Triggering competition in the Spanish airline market: the role of airport capacity and low cost carriers

Xavier Fageda & Laura Fernández-Villadangos[Ψ]

(University of Barcelona)

March 2007

Abstract: Airline competition in the post-liberalization period has been usually affected by airport congestion and dominance of former flag carriers. Furthermore, thin routes have been traditionally considered natural monopolies. In this paper, we analyze the influence of two major driving factors for a change in the competitive scenario where airlines operate; a large amount of investments to increase airport capacity and the success of low-cost carriers in short-haul routes. Taking advantage of a rich sample of routes for the period 2001-2006 concerning the Spanish airline market, we examine these issues using parametric and non-parametric techniques. We find that airlines conduct move from a near to joint-profit maximization setting to a point equivalent to the Cournot solution when capacity constraints are not binding. Also, we show entry choices are highly determined both by route prices and traffic density, and natural monopoly threshold decreases along time. Finally, low cost carriers have a moderate but still signifcant effect on prices and provide a higher number of alternatives to chose even in low-density routes.

Códigos JEL: D43, L13, L93, C30

Keywords: Air Transport, Oligopoly, Econometric Analysis

[Ψ] Research Unit Public Policy and Economic Regulation (GPRE-IREA) at Universitat de Barcelona, Dep. de Política Econòmica i EEM. Avd. Diagonal 690, 08034 Barcelona, (xfageda@ub.edu, laura.fernandez@ub.edu). Tel. 934039721. Fax. 934024573

Triggering competition in the Spanish airline market: the role of airport capacity and low cost carriers

1. Introduction

Airline competition across European markets in the post-liberalization period has been usually affected by airport congestion and dominance of former flag carriers. Furthermore, thin routes have been traditionally considered natural monopolies as long as density economies may be substantial (Caves et al., 1984; Brueckner et al., 1992).

In this paper, we analyze the influence of two major driving factors for a change in the competitive scenario where airlines operate. Indeed, a large amount of investments for increasing capacity of the largest airports have been made all over the Europe in last years. Additionally, low-cost carriers have an increasing presence in most of the European markets. These factors may influence both the overall level of prices and the number of effective competitors across routes. The latter aspect is particularly relevant in thin routes as most of these routes have been characterized by a monopoly structure even in the post-liberalization period.

Hence, we want to address the following questions: To what extent airlines conduct is more competitive when they are not subject to capacity constraints? Low-density routes have been benefited from the new competitive scenario? Given some control factors, are prices lower in routes where low-cost carriers operate? Do low cost carriers entry in thin routes?

In order to tackle these questions, we examine the dynamics of airline competition in the Spanish airline market. We make use of parametric and non-parametric techniques taking advantage of a rich sample of routes for the period 2001-2006.

The analysis of the Spanish market for the considered period allows quantifying the influence of the two major drivers of airline competition.[1] Indeed, the two main Spanish airports, Madrid and Barcelona, were subject to strong congestion until 2004 (Reynolds-Feighan and Button, 1999; Spanish Ministry of Transports-Orders of October, 2002). The huge amount of investments made in these airports by the Spanish airport operator, AENA, has implied a high increase in their capacity since 2005. Additionally, low cost-

[1] To this regard, it is worth noting that the Spanish market is relevant in the European context since it is the largest domestic market and the third one in terms of total traffic according to the data provided annually by the statistical agency office, Eurostat.

carriers have had an increasing presence in this market in the last years.[2] It is worth noting here that the two largest low-cost carriers in Europe, Ryanair and Easyjet, have announced a substantial increase of operations in Madrid airport for the winter of 2007. Such an increase in operations will include some direct flights in domestic links. From our analysis, it may be possible to obtain some inferences of the impact of these low-cost carrier plans in the Spanish domestic market.

The paper has to do with empirical studies that analyze the influence of market structure variables on airline prices [Borenstein (1989), Evans and Kessides (1993), Marín (1995), Berry et. al. (1996), Carlsson (2004) and others]. Controlling for cost shifters, a typical result in these studies is that route concentration along with airport concentration influences substantially on prices charged by airlines to travelers. Moreover, it is also connected with works that analyze entry choices in airline markets [Reiss and Spiller (1989), Morrison and Winston (1990), Bresnahan and Reiss (1991), Berry (1992), Joskow et al (1994), Dresner et al (2002) and others]. Most of this literature agrees on the fact that entry and exit are driven primarily by costs factors, which are likely to be both carrier and city pair specific. However the evidence is mixed regarding the effects of entry and exit on the competitive behavior of airlines. Indeed the amount of reduction in prices resulting from entry and the reduction itself depends on many factors concerning the previous market structure and the endogenous nature of the relationship between the entry and fares variables.

In addition the paper is closely related to several papers that quantify conduct parameters in airline markets [Brander and Zhang (1990, 1993), Oum et al. (1993), Brueckner and Spiller (1994), Fisher and Kamerschen (2003), Fageda (2006a)]. Within this context, it is commonly found that, on average, airlines compete a la *Cournot*. It is also closely related to some papers that analyze the impact of low-cost carriers, most notably Southwest, on prices and entry [Morrison and Winston (1995), Dresner et al. (1996), Morrison (2001), Boguslaski et al., (2004), Goolsbee and Syverson (2005)]. From these studies, it can be inferred that Southwest tends to enter high-density markets but the price effects of its entry go beyond the routes where actually operates.

