Competition and Public Service Obligations in European Aviation Markets

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Abstract

We analyze the effect of universal service policies in the airline markets of five European Union countries (France, Germany, Italy, Spain and Germany) in the period 2002-2010. We find that island residents price discounts expand the demand and have a positive effect in the competition level and in the frequencies offered by airlines. This effect is specially relevant in Spain, but it is also important in France and Italy. On the other hand, Public Service Obligations reduce the level of competition and may have different effects in the frequencies, depending on national regulations. In Spain, protected routes have more frequencies that unprotected routes of similar characteristics, but in France, Italy and UK they have less. Universally service policies might be complemented by the entry of low-cost airlines in thin routes. Moreover, low-cost airlines generate possitive effects in the level of competition and in the number of flights at route level.

Keywords: Airline, Competition, Discounts, Public Service Obligations, European Union.

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1 Introduction

The liberalization of air transport initiated in the EU in the nineties created a single aviation market with the objective of improving the mobility and well being of European citizens. Airlines reconfigured their networks, enhanced service quality, set lower prices and began competing more strategically. The lowering of entry barriers, the success of low-cost airlines, and the capacity expansion in many airports increased the competition and productive efficiency.[1] As a consequence, in domestic and international markets there has been a strong growth of scheduled flights and in the number of seats available for kilometer.[2]

In spite of this, more than 50% of domestic routes in European countries are still served by a monopolist airline. Some thin and peripheral routes are protected with universal service regulations, but most of them are unregulated and their users may receive a poor service and pay high prices. Moreover, the instruments used by European countries to regulate these routes can differ significantly and in many occasions public interventions appear as inconsistent and uncoordinated (Williams and Plagliari, 2004; Lian 2010).

Taking this into account, the objective of this paper is to analyze the evolution of competition in the European markets and to assess the universal service policies than have been adopted by national authorities. We use a rich data set with 6240 observations to examine if the protection of thin and peripheral routes have been effective to increase the level of competition and the quality of the service. In particular, we examine the effect of price discounts and Public Service Obligations (PSOs) at the route level in the period 2002-2010 in the domestic markets of France, Germany, Italy, Spain and the UK. We consider these countries because they are the five larger European markers in terms of routes and traffic (Figure 1).[3] Moreover, domestic markets are around two thirds of the total passengers traffic

[1] An analysis of the effect of liberalization in the EU and the US can be found in Maillebiau and Hansen (1995) and Button (1998).

[2] Dobruszkes (2013) reports that between 1995 and 2012 the number of routes in the European market has increased from 2070 to 3254. This has implied an important diversification in terms of spatial coverage and of the total number of seats offered. See also ICAO (2007) for a general perspective of the trends in the market.

[3] When considering both international and domestic airport passenger traffic Eurostat shows that UK, Germany and Spain accounted in 2011 for nearly half of the European Union total traffic. There is a second

(ICAO, 2007).

Several national and regional European governments grant important price discounts to island residents on domestic routes that have islands as endpoints. Discounts are financed by the governments which directly compensate airlines with a subsidy. Our empirical analysis shows that discounts have reduced the concentration in the countries analyzed and that this effect has been especially important in the case of Spain. One explanation for this result is that price discounts expand the demand of island residents and increase the profitability of protected routes. We also show that discounts have increased the number of frequencies offered in protected routes in Spain, France and Italy.

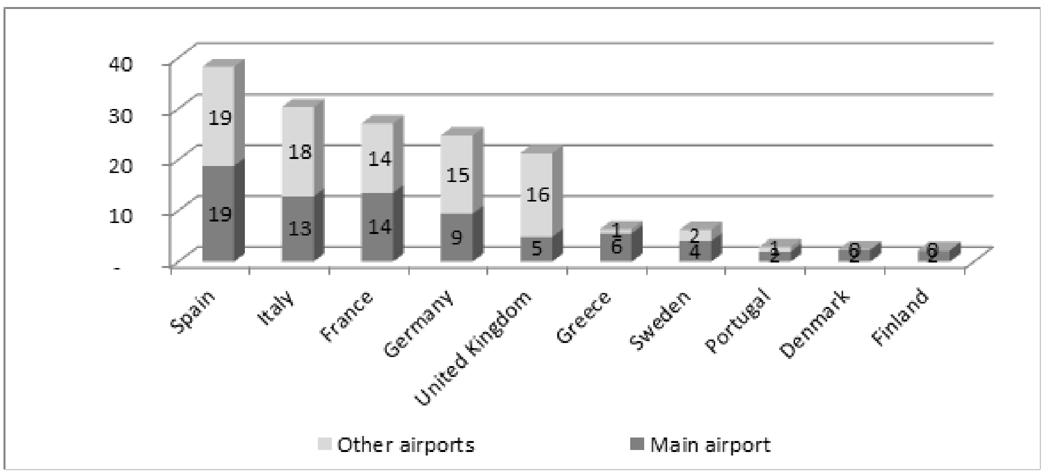

Figure 1: Domestic air traffic in European countries in 2010 (million passengers).

