators on selected routes. Under these obligations, airlines can freely determine their commercial policy but must satisfy some price caps and frequency floors.[9]

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[9] Billette de Villemeur (2004) shows that a conveniently designed "price-and-frequency" cap constraint of the form $p + \frac{v}{2f} \leq \overline{p}$ can implement the second-best allocations for p and f. In our model, however, we have considered separate constraints on the price and the frequency to identify the main effects of the Spanish regulatory regime.

In order to analyze the effects of PSOs implemented in Spain and in other European countries, imagine a monopolist that maximizes its profits subject to a price cap, $p \leq \overline{p}$, and a frequency floor, $\frac{v}{2f} \leq \overline{v}$.[10] Next we assume that all passengers are island residents, $\alpha = 1$, with the objective to clearly identify the effects of PSOs.

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

$$\begin{aligned} \frac{\partial L}{\partial p} &= X + (p - C'(K))\frac{\partial X}{\partial p} - \lambda_1 = 0; & (9) \\ \frac{\partial L}{\partial f} &= (p - C'(K))\frac{\partial X}{\partial f} - (C(K) - s) + \frac{X}{f}C'(K) + \lambda_2 \frac{v}{2f^2} = 0. & (10) \end{aligned}$$

where λ_1 and λ_2 are the Lagrange multipliers associated to the price and frequency constraints respectively. Simplifying the above conditions we obtain:

$$\begin{aligned} \frac{p - C'(K)}{p} &= (\frac{X - \lambda_1}{X})\frac{1}{\varepsilon_1}; & (11) \\ [(\frac{X - \lambda_1}{X})(\frac{1}{1 - d_1}) + \frac{\lambda_2}{X}]\frac{v}{2f} &= \frac{C(K) - s}{K} - C'(K). & (12) \end{aligned}$$

First note that when the two restrictions are not binding ($\lambda_1 = 0$ and $\lambda_2 = 0$) the price and the frequency are determined as in the standard case defined by Billette the Villemeur (2004): the airline establishes a mark-up over the price that is inversely related to the elasticity of the demand[11] 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 cap is binding, λ_1 is established to satisfy $p = \overline{p}$. In addition, the presence of λ_1 in the frequency equation reflects that now the airline wants to protect its profits by reducing the frequency offered.

The airline determines its frequency level taking into account the price cap, the price discount and the cost subsidies. Although the use of a price cap can reduce the frequency offered by the monopolist, the price discount and the cost subsidy can compensate this effect.

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[10] Note that the last expression can be written as $f \geq \frac{v}{2\overline{v}}$. That is, the establishment of a frequency floor is equivalent to limiting consumers' average waiting time.

[11] The price also depends on the frequency as the elasticity ε_1 is a function of the price and the frequency.

Only when the airline's profit maximizing frequency is lower than the floor fixed by the regulator, then λ_2 is set to satisfy the frequency constraint. Therefore, equation (12) shows that regulators can use different instruments to increase the frequency, such as residents' discounts and costs subsidies, and if these measures are not enough to attain the frequency objectives, or if they are too costly, then they can set a frequency floor.

Our empirical model of the next section analyzes the price caps and frequency floors imposed to intraisland flights in Spain. We show that these regulations have been effective in reducing the prices and in increasing the frequency compared to other domestic routes of similar characteristics but which do not benefit from PSOs.

4 Empirical model

In this section we develop an empirical model to analyze the effects of the universal service policy applied in the Spanish airline market during the period 2001-2009. To do so, we estimate a price and a frequency equation at the route level to assess the impact of the residents' discount scheme and the PSOs applied during this period.

4.1 The data

First, we describe the variables used in the price and frequency equations and explain the sources of this information. We have data for 86 domestic routes. Of these, 23 are routes that link islands with the mainland and 14 are intra-island routes. The frequency of the data is semi-annual, as we differentiate between the summer and the winter seasons in a time period that starts in the winter of 2001 and finishes in the winter of 2009. Overall, we have 1129 observations.

Price (p): Data on prices have been collected using two procedures. For routes that are not subject to PSOs, we consider the lowest mean round trip price charged by airlines present on a route weighted by their corresponding market share. This information has been obtained from airline web sites using a homogeneous process in a sample week for each period. The price for each route considers the city with the largest airport as the city of origin. Information 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 on all data collection for all airlines and routes, taking into account the fact that our empirical analysis exploits the variability across routes.