2 Taking into account that there is an increasing convergence of the business models across different types of airlines, we consider low-cost carriers to be those airlines that use a single-fare class in their whole network of routes. Traditional airlines uses yield management techniques to segment demand so that they offer different fare-classes associated to different quality conditions, while the use of the single-fare class implies that the airline do not differentiate the product offered to passengers.

We add several insights to the previous literature on airline competition. First, we quantify how airlines conduct is affected by airport capacity expansions. It is typically assumed that airlines compete à la Cournot, but this result may be affected by capacity constraints as long as such capacity constraints condition airlines conduct.[3]

Second, we examine entry choices of airlines considering route characteristics as major determinants, such as prices and traffic density. To this regard, the important issue of traffic thresholds for natural monopolies is analyzed. This has received little attention in previous literature on the airline industry. From a social welfare point of view, it is important to examine not only the general dynamics of airline competition but also whether low-density routes also take benefit from such dynamics. To our knowledge, only the work of Bitzan and Chi (2006) analyze empirically factors determining prices in airline markets focusing the attention on small comunities from US.

Finally, the empirical analysis of the influence of low-cost carriers on prices and natural monopoly thresholds is made for a European market. In this way, the effects of the success of low-cost carriers in Europe have been analyzed in a few number of works. Two unpublished papers [Alderighi et al., (2006); Gil-Moltó and Piga (2006)] analyze some implications of low-cost carriers entry in routes with origin in Italy and United Kingdom airports respectively but these studies do not consider the natural monopoly threshold issue.

At this point, it is useful to mention some facts about the Spanish airline market. Data are available for 74 non-stop pair links for the period 2001-2006, where the origin is the city with the largest airport.[4] Our data set excludes multi-segment markets so that the empirical analysis is made for routes matching city-pair markets. The frequency of the data is semi-annual so that we differentiate between the summer and winter season. We can found several types of airlines that operate in the Spanish domestic market. The two airlines with the largest market share, Iberia and Spanair, are network carriers that belong to Oneworld and Star alliance, respectively. The third largest carrier, Air Europe, is owned by a tourist operator. Importantly, two low-cost carriers have an active and increasing

[3] It is worth noting that airport dominance in a context of capacity constraints provides several demand and cost advantages to incumbents (Fageda, 2006b). Such advantages of the dominant carrier may provide incentives for a collusive behaviour of airlines (Deneckere and Kovenock, 1992).

[4] Madrid is the origin in 30 routes, Barcelona in 24 and other airports (Palma de Majorca, Valencia, Bilbao, Seville) in 20 routes.

presence in the Spanish market since 2004, Vueling and Air Berlin. Finally, there are other regional airlines that operate in a very few number of routes.[5]

Or main results confirm that airport capacity expansions and low-cost carriers entry trigger airline competition in the Spanish market. Indeed, we find airlines switching from a joint profit maximization behavior to roughly equivalent Cournot conduct after increasing airport capacity. Additionally, we obtain evidence that airlines entry choices are highly dependent upon route traffic density but also that the natural monopoly threshold decreases along time. Finally, low cost carriers presence has a moderate but significant impact on prices and more importantly they foster competition on low-density routes.

The remainder of the paper is organized as follows. In the second section, we estimate a pricing and demand equation system that allows quantifying changes in airlines conduct in the event of airport capacity expansions. Then, an ordered probit model is estimated to measure the relationship between the number of competitors and traffic levels and we make use of spline regressions to examine the evolution of natural monopoly thresholds. Finally, we study the impact of low-cost carriers both on price competition and the natural monopoly threshold through pricing and spline regressions. The last section is devoted to the concluding remarks.

2. Changes in airlines conduct in the event of airport capacity expansions

We follow the works of Parker and Roller (1997) and Fageda (2006a) in order to develop a demand-supply equation system that allows identifying conduct and cost parameters for airline markets.

In this way, the demand function (Q) for route k in period t is expressed through the following semi-logarithmic function:

$$log(Q_{kt}) = a_0 + a_1 log(emp_{kt}) + a_2 log(tour_{kt}) + a_3 D^{hub}{}_k + a_4 D^{modal}{}_k + a_5 p_{kt} + a_6 capacity_t + e^d{}_{kt} \qquad (1)$$

The demand function is composed of variables for the mean values of employment (*emp*) and tourism intensity (*tour*) of the route city-pairs. The variable for employment captures both the demographic size of the city-pairs and provides some indicator of economic activity (the employment rate). It must be taken into account that variables for income at the regional level are not available for the recent seasons of the considered

[5] At the end of 2006, Air Madrid has collapsed. This airline has been typically considered to be a low-cost carrier but its prices were based on different fare classes. On the other hand, the Iberia group includes a large regional airline, Air Nostrum, and a recently created low-cost carrier, Click air. At the beginning of 2007, Air Europe has become a member of the Skyteam alliance.

period. The variable for tourism captures traffic generation that comes from tourist activities.