Another contribution of the paper is to analyze the effect of PSOs in the level of competition and in the frequencies offered by airlines. PSOs usually guarantee a minimum frequency of the service in certain routes, and in many occasions frequency floors are complemented with capacity regulations (number of seats and aircraft size), time table requirements (time of departures and of arrivals) and/or price regulations (price caps and reference caps). Our model shows that PSOs have decreased the level of competition, possibly because they reduce the profitability of the routes. On the other hand, we find that routes with frequency floors

tier comprising France and Italy. In the rest of European countries, total traffic is much smaller.

can have higher or lower frequencies than unregulated routes, depending on the specific limits set by regulatory authorities. In Spain, regulated routes have more frequencies than those that are unregulated, but in France, Italy and the UK we observe the opposite result, meaning that the regulation is not enough to compensate the low demand in the routes. Taking all these results together reveals that in the EU there is not an homogeneous approach to regulate thin routes and that the intensity and scope of the regulation might depend on policy objectives.

The previous literature has analyzed how some market characteristics like route competition, airport dominance, or the presence of low-cost carriers influence the pricing strategies of airlines in thin routes. For example, Starkie and Starrs (1984) examine the development of news routes in the Australian market after its deregulation in 1979, and Bitzan and Junkwood (2006) show that in the US airfares for flights covering small communities are higher that those connecting large communities due to differences in costs and in market power. In spite of this, very few works have examined the effects of universal service policies. Calzada and Fageda (2012) explain that in Spain routes benefiting from price discounts present higher prices than the rest of domestic routes, and that intra-island routes regulated with price caps and frequency floors have lower prices and higher frequencies than unregulated routes of similar characteristics. Lian (2010) analyzes the weaknesses of the PSO regulation implemented in Norway and discusses the negative evolution of air fares. Lian and Ronnevik (2011) explain that residents in remote regions prefer to go by car to the larger airport in order to reduce their costs and that this undermines the PSO services at local airports. Di Francesco and Pagliari (2012) analyze which will be the impact in air fares of eliminating PSOs in the route that connects the Italian mainland and the island of Sardinia. They argue that removing PSOs would result in higher fares and a change of the traffic mix that would increase the proportion of inbound tourism.

Another group of papers has analyzed the determinants of route competition and airline frequencies in domestic markets, including the works of Bilotkach et al. (2010), Borenstein and Netz (1999), Brueckner and Pai (2009), Calzada and Fageda (2012), Pai (2010), Salvanes et al. (2005), Schipper et al. (2002) and Wei and Hansen (2007). These papers show the relevance of aspects such as route distance or aircraft size on the frequencies offered. Our approach is similar to the one in these papers, because we estimate competition and frequency equations at the route level. However, we focus on the specific effect of discounts and PSOs in these variables.

Finally, some papers have analyzed the effects of PSOs on the efficiency of operators. Santana (2009) examines the impact of PSOs on the productive efficiency of European and US airlines for the period 1991-2002.[4] She finds that PSOs increase the operation costs of European carriers, whereas this effect was not found in the centralized US system. Merkert and Williams (2013) evaluate the efficiency of 18 European airlines regulated with PSOs by studying technical and scale efficiency in the period 2007-2009. They report that in the early stage of the PSO contract operators perform better than when they are about to finish it. This suggests that they have little incentives to increase efficiency before the tender finishes due to the absence of competition. Pita et al. (2013) examine a decision approach for the design of subsidized air transportation and show the usefulness of this methodology with an application to the Azores network. Our paper differs from this literature since we are mostly interested in the effects of universal service regulations. In spite of this, the selection of the obligations imposed on the airlines and the assessment of their costs is clearly a relevant problem that must be considered in the design of universal service policies.

The rest of the paper continues as follows. Section 2 describes the universal service policies applied in the European Union. Section 3 explains our estimation strategy. Section 4 presents the data and describes the domestic markets in the five countries studied. Section 5 shows the results and discusses its implications. Finally, Section 6 summarizes our conclusions.

[4] Oum et al. (2005) and Fethi et al. (2000) analyze the increase in efficiency in the US and the EU, respectively.

2 Public service obligations in the European Union

In the European Union, PSOs were implemented following the deregulation of air transport in the nineties.[5] The objective of this policy was to promote the mobility of the population in remote and peripheral areas.[6] Although in the last decades the traffic in domestic markets has increased significantly and airlines have started to use smaller and cheaper aircrafts to operate thin routes, the number of routes protected with PSOs has continued to grow intensively.[7] One explanation could be that the European regulation allows national and regional authorities of the Member States to impose PSOs for scheduled air services in routes (generally thin) that connect with an airport considered important for the economic and social development of the region. The autonomy of regulators might have estimulated their interventions and explains the diversity of policies that is found across countries (Merkert and Williams, 2013; and Merkert and O'Fee, 2013).[8]

Indeed, some countries such as France, Spain and Norway have made an extensive use of universal service policies, whereas other countries like the UK and Germany are much more restrictive in their application.

Transport authorities use different mechanisms to promote the mobility of their citizens. Some countries use residents discount schemes to facilitate the movements of persons living in the islands. For example, in Spain all residents of Canary and Balearic Islands enjoy a

[5] In the US, the Essential Air Service Program (EAS) was created after the deregulation of the market in 1978. See Reynolds-Feighan (1995a and b), US DOT (1998), Metrass-Mendes and Neufville (2010), Matisziw, Lee and Grubesic (2012) and Brathen and Halpern (2012).