For routes with PSOs, we consider the maximum or the reference price established by the government, which is published in the Official Journal of the European Union. Therefore, the prices effectively charged in practice may be even lower that the ones we consider. We use these prices because we do not have information on the prices established in intra-Canary routes.

Frequency (f): This variable shows the weekly total frequency offered by airlines on each route. This information has been obtained from the web site of the Official Airlines Guide (OAG). Data collection for frequencies refers to the same sample week as for prices. Data for intra-Canary routes come from RDC Aviation Limited (capstats data).

Demand (X): Total number of passengers carried by airlines on the route, including direct and connecting traffic. Information has been obtained from the web site of the Spanish Airports and Air Navigation agency (AENA).

Population: (Pop): Mean population in the route's origin and destination provinces (NUTS 3). Data have been obtained from the Spanish National Statistics Institute (INE). We use data for population at NUTS 3 level rather than NUTS 2 level, because this variable captures the size of the urban agglomeration close to the airport more accurately.

Gross domestic product per capita ($GDPc$): Mean gross domestic product per capita in the route's origin and destination regions (NUTS 2). Data have been obtained from the Spanish National Statistics Institute (INE). We use this variable at the regional level because the information is not available at the province level for the whole period analyzed.

Tourism ($Tour$): Percentage of employment in hotels and restaurants. Data have been obtained from Cambridge Econometrics (European regional database publication). We use this variable at the regional level because the information is not available at the province level.

Distance (*Dist*): Number of kilometers that separates the route's origin and destination airports. Data have been obtained from the WebFlyer site.

Route concentration (*HHI*): Herfindahl-Hirschman Index at the route level. The index is computed as the sum of the market share squares of airlines operating the route in terms of departures. Data on departures of each airline on each route have been obtained from the Official Airlines Guide (OAG) web site and RDC Aviation limited.

The price and frequency equations also consider two dummy variables that are the focus of our analysis. First, we include a dummy variable that takes the value 1 in routes that enjoy island residents' discounts ($D^{discount}$). These are 23 domestic routes that connect the islands and the mainland and 14 intra-island routes, where island residents enjoy a 50% price discount. In addition, airlines operating these routes receive a reduction in airport fees. The second dummy variable included in the price and frequency equations takes the value 1 in the 14 intra-island flights with public service obligations considered in our analysis (D^{pso}). In particular, it takes the value 1 for intra-island routes in the Canaries since the winter of 2001 and for intra-island routes in Balearics since the summer of 2004.

Finally, we also consider a dummy variable that takes the value 1 in the summer season (D^{summer}).

Table 1 shows the mean values of the variables used in the empirical analysis for three sub-groups of routes: 1) Routes with no islands as endpoints; 2) Routes that link islands with the mainland; and 3) Intra-island routes. Recall that price discounts and airline subsidies are applied to the latter two groups and PSOs are only imposed on the latter group.

Prices per kilometer and frequencies are similar in the first two groups. However, routes that link islands with the mainland are longer and transport more persons. Intra-island routes show the lowest mean prices and the highest number of frequencies, but are shorter and transport less passengers. As a consequence, this is the group with the highest price per kilometer. It is also worth noting that the Herfindahl-Hirschman Index is particularly high in intra-island routes, which means that competition is soft. Note that these statistics only provide a rough picture of these route categories. In order to assess the effects of price discounts and PSOs, in the next section we undertake an econometric multivariate analysis.

Variable	**Routes with no islands as endpoints**	**Routes that link islands with the mainland**	**Intraislands routes**
Prices (euros)	175.63	228.70	133.17
Prices per kilometre (euros)	0.37	0.37	0.80
Frequency (weekly number of flights)	44.27	46.60	50.44
Demand (number passengers)	191,664.3	266,168.4	130,556.2
Distance (kilometres)	509.97	972.80	175.95
HHI (Hirschman-Herfinbdalh index)	0.80	0.53	0.87
Population (inhabitants)	3,024,522	2,534,382	978,640
GDP per capita (euros)	22,417.6	22,425.62	19,399
Tourism (% employment hotels & restaura.)	0.06	0.12	0.14
Number of routes	49	23	14

Table 1: Descriptive statistics of the variables

Table 2 presents the matrix of correlations between variables. It shows a strong relationship between demand and frequency and a strong correlation between the dummy for discount and tourism. Furthermore, we can see that distance is a major determinant of prices.