Our demand function also includes a dummy variable that takes value 1 for routes with origin in Madrid airport (D^{hub}). Indeed, connecting traffic represents a much higher proportion of total traffic in this airport than in the rest of the Spanish airports. Furthermore, it includes a dummy variable that takes value 1 for routes with no islands as an endpoint and/or less than 450 kilometers (D^{modal}_k) to account for the fact that air traffic in a route may be lower where other modes may offer the transport service at competitive conditions.

Demand also depends on prices (p) as it is usually considered in a demand equation for any service. Finally, we also consider the higher traffic that can arise after the event of airport capacity expansions since congestion may prevent airlines to increase operations. In this way, we use as explanatory variable an indicator for airport capacity expansions, *capacity*. This variable takes value 1 from the winter season of 2004-2005 to the winter season of 2005-2006, and takes value 2 since then, otherwise 0. A new runway has been fully working in Barcelona airport since october 2004, while two new runways (and a new terminal building) have been fully working in Madrid airport since the beginning of 2006. The way in which this variable is constructed allows us to capture the intensity of alleviation of airport congestion in the Spanish market.

Given the inverse demand function, the marginal revenue function of airline i is:

$$IM_{ikt} = p_{kt} + \lambda(\partial p_{kt}/\partial q_{ikt})q_{ikt}, \qquad (2)$$

where $\lambda=\partial Q_{kt}/\partial q_{ikt}$. If we assume a quadratic total cost function, marginal costs (MC) of airline i at the route k in period t can be expressed as follows:

$$MC_{ikt} = b_o + b_1 dist_k + b_2 q_{ikt}, \qquad (3)$$

The marginal cost function includes a parameter (b_o) that captures the allocation of costs at the firm level. In addition, it includes a variable for distance (*dist*) as a major determinant of the costs than an airline must afford when providing services in a route. Finally, the sign of the parameter (b_2) associated with the number of passengers carried by airlines on the route (q_{ikt}) determines the slope of marginal costs.[6]

[6] Marginal costs of carrying an additional passenger should include its direct cost plus a random fraction of costs of providing additional capacity. Under this interpretation, marginal costs would be equivalent to average variable costs. The slope of marginal costs would be the sensitivity of average variable costs to traffic density.

The equilibrium condition for each airline is the result of equating cost and revenue functions; $IM_{ikt} = CM_{ik}$. At the market level, such an equilibrium condition comes from the aggregation of the individual equilibrium conditions. Hence, the price equation can be expressed as follows:

$$p_{kt} = b_o + b_1 dist_k + b_2 Q_{mkt} - q(¶p_{kt}/¶Q_{kt})Q_{kt}, \qquad (4)$$

where $q = l/N$, Q_{mkt} is the average market demand and N is the number of route competitors. The demand term of the mark-up expression in (4) can be dropped due to the form of the price elasticity of demand in a semi-logarithmic equation. [7] Thus, the pricing equation to be estimated can be expressed in the following way:

$$p_{kt} = b_o + b_1 dist_k + bQ_{mkt} - q(1/a_k) + e^s_{kt}, \qquad (5)$$

where prices (p_{kt}) are a function of the mark-up [$q(1/a_k)$] on marginal costs ($MC_{kt} = b_o + b_1 dist_k + bQ_{mkt}$). The mark-up is composed of the conduct parameter (q), and the parameter that determines the price elasticity of demand (a_k) that should take a negative value. e^s_{kt} is a random error term. Note that the value of the parameter q, which measures the average degree of collusion, should be ranked from 0 to 1.

Our identification procedure of conduct and cost parameters should rely on the assumption that $q = 1$ in monopoly routes. Indeed, the pricing equation can be expressed as follows after applying some mathematical arrangements: [8]

$$p_{kt} = c_0 + b_1 dist_{kt} + bQ_{mkt} + D_{kt}^{oligopoly} g + e^s_{kt}, \qquad (6)$$

where $c_0 = b_0 - D_{kt}^{monopoly} a^{(-1)}$ and $g = a^{(-1)}(1 - q_{kt}^{ooligopoly})$. Note that $q_{kt}^{oligopoly}$ is the conduct parameter in oligopoly routes and $D_{kt}^{monopoly}$ is a dummy variable for monopoly routes. In case that the conduct parameter in monopoly routes takes the value 1, then the conduct parameter in oligopoly routes is ranked from 0 (prices equal to marginal costs) to 1 (prices set on a joint profit maximization setting). Importantly, q would take a value equal to the inverse of the number of competitors under the Cournot assumption.