[6] Council Regulation (ECC) No 2408/92 of 23 July of 1992, on access for Community Air Carriers to Intra-Community Air Routes. This regulation allows member states to impose PSOs in air transportation. In 2008, the PSOs was modified by the Regulation (EC) No 1008/2008 of the European Parliament and the Council of 24 September of 2008, on common rules for the operation of air services in the Community.For an extensive description of the PSOs in Europe see Williams and Pagliary (2004) and Williams (2010).

[7] According to Merkert and Williams (2013), while in 1997 there were 64 PSO contracts in operation, by September 2012 there were more than 250 PSO contracts.

[8] O'Fee ad Merkert (2011) have interviewed 16 European transport authorities and conclude that PSOs respond to two economic objectives: (1) for remote and isolated communities PSOs are essential for delivering lifeline services and for promoting regional development; and (2) PSOs increase the hinterland reach of the national/regional centre.

50% discount in their fares, which is financed by public funds. In Scotland, the government has created a Social Discount Scheme that gives residents living in the Highlands and islands 40% discount on prices within Scotland.[9] However, non-residents that travel to these locations have to pay the full price of the service. Similar discount schemes are applied in France, Italy or Portugal for island residents.

Other countries impose PSOs on airlines serving protected routes, which in some cases is complemented with price discounts. The objective of PSOs is to guarantee the continuity, frequency, capacity, quality and affordability of the service. In the European Union, Finland, France, Germany, Greece, Ireland, Italy, Portugal, Spain, Sweden and the UK apply some PSOs. Moreover, in Europe also Iceland and Norway have adopted this policy.

The five countries analyzed in our paper apply some type of PSOs (Table 2). Usually, transport authorities establish minimum daily service frequency between airports (frequency), minimum seating capacity for flight leg (aircraft type), and establish the earliest departure times and the latest arrival times to guarantee the existence of daily round trips (timetable obligations). In some cases regulators also apply some price regulations. In France, routes that connect mainland airports with Corsica and other routes that connect small regional airports with Paris have PSOs, but only the routes to Corsica have a price cap. In all these routes competition is restricted. In Italy, all flights connecting with Sardinia and Sicilia have frequency, aircraft, timetable and price regulations, and some routes have restricted competition due to their low profitability. In Spain, intra-island routes in Canary Islands and in Balearic islands are subject to price caps and frequency floors, but all the protected routes are open to competition. In Scotland the Hebrides, Orkney and Shetland are connected to the mainland by PSOs. Finally, in Germany the routes that connect Rostock-Laage with Frankfurt, München and Köln-Bonn have PSOs.

An interesting aspect of the European regulation is that authorities can restrict the entry in protected routes and give a subsidy to the monopolist offering the service if they consider that the profitability of the route is not guaranteed. In this case, the European regulation

[9] These discounts benefit residents of remote communities living in eligible areas like Western Isles, Colonsay, Islay and Jura, Caithness and North West Sutherland (Plagliary, 2003).

establishes that the selection of the PSO's provider must be made by a public tender at community level.[10] The routes with restricted entry use to have regulated prices. In Norway and Scotland, the maximum prices are defined in the tender requirements. In other countries like France airlines determine their prices as a part of the tender (Brathen, 2011).

The number of routes regulated varies importantly from country to country. Table 1 shows that France is the country with a larger percentage of protected routes: 21% of all the routes have PSOs and are open to competition and only 1% have restricted competition. Usually, protected routes connect the mainland and one island, but some routes connect small regions to Paris. In Italy, 8% of the routes are protected and are open to competition and 6% are protected and have restricted entry. In Spain, 6% of the routes are protected and all of them are open to competition and connect to islands. Finally, all protected routes in these countries enjoy of price-caps and frequency floors, except routes within the mainland of France. Moreover, all routes from/to islands (Balearics, Canary, Sardinia, Corsica) have discounts to residents, except Sicily.

	Routes with discounts	Routes with PSOs and open access	Routes with PSOs and restricted access	Routes with PSOs and without price caps
France	11%	21%	1%	11%
Germany	-	-	-	-
Italy	9%	8%	6%	0%
Spain	50%	6%	0%	0%
UK	0%	0%	6%	0%

Table 1. Public service obligation policies in 2010

In front of this diversity, it is essential to clarify which is the effectiveness of universal

[10] In Norway, routes with PSOs are tendered since 1996. The first tender was won by Wideroe who gave a bid for the whole regional air route system. In later tenders the network was divided into smaller areas and smaller regional carriers won parts of it. In spite of this, so far Widereo continues to be the main operator of these routes (Lian 2010).

service policies to increase competition and improve the quality of the service. While price discounts can favour the mobility of island residents and incentive the entry of additional airlines, PSOs may increase the operational costs of airlines and raise market concentration. The next section empirically examines these issues.