	Prices	**Freq.**	**Dem.**	**Dist.**	**HHI**	**Popul.**	**GDP**	**Tour.**	**$D^{discount}$**	**D^{pso}**
Prices	1									
Frequency	-0.20	1								
Demand	-0.11	0.94	1							
distance	0.52	-0.10	0.08	1						
HHI	0.001	-0.41	-0.49	-0.37	1					
Population	0.03	0.36	0.47	0.23	-0.29	1				
GDP	-0.06	0.20	0.18	-0.03	-0.25	0.44	1			
Tourism	0.01	0.20	0.08	0.05	-0.34	-0.22	0.04	1		
$D^{discount}$	0.10	-0.09	0.05	0.15	-0.31	-0.48	-0.16	0.78	1	
D^{pso}	-0.21	0.03	-0.10	-0.37	0.20	-0.64	-0.32	0.46	0.20	1

Table 2: Correlation Matrix of the variables (N=1129)

4.2 Estimation strategy

Our methodological approach is similar to that applied in the literature to analyze the determinants of prices and frequencies at the route level. The pricing equation includes distance and traffic density in order to reflect the airline's costs, and route competition to reflect the mark-ups of prices over costs. In a similar vein, the frequency equation considers distance, route competition and demand shifters at the route level. However, our interest is focused on the variables that allow identification of the impact of the universal service policy. Next we present the explanatory variables considered in our pricing and frequency equations and the expected sign of the coefficient associated with these variables.

Pricing equation. The price of route k at period t can be explained by the following equation:

$$\begin{aligned} p_{kt} &= b_0 + b_1 X_{kt} + b_2 Dist_{kt} + b_3 HHI_{kt} + b_4 {D^{discount}}_k + b_5 {D^{pso}}_{kt} \\ &\quad + b_6 {D^{summer}}_t + b_7 TimeTrend_t + e_{kt}. \end{aligned} \tag{13}$$

The expected influence of the explanatory variables is the following:

Demand (X): The expected sign of the coefficient of this variable is ambiguous. Intense traffic makes it possible to exploit density economies, as the airline can use bigger planes at higher load factors and optimize the use of the crew. In a competitive environment this should lead to lower prices, but when market power and capacity constraints are present more traffic might lead 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 three instruments for 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.[12]

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[12] Alternatively, we could have estimated the reduced form of the pricing equation. This will consist in including as explanatory variable the instruments of the demand instead of the fitted values of the demand from the first regression of the two-step procedure. However, the specification chosen fits better with the theoretical framework developed in the previous section. Additionally, it allows capturing whether density economies are relevant.

Distance (*Dist*): Distance is a major determinant of the costs faced by airlines and we expect that the coefficient of this variable will be positive and lower than one. That is, the costs will increase less than proportionally with an increase in kilometers flown. Long-haul routes involve higher average speeds, less intense consumption of fuel, and lower airport charges per kilometer.[13]

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 this variable. We deal with this problem by using as instrument the first lag of the variable (e.g. the instrument of route concentration in the summer of 2004 would be route concentration in the summer of 2003).

Dummy for island residents' discount ($D^{discount}$): Dummy variable that takes value 1 for domestic routes with an island as endpoint that benefits from residents' discounts and airport fee subsidies. Section 3 has shown that the expected effect of this measure is a price increase because the discount makes the demand of island residents less elastic. The discount should also increase the traffic on the route, but in our price equation this effect should be captured by the demand variable.

The magnitude of the discount effect could be distorted by the fact that flights to 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 conducted a separate estimation of equation (13) excluding domestic routes from the mainland with a distance less than 500 kilometers. This strategy allows us to compare routes with islands as endpoints and long-haul routes from the mainland. In both cases, intermodal competition should not be strong.

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[13] The estimation of the price equation using prices per kilometer offers almost identical results to those obtained when using prices as dependent variable. When using prices per kilometer, the coefficient associated with 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 intra-island flights (D^{pso}): Dummy variable that takes value 1 for intra-island routes that are regulated with PSOs. These are intra-island routes in the Canary islands for all the period analyzed and in the Balearic islands since 2004. The imposition of PSOs on a route implies that airlines must offer a minimum frequency and satisfy a price cap. If this price cap is set to equal the prices of non-regulated routes we should expect the coefficient of this dummy to be non-significant. However, the cap fixed by the government can be higher or lower than the prices set elsewhere.