---

7 The price elasticity of demand in a semi-logarithmic equation is: $\eta_{\alpha k} = a_k p_{kt}$. This is the case due to the fact that $a_k = ¶log(Q_{kt})/¶p_{kt}$ and so $a_k = ¶Q_{kt}/¶p_{kt}Q_{kt}$ given that $¶log(Q_{kt}) = ¶Q_{kt}/Q_{kt}$

8 The supply relationship can be expressed in the following way: $p = b_0 + b_1 dist + bQ_m - D^{monopoly} a^{(-1)} - D^{oligopoly} q^{oligopoly} a^{(-1)} + e^s_{kt}$, where $D^{monopoly}$ and $D^{oligopoly}$ are dummy variables that refer to monopoly and oligopoly routes respectively. The intercept term (c_o) in monopoly routes is $c_o^{monopoly} = b_0 - a^{(-1)}$, whereas it is $c_0^{oligopoly} = b_0$ in oligopoly routes. For this reason, the term $D^{oligopoly} a^{(-1)}$ should be added to the previous equation in order to express properly the intercept term: $p = b_0 + b_1 dist + bQ_m - D^{monopoly} a^{(-1)} - D^{oligopoly} q^{oligopoly} a^{(-1)} + D^{oligopoly} a^{(-1)} + e^s_{kt}$. From this expression, we can easily derive equation (6)

Fageda (2006a) shows that the assumption that q = 1 in monopoly routes is essentially correct in a scenario where capacity constraints are binding. Indeed, entry barriers can be high enough to protect incumbents when airport congestion takes place. However, this may not be the case just after the expansion in airport capacity. Thus, the conduct parameter in a period with no capacity constraints for monopoly routes may be lower than 1.

Our aim here is to examine changes in airlines conduct in the event of airport capacity expansions. In this way, we include in the pricing equation (6) a variable for increased airport capacity, *capacity,* which is constructed in the same way as the analogous variable for the demand equation. If the coefficient associated to this variable is statistically significant, we will find evidence of a structural change in the pricing behaviour of airlines when airport congestion does not condition such behaviour.

Additionally, we estimate our equation system for two subperiods differentiating whether capacity constraints are binding or not. In this way, we establish as a cutting point the winter season of 2004-2005, the period in which Barcelona airport has a new runway working. From these estimations, we can see differences in monopoly and oligopoly routes in terms of the mark-ups that airlines charge over costs for the two subperiods. It can also be obtained a rough approximation of the deviation from a Cournot behaviour, which is a common result in previous studies about conduct parameters in airline markets [Brander and Zhang (1990, 1993), Oum et al. (1993), Fisher and Kamerschen (2003)]. It must be said that we cannot provide robust tests of alternative oligopoly models because we are not able to test that the assumption q = 1 is correct when airport congestion does not take place.

In the appendix, we specify how the variables used in the empirical analysis have been constructed, providing data sources and descriptive statistics for those variables. Following strict rules for data collection (see the appendix), it is worth mentioning here that the variable for prices is the lowest mean round trip price charged by airlines offering services in the route weighted by their corresponding market share. We use the lowest mean price across airlines because one of our main purposes is to analyze the impact of low-cost carriers on prices. In this way, we are particularly concerned on price-sensitive passengers.

Table 1 shows the results of the system equation estimates (equations 1 and 6) using the Generalized-Two Stage Least Square technique within the framework of random effects models. It must be said that our estimation procedure takes into account both the panel data nature of the sample and the possible endogeneity of the dummy variable for oligopoly routes.[9] Furthermore, it must be noted that we include a dummy variable that takes value 1 for the summer season, D^{summer}, both for the demand and pricing equations. Such variable accounts for differences across seasons.

Insert Table 1

The overall explanatory power of the equation is reasonably good. Furthermore, most of the coefficients of the control variables for both the demand and pricing equations are statistically significant and with the expected signs. Importantly, the coefficient of the dummy variable for capacity constraints, $D^{capacity}$, is statistically significant both in the demand and pricing equations. Thus, route traffic density seems to be higher after the event of capacity expansions. Furthermore, given the value of the cost shifters, we find that prices are lower after this event has taken place.

As expected, air traffic in a route is greater in city-pairs with a higher amount of employment and in case that other transport modes are not able to offer transport services at competitive conditions. Concerning the demand equation, only the coefficient of the variable for tourism is not significant when considering the whole period, while the dummy variable for routes with origin in Madrid is not significant when considering the period without capacity restrictions. In that period, traffic may have increased at a higher rate in routes that do not have Madrid airport as origin since low cost airlines have had a more active role in other airports. Otherwise, the tourism effect seems to be better captured when we differentiate between the two subperiods.

If we look at the pricing equation, only the variable for traffic density is not significant when considering the period without capacity restrictions. In this way, we find some evidence of density economies as long as the variable for demand in the pricing equation is statistically significant and with a negative sign when the estimation is made for the whole period. However, density economies seem to be exhausted after the airport capacity expansions. To this regard, it is worth noting the high growth rate of air traffic in Spain during last years.

[9] We use as an additional instrument for the dummy variable for oligopoly routes, a variable for airport concentration at both endpoints of the route. The number of competitors in a route should be correlated with the variable for concentration at the airport level as it captures the relative presence of the dominant carrier's rivals both in the endpoints of the route.

Interestingly, demand and prices are higher for the summer and this is particularly true in the period after the capacity expansion. In a tourist oriented market as it is the case in Spain, people travel and are willing to pay more in the summer season.