3 Empirical analysis

This section analyses the effect of price discounts and public service obligations in the five larger European domestic airline markets. Our data set is for the period 2002-10 and allows to examine the impact of these policies in the competition and in the frequencies at the route level. We measure the level of competition in a route with the Herfindahl-Hirschman index (*HHI*), which is the sum of the market share squares of airlines operating the route in terms of frequencies. We also analyze the number of annual frequencies (*Frequencies*), which is the number of flights offered by airlines in a week for each route. More precisely, we estimate the following two equations:

$$HHI_{kt} = a_0 + a_1 Population_{kt} + a_2 GDP_{kt} + a_3 Dist_k + a_4 D^{hub}{}_k + a_5 D_{kt}^{high-speed-train} + a_6 D_{kt}^{low-\cos t} + a_7 D_k^{discount} + a_8 D_{kt}^{pso\_open} + a_9 D_{kt}^{pso\_restricted} + a_{10} Country_k + a_{11} TimeTrend_t + e_{kt}.$$

$$\begin{aligned} Frequency_{kt} \quad = \quad & b_0 + b_1 Population_{kt} + b_2 GDPc_{kt} + b_3 Dist_k + b_4 D^{hub}{}_k + b_5 D_{kt}^{high-speed-train} + b_6 D_{kt}^{low-\cos t} \\ & + b_7 D_k^{discount} + b_8 D_{kt}^{pso\_open} + b_9 D_{kt}^{pso\_restricted} + b_{10} Country_k + b_{11} TimeTrend_t + e_{kt}. \end{aligned}$$

To estimate these equations we consider a group of explanatory variables related to the characteristics of routes. We use the variables *Population, Gross Domestic Product per capita* (GDP), and *Hub* (D^{hub}) as demand shifters. *Population* is the weighted average of population at the origin and destination regions of the route and *GDP* is the weighted average *GDP* per capita at the origin and destination regions of the route (weights are based on the population). We expect demand to be higher in routes that connect richer and more populated endpoints. Thus, we expect a negative sign of the coefficients associated to these variables in the *HHI* equation and a positive sign in the *Frequency* equation. On the other hand, the variable D^{hub} controls for the presence of a hub in the route. This variable takes the value of one for routes where at least one of the endpoints is a hub airport of a network airline. Hubs generate more traffic due to the existence of connecting traffic from the hubbing airline, but dominance of the airline may harm competition. Thus, a priori it is unclear the expected sign of this variable in the competition equation, while we expect a positive sign in the frequency equation.

The variable *Distance* reflects the number of kilometers flown to link the endpoints of the route. Demand should be higher in longer routes because they face less competition from cars and trains. Thus, we expect a negative sign in the coefficient of this variable in the competition equation. Following the same argument, airlines should not be interested in offering high-frequency services in long routes because they don't face the competition of other transportation modes. Moreover, they may use smaller planes at higher frequencies in short-haul routes (Fageda and Flores-Fillol, 2012). Thus, we expect a negative relationship between distance and frequency.

We also include a dummy variable $D^{high-speed-train}$ that identifies the routes that compete with high speed trains. This variable takes the value of one for routes that face this type of competition. Market concentration should be higher in routes with intermodal competition due to lower demand of air services, but at the same time airlines might offer more flights in order to increase their competitiveness. Taking this into account, we can expect a positive coefficient in the competition equation and we have a less clear prediction for the frequency equation.

Another dummy variable is included for the routes served by low-cost airlines. Low-cost airlines offer lower prices than traditional airlines and this can spur demand and competition. However, the entry of a low-cost airlines in a route can imply the reduction (or withdrawal) of services of its competitors. Thus, the expected sign for this variable in the competition and frequency equations is ambiguous.

The main objective of our model is to estimate the impact of universal service policies and for this reason we include a group of dummies that identify the routes regulated with price discounts and PSOs. $D^{discount}$ is a dummy that takes the value of one for those routes where residents benefit of a price discount. In our sample, discounts are essentially given to the residents of islands in France, Italy and Spain that have a large population ans with an important tourism activity. One possible effect of this regulation is to reduce the elasticity of the demand to the price and as a result to incentive airlines to set higher retail prices (Calzada and Fageda, 2012). On the other hand, discounts increase the demand of island residents and this generates positive effects in the competition and the frequency.

We also consider two dummy variables that reflect the presence of PSOs in a route. D^{pso_open} is a dummy that takes the value of one for those routes protected with PSOs but are not affected by any restriction in the competition. These routes are regulated with frequency floors, price caps and other measures, but airlines don't obtain any subsidy for providing the service. On the other hand, the dummy $D^{pso\_restricted}$ takes the value of one for routes regulated with PSOs where the authorities have restricted the number of competitors. In this case, airlines can receive a direct subsidy for providing the service, but this is not always the case. We don't have a particular prediction about the effects of these regulations because price caps and frequency floors established by regulators can take several values and can partly or completely compensate the absence of traffic in the route.

Finally, we include country and year dummies in both equations, being 2002 the excluded year and the UK the excluded country.

4 The data

Our dataset contains 6240 observations for five European countries and covers the period 2002-2010. In particular, we have 1490 observations for Spain, 1350 for France, 1254 for Italy, 1406 for UK and 741 for Germany. There are some missing values for some years in several routes. In most cases, this is because no air traffic services were provided in the route.