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

Time trend ($TimeTrend$): A time trend is also included in the model to account for changes over 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:

$$\begin{aligned} f_{kt} \quad = \quad & c_0 + c_1 Pop_{kt} + c_2 GDPc_{kt} + c_3 Dist_k + c_4 HHI_{kt} + c_5 {D^{discount}}_k \\ & + c_6 {D^{pso}}_{kt} + c_7 {D^{summer}}_t + c_8 TimeTrend_t + e_{kt}. \end{aligned} \tag{14}$$

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

Demand (X): The frequency equation adopts a different empirical strategy in relation to the demand variable. An estimation that regresses 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. It is unlikely that this over-identification is corrected by an instrumental variable procedure. Thus, instead of estimating the demand variable we prefer to include the instruments of demand (population and GDP per capita) in the frequency equation. We expect a positive sign of the coefficient of these variables.[14]

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[14] The high correlation between the dummy variable for islands and tourism intensity in the destination region argues against including the tourism variable as an explanatory variable in equation (14). Hence,

Distance ($Dist$): We expect a negative relationship between frequency and distance on a route. Airlines may prefer to reduce frequencies in longer routes where they can exploit density economies by using bigger planes at high load factors. In addition, since intermodal competition is soft in long-haul routes, airlines do not need to offer high frequencies to compete with cars and trains.

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

As in the pricing equation, there may be a simultaneous determination of the dependent variable and market concentration. We deal with this problem by using the first lag of the concentration at the route level as instrument.

Dummy for island residents' discount ($D^{discount}$): Variable that takes value 1 for routes with an island as endpoint. Frequency may be lower in these routes because airlines do not suffer from intermodal competition and they have a higher proportion of tourists, who are less time-sensitive than business passengers. In spite of this, there are also important reasons that would favor higher frequency in island routes: first, they have more demand due to tourism. And second, island residents enjoy price discounts, which increase the demand and as a result the frequencies. Taking all these influences into account, it is not clear what the sign of the coefficient associated to this variable should be.

As for the pricing equation, we account for the role of intermodal competition by estimating equation (14) excluding routes from the mainland of a distance lower than 500 kilometres. Therefore, in this sub-sample we compare routes with islands as endpoints and long-haul routes from the mainland. In both cases, intermodal competition should not be strong.

Dummy for intra-island flights (D^{pso}): This variable takes value 1 for intra-island routes

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the dummy variable for island residents' discounts 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.

regulated with PSOs. Airlines operating intra-island routes in the Canary and Balearic islands must offer a minimum frequency requirement. The frequency level set by the government can be higher or lower than those of the routes not protected with PSOs.

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

Time trend ($TimeTrend$): A time trend is also included in the frequency equation to account for changes in the variables over time.

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 on each route may influence airline entry patterns.

The frequency equation is also estimated using 2SL-IV, but only the route concentration variable 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. The instrument suitability tests, the partial R^2 of the first stage regression and the Hansen's J test of the possible endogeneity of the instruments, show a high correlation between the variables instrumented and the instruments, and indicates the exogeneity of the instruments.

Note also that we compute standard errors that are robust to any bias from heteroskedasticity. Additionally, we adjust our estimates by clustering observations from the same route.

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. Nor is a random-effects model appropriate because the individual effects related to routes are probably correlated with the error term, as indicated by the 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 in the mainland shorter than 500 kilometers. The estimation for this sub-sample allows us to compare differences between routes with islands as endpoints and routes in the mainland where intermodal competition should be soft.[15]
3. A sub-sample that only includes routes with islands as endpoints. All routes in this sub-sample enjoy island residents' discounts. As a result, we can more accurately differentiate between the effects of price caps and frequency floors and those created by residents' 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. The demand variable is not statistically significant. A possible explanation is that the negative effect of demand on the price related to the exploitation of density economies is compensated by the positive effect generated by airlines market power and by capacity restrictions. The distance variable is statistically significant, as expected, and the sign of its 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. Furthermore, prices are higher in the summer when tourism is more intense, and no clear time trend appears from our estimation.

The main interest of our analysis is the result that airlines set higher prices on routes with residents' discounts than on the rest of domestic routes.This result suggests that airlines may be taking advantage of the universal service policy to increase prices. A similar result

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[15] Some routes in Spain are served by high-speed trains but none of them covered a distance of more than 500 kilometres in the period considered.

appears when we compare routes with islands as endpoints with long-haul routes on the mainland, although in this case the coefficient of the dummy variable for residents' discounts is smaller. Therefore, the lack of intermodal competition in routes with islands as endpoints only partially explains the higher prices.