Table 2 shows the structural parameters obtained from the system equation estimates for some relevant variables.

Insert Table 2

Price elasticity of demand lies between -0.64 and -1.00. These values are in the inelastic range of results obtained in previous studies (Oum et al., 1992). We also confirm the existence of distance economies and the estimated elasticity of about 0.39 is similar to that obtained in previous studies (Oum et al. 1993, Brueckner and Spiller, 1994; Fageda, 2006a). Our results also show that, in case of airport congestion, a ten per cent increase in route traffic density implies about a one per cent decrease in prices charged to consumers.

Regarding airlines conduct, the parameter estimated for the whole period takes a value of 0.73. This implies a substantial market power for Spanish airlines. However, we find high differences between both sub-periods. Indeed, the conduct parameter estimated in the period with capacity constraints is 0.83, whereas it takes the value 0.66 in the period without capacity constraints. In terms of oligopoly models, conduct in the period with capacity constraints would be near to a joint profit maximization behavior, so that mark-ups over costs in oligopoly routes are similar to mark-ups charged in monopoly routes. Otherwise, conduct in the period with no capacity constraints would be roughly equivalent to the Cournot solution, as it has been found in several previous studies.[10]

To this point, it must be stressed that price differences between both sub-periods are likely to be higher than the amount that we can capture in our estimates. As we have mentioned above, the conduct parameter should be 1 in monopoly routes when airport congestion binds, while the conduct parameter for monopoly routes in the period with no capacity constraints may be lower than 1. Indeed, the conduct parameter in monopoly routes is the reference value to quantify mark-ups in oligopoly ones. And such reference value should be higher in the period with capacity constraints due to the existence of stronger entry barriers then.

[10] Using a non-linear test ($\chi^2(1)$), we both reject that the conduct parameter takes a value of 0.57 (the inverse of the mean number of competitors) and that takes a value of 1 in the period with capacity constraints. Otherwise, we do not reject that the conduct parameter takes a value of 0.48 (the inverse of the mean number of competitors) but we reject that takes a value of 1 in the period with no capacity constraints. Concerning the whole period, we both reject that the conduct parameter takes a value of 0.53 (the inverse of the mean number of competitors) and that takes a value of 1.

In addition to this, we want to remark that our aim is not to examine the sensitivity of airlines conduct to variables of market structure. However, it is interesting to note that results of additional specifications of the demand and pricing equations systems, which account for the determinants of the conduct parameters, show that airlines conduct is less competitive when both airport and route concentration is higher.[11]

To sum up, the scenario where airlines compete becomes much more competitive after the event of airport capacity expansions, as it could be expected. Given that our analysis is focused on the lowest fare class, the overall impact for price-sensitive consumers must be high.

Once we have found that mark-ups over costs in oligopoly routes are significantly lower when capacity constraints do not condition airlines conduct, other questions must be addressed. Accounting for the fact that density economies can be exploited up to some traffic levels, it must be analyzed which type of routes takes benefit of the more competitive scenario that follows airport capacity expansions. In other words, it must be examined to what extent low-density routes are still monopoly routes even when airport access does not prevent the entry of new air carriers. We deal with this question in the following section.

3. Entry patterns and route traffic density

Entry choices of airlines across routes are determined by the expected profitability of these choices. The empirical literature about entry in airlines markets typically account for several route characteristics as major factors explaining the profitability of entry. This is the case in those papers of Johnson (1985), Joskow et al (1994), Boguslaski et al (2004) and others. In this way, route traffic density and different variables that capture the competitive position of incumbents (route concentration, airport presence, service quality of incumbents and so on) are commonly considered to be the main determinants of entry choices by airlines not still operating the route. Additionally, some studies also include in their empirical analysis some indicator of the prices charged in the route. Among them we can cite those from Reiss and Spiller (1989), Strassmann (1990), Dresner et al (2002), Schipper et al (2003) and others.

In our context, the determinants of the number of competitors in route k at period t can be analyzed through the following equation:

[11] Results of these estimates are available to authors upon request.

$$Num\_competitors = d_0 + d_1 p_{kt} + d_2 Q_{kt} + d_3 HHR_{route(kt)} + d_4 D_{kt}^{hub} + d_5 capacity_t + e^d_{kt}, \quad (7)$$

where the number of competitors in a route is made dependent of the following explanatory variables. First, the number of route competitors should depend positively both on prices, p, and route density, Q. Indeed, higher prices and demand should imply higher profitability rates for airlines operating there. Second, entry choices are also influenced by the level of competition. In this way, we include a variable for concentration at the route level, HHR_{route}. Furthermore, we also include a dummy variable that takes value 1 for routes with origin in Madrid airport, D^{hub} . This variable may capture an airport dominance effect as the main hub of the largest Spanish airline, Iberia, is Madrid airport.