We only consider airline services on a given route in one direction. In fact, the inclusion of the two directions as separate observations will overlook the fact that the airline supply would be nearly identical in both directions. Taking this into account, we consider the link that has as origin the largest airport. For example, on the route Barcelona-Ibiza-Barcelona, we consider the link Barcelona-Ibiza but not Ibiza-Barcelona.

Data on departures of each airline on each route that is used to compute the *HHI* index and frequencies have been obtained from the Official Airlines Guide (OAG) and RDC Aviation limited (capstats statistics). Information for *Population* and *GDP* per capita at the NUTS 3 level (Statistical unit used by Eurostat) have been provided by Cambridge Econometrics (European Regional Database publication).

Data about *Distance* between the route's origin and destination airports has been obtained from Official Airlines Guide (OAG) and the website of webflyer (http://www.webflyer.com).

The main hub airports that are considered are London-Heathrow in the UK, Paris-Charles de Gaulle in France, Frankfurt in Germany, Madrid in Spain, and Rome-Fiumicino in Italy. These are the airports that concentrate more domestic traffic in each country and all of them are dominated by traditional flag carriers that operate Hub-and-Spoke networks.

In our sample, the low-cost airlines that offered domestic services in at least one year during the period considered were: Air Berlin, Air One, BMI baby, Clickair, Condor, Easy-jet, Fly Thomas Cook, Flygobespan, Germanwings, Hapag Lloyd, Jet2, Monarch, Myair, LTU,Niki,Ryanair, Thomsonfly, Volare, Transavia, Vueling and Windjet.

Information about the routes with discounts and PSOs have been obtained from the European Commission, the Official Journal of the European Union and from the Department of Transportation of the corresponding country. Our data set don't includes routes in Scotland that connect the mainland and some islands that benefit of price discounts, and three routes in Germany regulated with PSOs.

Next, we offer offer a closer look at the economic features of the five national markets analyzed in the paper. Table 1 shows that in Italy and in Spain there is a similar number of annual frequencies, around 50% of the traffic goes to the islands, and around 20% of the routes connect with a hub. In France, there are less annual frequencies, only 10% of the routes connect with a hub, and only 11% connect with an island. In addition, in France the average population of the regions covered by the airport is 5178 million, significantly larger than in the rest of countries.

In the UK and Germany, the average distance of mainland routes is shorter and there are no routes that connect the mainland to islands. In the UK there are some routes that have Scottish islands as endpoints, but we don't have information about them. The British market is the more decentralized one, with only 6% of the routes connecting with a hub. On the other hand, Germany is the country with a higher number of annual frequencies, which might be explained by the fact that routes are shorter and compete with other transportation modes. It is also worth mentioning that in Germany the areas with domestic flights have on average less population than in other countries,[11] meaning that a smaller population enjoys of more daily frequencies. This situation might justify why Germany has so few routes protected with PSOs.

	Number observat.	Annual frequencies	Routes to/ from hubs (%)	Popul. of endpoints (millions)	Island routes (%)	Aver. distance mainland routes (km)	Aver. distance mainl.-islands (km)
France	1350	987	10%	5178	11%	531	663
Germany	741	1687	18%	1258	0%	395	-
Italy	1250	1083	22%	2139	56%	595	596
Spain	1490	1355	20%	2667	50%	513	936
UK	1406	1120	6%	2094	-	389	-

Table 2. Market charactetistics (mean values in the period 2002-2010).

The economic and institutional characteristics of national markets might have an important impact in the level of competition. Table 2 shows that in the five countries the mean *HHI*

[11] The mean population of the route endpoints in Germany in quite low in relation to the case of France. This is a consequence of the large number of routes that have Paris as endpoint.

index is higher than 0.70 and in France and UK it is even higher than 0.80. Figure 2 shows that in the period 2005-07 the index decreases in all countries, possibly as a consequence of the liberalization process initiated at the end of the nineties and the entry of low-cost airlines. However, since 2007 there has been a significant reduction in the level of competition that coincides with the economic crisis. The financial difficulties that affect most European airlines has also generated a consolidation process that might reinforce this trend in the future. For example, in Spain Clickair and Vueling made effective their merger in 2009. In Germany, Air Berlin took over DBA and LTU in 2006 and 2007, respectively. In Italy, Air One was acquired by Alitalia in 2009.

	Number observat.	HHI index	Monopoly routes (%)	Competition with high-speed trains (%)	Routes with < 500 km & no islands (%)
France	1350	0.80	50	5	34
Germany	741	0.72	28	1	82
Italy	1250	0.72	40	1	15
Spain	1490	0.76	52%	2	22
UK	1406	0.84	49%	0	67

Table 3. Competition characteristics (mean values in the period 2002-2010)

On the other hand, Table 2 shows that in France, Italy, Spain and UK between 40% and 52% of the routes are monopolized by one airline, and most of the routes have more than 500 km. In Germany, by contrast, only 28% of the routes are operated by a monopoly and 84% of them are of less than 500 km.