The conclusion that the higher prices of island routes may be related to the discount policy is supported by our estimates of the demand elasticity. Indeed, while the estimated demand elasticity for all routes in our sample is -1.32, the estimated elasticity for routes with islands as endpoints is just -0.98. As we explained in the theoretical framework of section 3, this difference may be due to the presence of the discount.[16]

Explanatory Variables	**All Sample**	**All sample except routes <500 kms from the mainland**	**Routes with an island as endpoint**
Demand (*X*)	-0.000016 (0.000031)	0.000095 (0.000097)	0.000093 (0.000097)
Distance (*dist*)	0.11 (0.009)***	0.11 (0.009)***	0.11 (0.009)***
HHI	110.31 (28.71)***	191.21 (59.10)***	142.66 (58.04)**
$\mathbf{D^{discount}}$	37.96 (10.05)***	29.50 (14.39)**	-
$\mathbf{D^{pso}}$	-45.65 (12.09)***	-58.85 (18.98)***	-42.82 (19.63)**
$\mathbf{D^{summer}}$	54.82 (6.51)***	71.02 (9.13)***	69.44 (12.99)***
Time Trend (*T*)	-0.41 (1.37)	2.46 (2.40)	3.98 (2.17)*
Intercept	8.38 (31.70)	-76.90 (63.32)	-28.93 (55.64)
N	1129	706	470
$\mathbf{R^2}$	0.42	0.41	0.48
F (Joint Significance)	36.58***	25.38***	20.85***
Tests of instruments:			
Partial R^2: *X*	0.43	0.40	0.39
Partial R^2: *HHI*	0.60	0.54	0.57
Hansen J (H_o:Instrum. Exogen.)	2.97	5.34*	1.98

Note 1: Standard errors in parenthesis (robust to heteroscedasticity)
Note 2: Stastistical significance at 1% (***), 5% (**), 10% (*)
Note 3: Instruments for the demand and route concentration variables are the following: GDP per capita, population and tourism per capita, and the lag of concentration index.

Table 3. Pricing equation estimates (2SLS-IV)

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[16] Results of the estimates of the demand equation are available upon request from the authors.

The second objective of this paper is to determine whether intra-island routes subject to PSOs exhibit different prices than unregulated routes. The estimates show that prices in intra-island routes are lower than on the rest of domestic routes. Hence, price caps seem to over-compensate for the lack of demand and competition on these routes. At this point, it is natural to ask how can these intra-island routes be profitable with these low regulated prices and without receiving public subsidies. Although there is not information available to answer this question, we consider that the sustainability of these routes may in part be attained through the demand increases generated by residents' discounts. If so, the discounts will compensate for the price constraints.

Explanatory Variables	**All Sample**	**All sample except routes <500 kms from the mainland**	**Routes with an island as endpoint**
Population (*pop*)	0.000024 (0.000012)**	0.000011 (4.43e-06)**	0.00014 (7.06e-06)**
GDP per capita (*GDPc*)	0.0013 (0.0013)	0.00063 (0.0013)	-0.00019 (0.002)
Distance (*dist*)	-0.029 (0.008)***	-0.024 (0.0087)***	-0.026 (0.009)***
HHI	-100.25 (15.32)***	-93.07 (18.14)***	-106.67 (28.32)***
$\mathbf{D^{discount}}$	-0.43 (3.71)	2.06 (8.23)	-
$\mathbf{D^{pso}}$	58.32 (13.81)***	35.85 (11.86)***	42.30 (13.45)***
$\mathbf{D^{Summer}}$	0.68 (1.43)	3.73 (1.67)**	5.41 (2.45)**
Time Trend (*T*)	-4.25 (2.09)**	-3.02 (1.57)*	-1.47 (1.88)
Intercept	56.14 (39.05)	88.40 (33.65)**	99.60 (46.96)**
N	1123	705	468
$\mathbf{R^2}$	0.40	0.42	0.39
F (Joint Significance)	10.50***	6.39***	6.75***
Tests of instruments: **Partial R^2: HHI_{route}**	0.52	0.47	0.51