To this point, it is worth mentioning that our aim here is not to make an exhaustive analysis of airline entry choices as long as such analysis would require considering the dynamics of the airlines decision making process. What we want to analyze is which types of routes are affected by the competition benefits derived from several airlines operating there. Such benefits refer particularly to the period that follows investments in airport capacity. In this way, we also include in equation (7) a variable that accounts for airport capacity expansions, *capacity*, which is constructed in the same way as the analogous variable in the demand and pricing equations of the previous section. This variable should capture the expected increase in the number of route competitors due to the reduction (maybe even withdrawal) of the entry barriers associated to airport access for non-incumbent airlines.

Table 3 shows the results of the estimates concerning the determinants of the number of competitors in a route. The estimation has been made using the ordered probit technique within the framework of random effects models. In this way, we account both for the panel data nature of the sample and the discrete form of the dependent variable. Additionally, the possible endogeneity of the variables for demand, prices and route concentration are considered in our estimation procedure.[12] As before, we include a dummy variable that takes value 1 for the summer season to account for differences across seasons.

Insert Table 3

[12] The explanatory variables of the equation system previously formulated are used as instruments for the demand and price variables. The variable for route concentration is instrumented using data of the previous period. In this way, the considered period in this estimation goes from the summer of 2002 to the winter of 2006-2007 since we cannot make use of data for 2001.

The overall explanatory power of the equation is good. All the explanatory variables are significant, with the exception of the dummy variable for season. In general terms, the number of competitors is higher after the event of increasing airport capacity. Thus, it seems that travelers have more alternatives to choose (and likely at lower prices) in this latter period.

Moreover, as it could be expected, the higher the prices and demand, the greater the number of competitors in a route. Additionally, the number of competitors decreases as long as it increases the degree of concentration at the route level. Given prices, this means that the relative strength of major incumbents may deter the entry of new airlines.[13] Finally, the number of airlines offering services seems to be lower in routes with origin in Madrid airport. This latter result seems to confirm the hub dominance effect of Madrid previously mentioned.

Given the value of other control factors, it seems that travelers of high-density routes take benefit from several airlines offering services there. However, some routes may not be able to generate enough traffic to attract more than one airline. Indeed, the main concern that can be inferred from the estimates of the equation of the number of route competitors determinants is referred to low-density routes. Indeed, travelers of low-density routes may not take benefit from airline competition as long as just one airline may monopolize the supply of air services.

A central issue here is to identify the natural monopoly thresholds and their evolution. Density economies imply that average costs (and even marginal costs as we found above) decrease as long as the number of passengers moved at the route level increases. Hence, competition may be neither efficient nor possible for low-density routes. However, pressures for cost reduction coming from competition could reduce the amount of route traffic needed for making optimal the fact that more than one airline operates in this route. In such a case, travelers of low-density routes would also benefit from airline competition even though the number of competitors is strongly correlated with the traffic levels at the route.

The analysis of the natural monopoly thresholds is made through non-parametric analysis. Non-parametric techniques are used to estimate the value of a regression function

[13] However, it must be taken into account that high prices are affected by market structure features. In this way, a high market concentration could likely attract the entry of other airlines as they can find opportunities for capturing extraordinary profits.

among two or more variables in a given point, using observations near to this point without introducing any constraint about the functional form. Additionally, it allows considering results across different ranges of values for at least one of the variables of interest. In particular, our analysis makes use of spline regressions, which is a suitable non-parametric tool in those cases in which one or more of the implied variables have a discrete nature.

Figure 1 shows the spline regression that relates the number of competitors with the traffic levels for low-density routes. We define low-density routes as those that have a traffic lower than 205,926 passengers per season, which is the mean number of passengers of our sample of routes for the considered period (see appendix for details). In order to see the evolution of the natural monopoly thresholds along time, we present the results of the spline regression for the mean values of demand and number of competitors concerning three subperiods: 1) seasons going from summer of 2001 to summer of 2004, 2) the period that goes from the winter of 2004-2005 to the winter of 2005-2006, and 3) the period that goes from the summer of 2006 to the winter of 2006-2007. Recall that these three periods capture the event of airport capacity expansions in the two main Spanish airports, Barcelona (the new runway has been fully working since the end of 2004) and Madrid (the new runways and terminal has been fully operating since the beginning of 2006).

For 2001-2004, the natural monopoly threshold seems to break up definitely at the traffic level of about 125,000 passengers per season. From that amount of passengers, the mean number of competitors tends to be higher than two. In routes with a traffic that lies between 110,000 and 125,000 passengers, the mean number of competitors is about 1 so that most of the routes within these traffic levels are monopoly routes. Routes with less than 110,000 passengers are monopolies in most cases, as well while the mean number of competitors for routes with more than 175,000 passengers ranges from 2 to 2.5.

For the period ranging from 2004 to winter 2005-06, the natural monopoly threshold is broken up at 60,000 passengers per season since the mean number of routes at these traffic level is higher than 1.5. This trend is sustained across all traffic densities, and becoming even stronger for those routes with more than 150,000 passengers.

For the period that goes from summer 2006 to 2007, the natural monopoly threshold seems to break up at the traffic level of about 50,000 passengers per season, although this trend is not fully consistent until we consider routes of more than 125,000 passengers. It must be taken into that the fewer number of observations for this period may be distorting the spline regression, at least for some range of traffic densities.