In spite of this concentration, inter-modal competition is present in all countries. As the average distance of mainland routes is lower than 600 kilometers all routes can be considered short-haul routes, except those that connect the Spanish mainland with Canary Islands,

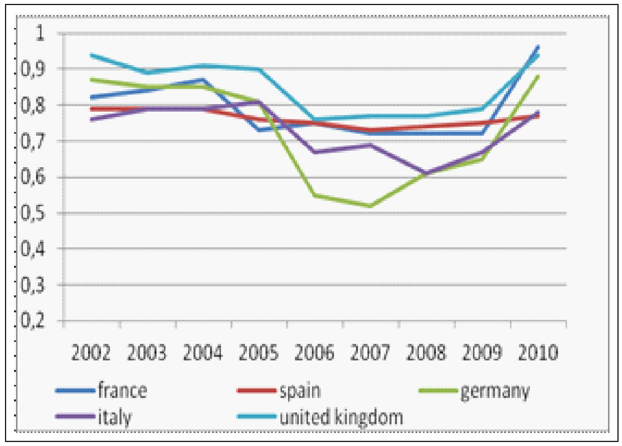

Figure 2: **Evolution of the mean *HHI* at the route level (2002-10)**

which can be longer than 2000 kilometers. This situation facilitates the competition of other transport modes such as high-speed trains.

Finally, it is interesting to explain that former flag carriers still dominate domestic markets, although their position is quite diverse in each country. In France, Air France and their regional partners (CCM, Airlinair) have a share of 87% of total frequencies and their main competitors (the two biggest European low-cost carriers) have a very modest share. In Germany, Lufthansa and partner airlines (Germanwings, Cirrus Airlines) have a joint share of 65% of total frequencies. Their main competitor is Air Berlin, a hybrid German airline. In Italy and Spain, the former flag carrier suffer a more intense competition from other national airlines while in the UK the market is relatively equally distributed between British Airways and four additional airlines.

5 Estimation and results

We estimate the competition equation using the generalized linear model with fractional response variables. This technique is appropriate when the dependent variable takes a continuous value between 0 and 1. On the other hand, we estimate the frequency equation using the Zero Truncated Poisson (ZTP) technique.[12] This allows us to exploit the form of the dependent variable which takes positive integer values. However, since the number of counts is high, we do not expect substantial differences in the results when using either ZTP or the standard Ordinary Least Square Regressions. Standard errors are robust to heterocedasticity and we apply clusters at the route level to take into account the potential correlation between observations within the same route.

Table 4 reports the estimates for the competition equation and Table 5 for the frequency equation. The first column in the two tables shows the results when the five countries are considered and the rest of columns the individual analysis for each country. The joint estimation for all countries shows that Germany and Italy have the domestic markets with a larger level of competition (lower concentration). On the other hand, Germany is the country with more frequencies per route and France with less.

Regarding the control variables, the coefficients associated to the demand shifters show the expected sign, although in the two equations *GDP* is not statistically significant when the five countries are jointly considered. Competition and frequencies are higher in routes with more populated endpoints and when one of these endpoints is the hub of a network airline. *GDP* generates different effects in the competition and frequency equations at the country level. In France and Germany, *GDP* reduces concentration and increases frequencies. However, in Italy it increases concentration and in Spain it reduces frequencies. Note that our estimations might also be capturing the effects of business cycles through the time fixed effects. ACLARIR AQUESTA FRASE

[12] An alternative approach will be to jointly estimate the competition and the frequency equations by using an instrumental variables technique. However, in this case the main difficulty is finding the adequate instruments for the HHI index and the amount of frequencies, since both variables are determined by the same explanatory variables. Note also that the use of a fixed effects model is not convenient in our context because it does not allow to take into account the effect of time-invariant variables

	All countries	Spain	France	Italy	United Kingdom	Germany
Population	-0.00004*** (8.92e-06)	-0.0002*** (0.00005)	0.00003 (0.00002)	-0.0003*** (0.00006)	-0.00002 (0.00002)	-0.00044*** (0.00008)
GDP	-0.000041 (0.0009)	0.005 (0.005)	-0.009*** (0.003)	0.007*** (0.002)	0.0013 (0.0019)	-0.0101*** (0.0018)
Distance	-0.0002*** (0.00007)	-0.00002 (0.00008)	-0.0005*** (0.0001)	-0.001*** (0.0002)	-0.0006** (0.0002)	-0.000035 (0.0004)
$\mathbf{D}^{hub}$	-0.36*** (0.06)	-0.05 (0.14)	-0.12 (0.10)	-0.38*** (0.14)	-0.71*** (0.22)	0.51*** (0.15)
$\mathbf{D}^{high\_speed\_train}$	0.037 (0.12)	0.04 (0.32)	-0.20* (0.11)	-0.06 (0.26)	-	0.05 (0.14)
$\mathbf{D}^{low\_cost}$	-0.55*** (0.04)	-0.93*** (0.07)	-0.53*** (0.12)	-0.54*** (0.09)	0.02 (0.11)	-0.77 (0.09)***
$\mathbf{D}^{discount}$	-0.46*** (0.08)	-0.80*** (0.11)	-0.12 (0.10)	-0.18 (0.17)	-	-
$\mathbf{D}^{pso\_open}$	0.42*** (0.12)	-	-	-	-	-
$\mathbf{D}^{pso\_restricted}$	0.22*** (0.07)	-	-	-	-	-
$\mathbf{D}^{pso}$	-	-0.13 (0.22)	0.02 (0.08)	0.34** (0.16)	0.15 (0.22)	-
$\mathbf{D}^{Spain}$	0.08 (0.10)	-	-	-	-	-
$\mathbf{D}^{France}$	-0.13 (0.08)*	-	-	-	-	-
$\mathbf{D}^{Germany}$	-0.18** (0.09)	-	-	-	-	-
$\mathbf{D}^{Italy}$	-0.17**	-	-	-	-	-