Note 1: Standard errors in parenthesis (robust to heteroscedasticity)
Note 2: Stastistical significance at 1% (***), 5% (**), 10% (*)
Note 3: Instrument for route concentration is the lag of concentration index.
Note: The Hansen J-test for exogeneity of instruments can not be implemented in case that just one instrument is used for the corresponding endogenous explanatory variable

Table 4. Frequency equation estimates (2SLS-IV)

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 population variable is positive and statistically significant, as expected. The coefficient of the GDP per capita variable is also positive but not statistically significant. As anticipated, airlines reduce frequencies on long and concentrated routes. Finally, airlines offer slightly higher frequencies in the summer season and there is a tendency towards a decrease in the number of weekly flights offered over time for the period 2001-2009.

Importantly, the coefficient of the dummy variable for residents' discounts is not statistically significant. Recall that this variable captures a variety of effects. On the one hand, island routes have higher demand, due to tourism and residents' discounts. On the other hand, the lack of intermodal competition and the lower proportion of business passengers may reduce frequencies. In spite of this, when we compare routes with islands as endpoints with long-haul routes from the mainland (which are not affected by intermodal competition), the coefficient of the dummy for discounts is still not statistically significant.

These results merit some further discussion. Our interpretation is that airlines do not find it profitable to increase frequency on these routes, even if they are favored by residents' discounts. In fact, higher frequencies imply higher costs for airlines: they cannot fully exploit density economies and must pay additional fixed costs. Moreover, in Spain airlines may have few opportunities to increase route frequencies due to the restrictive system of slot allocation and airport congestion. In this context, the increase in demand generated by the discounts might be adjusted via price increases. This result is consistent with our findings for the price equation.

Finally, another interesting result from the frequency equation is that intra-island routes protected by PSOs exhibit higher frequencies, even although the prices are substantially lower in these routes. Therefore, it seems that frequency floors have been effective in increasing frequencies, even beyond those offered in competitive routes. Note also that the use of small regional jets in intra-island routes may also explain the high amount of frequencies offered.[17]

We finish this discussion by showing the magnitude of the effects of the universal service

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[17] For a more detailed analysis of the effects of regional jets see Brueckner and Pai (2009).

policy applied in Spain in terms of variations in prices and frequencies. Controlling for several factors, table 5 shows that prices of round trip flights that benefit from residents' discounts are about 37 euros higher than the prices of the rest of domestic routes. However, frequencies are not affected by the discounts. If we now compare round trip flights that benefit from residents' discounts with long-haul routes on the mainland, in the first case prices are about 29 euros higher, and airlines frequencies are still quite similar. Thus, the lack of intermodal competition in islands explains only part of differences in prices.

The analysis of intra-island routes gives even more strong results. The prices in intra-island routes are 42 euros lower than those of routes with an island as an endpoint that benefit from discounts. Controlling for several factors, the impact of PSOs on frequencies is also quite important since airlines offer around twice as many weekly flights on intra-island routes than on the rest of domestic routes.

	All Sample		**All sample except routes <500 kms from the mainland**		**Routes with an island as endpoint**	
	Prices	**Frequency**	**Prices**	**Frequency**	**Prices**	**Frequency**
Mean	182.4 Euros	45.9 weekly flights	197.7 Euros	42.4 weekly flights	191.6 Euros	47.9 weekly flights
Estimated elasticity for $D^{discount}$	0.21	-0.009	0.15	0.05	-	-
Change in values for $D^{discount}$=1	37.6 Euros	-0.4 weekly flights	29.1 Euros	2.0 weekly flights	-	-
Estimated elasticity for D^{pso}	-0.25	1.24	-0.29	0.83	-0.21	0.84
Change in values for D^{pso} =1	-45.2 Euros	57.1 weekly flights	-58.0 Euros	35.2 weekly flights	-41.9 Euros	40.3 weekly flights
Overall change in routes with price discounts (D^{island}=1 + D^{pso} =1)	-7.6 Euros	56.7 weekly flights	-28.9 Euros	37.2 weekly flights	-	-

Table 5: Elasticies evaluated at sample means

5 Conclusions

We have examined the effects of the universal service policy applied in the Spanish airline market from both a theoretical and an empirical point of view. The results of our analysis show that prices are higher on routes with island residents' discounts than on the rest of domestic routes. By contrast, we did not find a clear effect of residents' discounts on frequencies. The logic behind this result is that residents' discounts have expanded consumption and made island residents' demand less elastic. These effects have allowed airlines to increase their prices, but the increases in demand have not been enough to induce them to increase their frequencies. Indeed, more frequencies mean higher costs and in addition airlines must acquire more slots, which is not always an option.