Thus, increasing competition in the Spanish market after the expansion of airport capacity at the main airports has dramatically altered the traffic thresholds that determine the existence of a natural monopoly in almost every route, even those with low traffic density.

Insert Figure 1

Price competition and an increase in the number of competitors seems to be the outcome of a liberalized airline market in which airport congestion does not become a strong entry barrier. However, are the capacity expansions at major airports the only driving factor for the increase in competition?. A current central issue in the European airline industry is the success of low-cost carriers to compete in short-haul routes. Hence, it is critical to examine the role of low-cost carriers with regard to the more competitive scenario that characterize the Spanish airline market in last years.

4. The impact of low-cost carriers on airline competition

In Europe, former flag carriers and other airlines integrated in international alliances are progressively concentrating their main business in long-haul air services, whereas low-cost carriers are exploiting some cost-advantages to be competitive in short-haul routes. Indeed, low-cost carriers tend to operate with lower labour costs than legacy carriers. Additionally, they take advantage of a more simple business structure as long as they usually use a unique type of plane (with the maximum seat configuration), they concentrate operations in non-stop services and offer a single-fare class. Some low-cost carriers, most notably Ryanair, also benefit from the lower costs that involves operating from secondary airports.

Along with these cost advantages, a major factor for a low-cost carrier to be competitive is that they may exploit density economies derived from a high utilisation of the planes and crew. However, this could require developing a network of short-haul routes but also operating in routes with a minimum amount of traffic. In this way, it is generally accepted that low-cost carriers contribute to the reduction of prices in the routes in which they operate [Morrison and Winston (1995); Morrison (2001)]**.** However**,** some studies about entry patterns of low-cost carriers reveal that they prefer to operate on high-density routes, particularly in the first years of operation [Boulaski et al (2004); Ito and Lee

(2003), Gil-Moltó and Piga (2006)]. And even other works suggest that carriers enter those routes consistent with the hypothesis that they pursue a differentiation strategy in order to expand the variety of products offered in the market [Lederman and Januszewski (2003)].

Here we analyze not only the impact of low-cost carriers on prices but also their influence on the relationship between traffic and number of competitors in low-density routes.

Price effects of low-cost carriers are considered through a price equation for oligopoly routes *k'*. In this way, we put the attention on non monopoly routes to isolate the low-cost carriers impact on prices from the global effect associated to the increase in the number of airlines offering services in the route (with respect to a monopoly scenario). This price equation accounts for the main cost shifters; demand at the route level, *Q*, and route distance, *dist*. In addition to this, it includes a dummy variable that takes value 1 for routes with presence of low cost carriers, D^{low_cost}. The equation to be estimated is as follows:

$$p_{k't} = e_0 + e_1 dist_{k't} + e_2 Q_{k't} + e_3 D_{k't}^{low\_cost} + e^{e}_{kt}, \qquad (8)$$

Table 4 shows the results of the pricing equation estimates using the Generalized-Two Stage Least Square technique within the framework of random effects models. Again it is worth noting that our estimation procedure takes into account both the panel data nature of the sample and the possible endogeneity of the variables for demand and presence of low-cost carriers.[14] As in previous estimations, we also include a dummy variable that takes value 1 for the summer season, D^{summer}.

Insert Table 4

The overall explanatory power of the equation is high, and all the variables are significant and with the expected sign. For oligopoly routes, the presence of low-cost carriers seems to reduce prices in a statistically significant way. In terms of elasticities, the decrease of prices in oligopoly routes due to the presence of low-cost carriers is about 4 per cent.

The amount of the price reduction related to low-cost carriers seems to be modest but we must take into account that our price indicator refers to the mean average prices weighted by the market share of each airline. Since the market share obtained by low-cost

[14] We use the variable for airport concentration at both endpoints of the route as an additional instrument for the dummy variable of low cost carriers presence. This variable accounts for the relative presence of the rivals of largest carriers, among them low cost-carriers, both in the endpoints of the route.

carriers in Spanish routes is generally low, the price discounts of low-cost carriers with regard to other airlines must be substantial. Thus, some travelers may benefit from very low prices in specific flights, not to mention the benefits derived from low-cost carriers presence if they offer services in low-density routes. And even more important, the aggregate effect on prices of the low-cost carriers presence may be higher as these carriers enter in a variety of routes including that previously operated under monopoly conditions. According to our estimations with regard to equation (8), the move from monopoly to a more competitive structure implies a reduction in prices of about 17 per cent.

Figure 2 shows the spline regression that relates the number of competitors with the traffic levels for low-density routes, which are the routes with traffic lower than the mean number of passengers of our sample of routes for the considered period. Here we differentiate among all routes, those with presence of low-cost carriers and routes without low-cost carriers. The analysis is restricted to the period after the increase in capacity at major airports because most of low-cost carriers entries have taken place in this period.

Note that we consider the number of competitors in the period before the expansion in airport capacity. This allows avoiding any possible endogeneity bias related to the simultaneous determination of low-cost carriers presence and number of competitors.