Table 4. Competition equation estimates (Generalized linear model with fractional response variables). Standard errors in parenthesis (robust to heterocedasticity) and clustered by route. Significance at 1% (***), 5% (**),10% (*)

	All countries	Spain	France	Italy	United Kingdom	Germany
Population	0.0001*** (0.00001)	0.0004*** (0.0001)	-0.00002 (0.00003)	0.0004*** (0.00009)	0.00009*** (0.00002)	0.019*** (0.003)
GDP	0.0012 (0.0015)	-0.027* (0.013)	0.02*** (0.005)	-0.004 (0.004)	0.002 (0.001)	0.019*** (0.003)
Distance	-0.0005*** (0.0001)	-0.0008*** (0.0002)	-0.0004 (0.0002)	0.0007 (0.00046)	-0.0001 (0.0003)	0.001** (0.0007)
$\mathbf{D^{hub}}$	0.58*** (0.12)	0.62** (0.25)	-0.23 (0.25)	1.12*** (0.24)	0.67*** (0.25)	-0.08 (0.19)
$\mathbf{D^{high\_speed\_train}}$	0.27 (0.21)	0.37 (0.33)	0.67** (0.26)	-0.09*** (0.16)	-	-0.08 (0.19)
$\mathbf{D^{low\_cost}}$	0.54 (0.08)***	0.73*** (0.20)	0.87*** (0.29)	0.68*** (0.10)	-0.005 (0.12)	0.58 (0.109
$\mathbf{D^{discount}}$	0.19 (0.17)	0.51** (0.22)	0.78*** (0.18)	0.66** (0.20)	-	-
$\mathbf{D^{pso\_open}}$	0.36 (0.24)	-	-	-	-	-
$\mathbf{D^{pso\_restricted}}$	-0.28 (0.15)*	-	-	-	-	-
$\mathbf{D^{pso}}$	-	1.19*** (0.40)	-0.58*** (0.23)	-1.09*** (0.34)	-0.89*** (0.21)	-
$\mathbf{D^{Spain}}$	0.13 (0.16)	-	-	-	-	-
$\mathbf{D^{France}}$	-0.41*** (0.13)	-	-	-	-	-
$\mathbf{D^{Germany}}$	0.21 (0.15)	-	-	-	-	-
$\mathbf{D^{Italy}}$	-0.17	-	-	-	-	-

Table 5. Frequency equation estimates (Zero Truncated Poisson). Standard errors in parenthesis (robust to heterocedasticity) and clustered by route. Significance at 1% (***), 5% (**),10% (*).

The effect of *Distance* in competition is negative in all countries, but only significant in France, Italy and the UK. On the other hand, Table 5 shows that *Distance* has a negative effect in the number of frequencies when all countries are considered, but the coefficient is negative and significant for Spain and positive for Italy and Germany. In order to interpret these results, notice that airlines in longer routes are not subject to competition of other transportation modes and can use bigger planes at lower frequencies. In this sense, recall that Germany is the country with the lowest average distance.

Finally, *High speed train* services don't affect airline competition when the five countries are considered together but it does reduce concentration in France. Moreover, high-speed trains increases frequencies in France and reduce them in Italy. Although we don't present the results, we have repeated the estimation considering the routes with less than 500 kilometers, which is usually considered the threshold distance below which high-speed trains and airlines compete. These exercise offer similar results, except for Germany where high-speed trains appear to be positively correlated with route competition.

The *HHI* index is lower and frequencies are higher in those routes with the presence of low-cost carriers. The only exception is the UK, where low-cost carriers have a smaller differential impact. Overall, these results indicate that the entry of low-cost carriers has favoured competition and increased the supply of flights in domestic routes. It also suggest that the development of this business model has help to enhance the mobility of European travelers. This idea is reinforced with the findings of Fageda and Flores-Fillol (2012) that low-cost airlines in Europe tend to concentrate flights in thin routes.

Turning now to the analysis of universal service regulations, Table 4 shows that the effect of price discounts on the concentration equation is negative and significant. This effect is especially important in the case of Spain, where discounts have been widely employed to protect the residents of the Balearic and Canary islands. Discounts are also applied in some routes of France and Italy, but in this case we don't find a significant effect. On the other hand, discounts don't affect the number of frequencies when all countries are considered, but they have a positive and significant impact in the case of France, Italy and Spain (Table 5).