Our results suggest that in Spain part of the benefits of price discounts have been transferred to the airlines via price increases, which harms both island residents and passengers who are not covered by the discounts. Therefore, the discounts seem to be working more as a subsidy to airlines rather than as an effective instrument for achieving policy goals such as citizen mobility, social cohesion, and regional development.

We have also found that the price caps and frequency floors established in intra-island routes in the Canary and Balearic Islands have led to lower prices and higher frequencies than on unregulated routes with similar features. This means that public service obligations are overcompensating for the lack of traffic and competition of protected routes. In these circumstances one could conclude that PSOs are seriously weakening the commercial attractiveness of protected routes. However, we argue that a key element that helps to guarantee the viability of these routes is the demand increases generated by residents' discounts.

We conclude by noting that universal service policies in air transportation have received very little attention by the economic literature in spite of its relevance in the European Union and in other countries. Further research should focus on issues like the competition effects of universal service policies and on the optimal design of these regulations.

References

[1] Armstrong, M. (2001), Access Pricing, Bypass and Universal Service, American Economic Review, Papers and Proceedings, 91, 297-301.

[2] Anton, J., J. Vander Weide and N. Vettas (1998), Strategic Pricing and Entry under Universal Service and Cross-Market Pricing Constraints, International Journal of Industrial Organization, 20, 611-629.

[3] Berry, S., M. Carnall and P.T. Spiller (1996), Airline Hubs: Costs, Markups and the Implications of Customer Heterogeneity, NBER Working Paper, 5561, 1-38.

[4] Billette de Villemeur, E. (2004), Regulation in the air: price-and-frequency caps, Transportation Research, Part E, 40, 465-476.

[5] Bilotkach, V., X. Fageda, X. and R. Flores-Fillol (2010), Scheduled service versus personal transportation: The role of distance, Regional Science and Urban Economics, 40, 60-72.

[6] Bitzan, J. and C. Junkwood (2006), Higher airfares to small and medium sized communities-costly service or market power?, Journal of Transport Economics and Policy, 40, 473-501.

[7] Borenstein, S. (1989), Hubs and High Fares: Dominance and Market Power in the U.S Airline Industry, Rand Journal of Economics, 20, 344-365.

[8] Borenstein, S. and J. Netz (1999), Why do all the fights leave at 8.am?: Competition and departure time differentiation in airline markets, International Journal of Industrial Organization, 17, 611-640.

[9] Brander, J.A. and A. Zhang (1990), A Market Conduct in the Airline Industry: An Empirical Investigation, Rand Journal of Economics, 21, 567-583.

[10] Brander, J.A. and A. Zhang (1993), Dynamic Oligopoly Behavior in the Airline Industry, International Journal of Industrial Organization, 11, 407-433.

[11] Brueckner, J.K. (2004), Network Structure and Airline Scheduling, Journal of Industrial Economics, 52, 291-312.

[12] Brueckner, J.K. (2010), Schedule Competition Revisited, Journal of Transport Economics and Policy, forthcoming.

[13] Brueckner, J.K. and R. Flores-Fillol (2007), Airline Schedule Competition, Review of Industrial Organization, 30, 161-177.

[14] Brueckner, J.K. and P.T. Spiller (1994), Economies of Traffic Density in the Deregulated Airline Industry, Journal of Law and Economics, 37, 379-415.

[15] Brueckner, J.K. and V. Pai (2009), Technological innovation in the airline industry: The impact of regional jets, International Journal of Industrial Organization, 27, 110-120.

[16] Calzada, J. (2009), Universal Service Obligations in the Postal Sector: The Relationship between quality and coverage, Information Economics and Policy, 21, 10-20.

[17] Calzada, J., C. Jaag and U. Trinkner (2010), Universal Service Auctions in Liberalized Postal Markets, in M. A. Crew and P. R. Kleindorfer, Heightening Competition in the Postal and Delivery Sector. Cheltenham, UK, Edward Elgar.

[18] Caves, D.W., .L.R. Christensen and M.W. Tretheway (1984), Economies of Density versus Economies of Scale: Why trunk and locals service airline costs differ, Rand Journal of Economics, 15, 471-489.

[19] Chone, P., L. Flochel and A. Perrot (2000), Universal Service Obligations and Competition. Information Economics and Policy, 12, 249-259.

[20] Cremer, H. (2009), Costes sociales y beneficios de las obligaciones de servicio universal en las industrias de red, in J. Calzada, A. Costas and J. Jordana "Mas alla del mercado: Las politicas de servicio universal en América Latina", Fundacio CIDOB. Barcelona.

[21] Cremer, H., F. Gasmi, A. Grimaud and J.J. Laffont (2001), Universal service: an economics perspective, Annals of Public and Cooperative Economics, 72, 5-43.

[22] Dresner, M., R., Windle and Y. Yao (2002), Airport Barriers to Entry in the US, Journal of Transport Economics and Policy, 36, 389-405.

[23] Dresner, M., J.S. C.Lin and R. Windle (1996), The impact of low-cost carriers on airport and route competition, Journal of Transport Economics and Policy, 30, 309-329.

[24] Evans, W.N. and I. N. Kessides (1993), Localized Market Power in the U.S. Airline Industry, The Review of Economics and Statistics, 75, 66-75.

[25] Fageda, X. (2006), Measuring conduct and cost parameters in the Spanish airline market, Review of Industrial Organization, 28, 379-399.

[26] Fageda, X. and L. Fernandez-Villadangos (2009), Triggering competition in the Spanish airline market: the role of airport capacity and low cost carriers, Journal of Air Transport Management, 15, 36-40.

[27] Fisher, T. and D.R. Kamerschen (2003), Price-Cost Margins in the U.S Airline Industry using a Conjectural Variation Approach, Journal of Transport Economics and Policy, 37, 227-259.

[28] Fisher, T. and D.R. Kamerschen (2003), Price-Cost Margins in the U.S Airline Industry using a Conjectural Variation Approach, Journal of Transport Economics and Policy, 37, 227-259.

[29] Hofer, C., R. J. Windle and M. E. Dresner (2008), Price premiums and low cost carrier competition, Transportation Research Part E 44, 864-882

[30] Marín, P.L. (1995), Competition in European Aviation: Pricing Policy and Market Structure, Journal of Industrial Economics, 16, 141-159.

[31] Morrison, S.A (2001), Actual, Adjacent and potential competition: Estimating the full effect of Southwest airlines, Journal of Transport Economics and Policy, 35, 239-256.

[32] Mirabel, F., J.-C. Poudou and M. Roland (2009) Universal Service Obligations: The role of subsidization schemes, Information Economics and Policy, 21, 1-9.

[33] Nolan, J., P. Ritchie and J. Rowcroft (2005), Small market air service and regional policy, Journal of Transport Economics and Policy, 39, 363-378.

[34] Oum, TH., A. Zhang and Y. Zhang (1993), Interfirm Rivalry and Firm-Specific Price Elasticities in Deregulated Airline Markets, Journal of Transports Economic and Policy, 27, 171-192.

[35] Pagliari, R.A. and G. Williams (2004), Comparative Analysis of the Application of Public Service Obligations in Air Transport within the EU, Transport Policy, 11, 55-66.

[36] Pai, V. (2010), On the factors that affect airline flight frequency and aircraft size, Journal of Air Transport Management, 16, 169-177.

[37] Salvanes, K.G., F. Steen and L. Sorgard (2005), Hotelling in the air? Flight departures in Norway, Regional Science and Urban Economics, 35, 193-213.

[38] Santana, I. (2009), Do Public Service Obligations Hamper the Cost Competitiveness of Regional Airlines?, Journal of Air Transport Management, 15, 344-349.

[39] Schipper, Y., P. Rietveld and P. Nijkamp (2002), European airline reform: an empirical welfare analysis, Journal of Transport Economics and Policy, 36, 189-209.

[40] Sorana, V. (2000), Auctions for Universal Service Subsidies, Journal of Regulatory Economics, 18, 33-58.

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

[42] Valletti, T., S. Hoernig and P. Barros (2002) Universal service and entry: the role of uniform pricing and coverage constraints, Journal of Regulatory Economics, 18, 235-245.

[43] Wei, W. and Hansen, M. (2007), Airlines competition in aircraft size and service frequency in duopoly markets, Transportation Research Part E, 43, 409-424.

[44] Williams, G. (2005), European Experience with Direct Subsidization of Air Services, Public Money and Management, June, 155-161.