These results complement those of Calzada and Fageda (2012), who analyze the Spanish market with a smaller dataset and show that discounts have a significant positive impact in the prices but does not affect the frequencies.[13] In the present paper, discounts in Spain have a significant effect in the concentration level and in the frequencies, suggesting that they expand the demand and increase the offer of frequencies by airlines.

A part from the discounts, authorities also impose PSOs on specific routes. In our model we consider routes protected with PSOs (frequency floors and price caps) that are open to the competition, D^{pso_open}, and routes with the same type of regulation with restricted competition, $D^{pso\_restricted}$. In the case of routes open to competition, it can be observed that PSOs increase the concentration in the market (Table 4) but don't affect the aggregate number of frequencies offered by airlines (Table 5). One explanation of this is that PSOs reduce the profitability of the routes, but the number of daily flights imposed by regulators is not significantly different than in unprotected routes by airlines.

On the other hand, in the case of the routes with PSOs and restricted competition the coefficient is positive and significant (Table 4). This result means that the unprotected routes that have similar observed characteristics than these routes enjoy a higher competition level and exhibit an *HHI* index smaller than 1. Hence, some competition might be feasible in these routes, although in practice the regulators must subsidize them to attract airlines. On the other hand, routes with restricted competition and PSOs exhibit less frequencies (Table 5). This reflects that regulators impose in these routes lower frequencies than those observed in unprotected routes of similar characteristics. More information and more research would be needed to understand in which cases it is necessary to restrict the competition in a route in order to guarantee a service with a satisfactory quality level. In spite of this, it is important to mention that the regulations imposed on these routes are mainly based on policy considerations and that their viability depends on the subsidies granted to the airlines.

We don't have enough observations in our data set to separate the analysis for open and restricted routes at the country level. For this reason the country analysis presented in Table 4 and 5 consider together all the routes wit PSOs. In this case, the first result of interest

[13] This paper argues that the increase in the demand of island residents might not be enough to incentive airlines to offer additional flights.

is that only in Italy the presence of PSOs affects the level of competition in the market. In the rest of countries, the imposition of PSOs don't produce a substantial change in market concentration, possibly because most unprotected routes of similar characteristics are also operated by a monopolist. In other words, many unprotected thin routes are operated by a monopolist.

Regarding the effects of PSOs on the frequencies, we find that in France, Italy and the UK routes regulated with PSOs have less flights that unprotected routes, once we control for different observed characteristics of the market. Indeed, in these countries the sign of the coefficient associated to PSOs is negative and significant, which mean that frequency floors are not enough to increase the number of flights at the same level than in unregulated routes. Only in Spain, the coefficient is significant and positive, which implies that PSOs over protect island residents.

6 Conclusions

This paper has analyzed the impact of universal service policies in the five largest European domestic airline markets. The first relevant finding is that price discounts reduce market concentration and increases the frequencies at the route level. Although this result appears in the estimation where the five countries are considered together, it is more evident in the case of Spain where important discounts are given to the residents in the Balearic and the Canary Islands. We consider that the main driver of this result is that discounts increase the demand of island residents and generate more entry.

In spite of this, these results have to be interpreted with caution for two reasons. On the one hand, our analysis does not include the costs of the subsidies granted by public authorities to island residents. For example, in Spain the annual cost of these subsidies could be around 350 million euros. On the other hand, in routes with little competition discounts increase the price paid by non-residents, which reduce their consumption.[14] Public authorities should be aware of these problems when they design the discounts schemes and when they analyze the

[14] This result is shown in Calzada and Fageda (2012).

welfare impact of this regulation.

Our second important result is that PSOs increase the concentration in the market when all the countries are taken into account. In spite of this, this effect only appears for Italy when separate regressions are estimated for each country. This might be explained by the large number of unprotected routes that are operated by a monopoly, specially in France, Spain and UK. On the other hand, routes protected with PSOs have a large number of frequencies in Spain and a smaller number in France, Italy and the UK. Hence, in Spain the regulation forces airlines to offer more frequencies that in un-protected routes of similar characteristics, whereas in the other countries PSOs only partly compensate the absence of flights in thin routes. In spite of this, note that in Spain all routes regulated with PSOs connect two islands, while in France there are several protected routes in the mainland that compete with other transportation modes.

Finally, in order to assess the benefits of the universal service policies applied in European countries it is important to consider the dyanamics of national markets in the last years. Our analysis reveals that in the last decade, the total number of routes operated has increased very importantly in the five countries, but at the same time market concentration has also increased. This can be explained because entrants tend to cover routes with small traffic that can sustain a fewer number of operators. On the other hand, since 2008 the economic crisis has reduced the traffic in many routes and has favoured a process of consolidation by the airlines. This situation could suggest the need for a stronger supervision of the competition by national authorities. However, the irruption of low-cost airlines in domestic markets might compensante part of these negative effects. First, low-cost airlines have open an important number of new routes. And second, our empirical analysis shows that low-cost airlines increase the competition and the frequencies at the route level, even although they are monopolist in many of the new routes. Low-cost airlines use new management strategies and smaller and cheaper aircrafs that make profitable routes traditionally ignored by former flag carriers. This is a situation that moderates the costs of PSOs by airlines.

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