Insert Figure 2

From figure 2, it can be observed that low-cost carriers alter substantially the relationship between the number of competitors and traffic levels at the route. This is true in routes with traffic from 50,000 passengers per season and even more dramatically for traffics of more than 90,000 passesngers. Here the presence of low-cost carriers implies more than double the mean number of competitors according to traffic levels. Such mean number lies at 1 for all routes and routes without low-cost and from 1.5 to 2.5 for the restricted sample of routes with presence of low-cost carriers.

This result fits well with our previous finding that the mean number of competitors has increased for low density routes after the airport capacity expansions. It seems that low cost-carriers have played a major role concerning this effect.

In short, travelers have taken two benefits from the success of low-cost carriers in the Spanish market. First, they may take advantage of low prices in specific flights. And second, low-cost carriers allow travelers to have a higher number of alternatives to chose in low-density routes.

5. Concluding remarks

This paper has dealt with the dynamics of airline competition in the Spanish airline market, which is one of the largest markets in the European context. Our main purpose has been to measure the role of two major triggering factors for the Spanish market becoming more competitive; the withdrawal of capacity constraints at main airports and the increasing presence of low-cost carriers there.

The main empirical findings of the paper are the following. First, we find that airlines conduct is near to a joint profit maximization setting when capacity constraints are binding, whereas such airlines conduct is roughly equivalent to the Cournot solution when airport congestion at the main airports do not take place.

Additionally, our results show that prices and traffic density are major determinants of the number of competitors at the route level. However, we obtain evidence that the natural monopoly threshold breaks up dramatically at low traffic density levels after the increase in airport capacity.

Finally, the presence of low-cost carriers has a modest but still significant estimated effect on prices although their aggregate impact may be higher as long as they enter previously monopoly routes. In this way, low cost-carriers alter the relationship between the number of competitors and traffic levels for low-density routes. Indeed, they contribute to the increase in the number of competitors in routes which traffic from 50,000 passengers per season.

To sum up, tough competition in airline markets requires providing enough capacity at main airports. Otherwise, incumbents may take advantage of airport dominance as a major source of demand and cost advantages and as a strong entry barrier. However, efficiency effects of tougher competition must be compared with the possible social and environmental costs of increasing airport capacity.

In addition to this, low-cost carriers have a positive impact on the traveler welfare as long as they provide lower-prices in some flights and more alternatives to chose even in low-density routes. Nevertheless, their market share is still low in most routes so that competition concerns are still in place in the post-liberalization period. To this regard, a number of low-density routes remain operated by just one airline.

To sum up, policies for maximizing the impact of the airline industry on the social welfare should involve preventing airport congestion and promoting the entry of low-cost carriers in short-haul routes.

References

Alderighi, M., A. Cento, P. Nijkamp and P. Rietveld (2004) The entry of low cost airlines, Tinbergen Institute Discussion Paper TI 2004-074/3

Berry, S. (1992) Estimation of a model of entry in the airline industry, *Econometrica*, 60(4), 889-917

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.

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

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

Braeutigam, R.R. (1989) Optimal Policies for Natural Monopolies, in R. Schmalensee, and R.D. Willig eds., *Handbook of Industrial Organization*. Amsterdam: North Holland, pp. 1290-1346.

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

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

Bresnahan, T. F. (1989) Empirical Studies in Industries with Market Power, in R. Schmalensee, and R.D. Willig eds., *Handbook of Industrial Organization*. Amsterdam: North Holland, pp. 1011-1057.

Bresnahan, T.F. and P.C Reiss (1991) Entry and competition in concentrated markets *Journal of Political Economy*, 99(5), 977-1009

Bogulaski, C., H. Ito and D. Lee (2004), Entry Patterns in the Southwest Airlines Route System, *Review of Industrial Organization* 25, 317–350.

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

Brueckner, J.K., N.J. Dyer and P.T. Spiller (1992) Fare Determination in Airline Hub-and-Spoke Networks, *Rand Journal of Economics*, 23, 309-333.

Carlsson, F. (2004) Prices and Departures in European Domestic Aviation Markets, *Review of Industrial Organization*, 24, 37-49.

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.

Deneckere, R.J. and D. Kovenock (1992) Price Leadership, *Review of Economic Studies*, 59, 143-162.

Dresner, M.; R. Windle and Y. Yao (2002) Airport barriers to entry in the US *Journal of Transport Economics and Policy*, 36(2), 389-405

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.

Fageda, X. (2006a), Measuring conduct and cost parameters in the Spanish airline market, *Review of Industrial Organization*, 28 (4), 379-399.

Fageda, X. (2006b), Infrastructure dominance in short-haul air transport markets, University of Barcelona, Mimeo.

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.

Gil-Moltó, and C. Piga (2006), "Entry and Exit in a Liberalised Market", WP.2005/10, Discussion Paper Series, Loughborough University.

Goolsbee and Syverson (2005), "How do incumbents respond to the threat of entry? Evidence from major airlines", *NBER Working Paper Series*, 11072, 1-29.

Johnson, R.L. (1985) Networking and market entry in the airline industry, some early evidence from deregulation, *Journal of Transport Economic and Policy* 19, 299-304.

Joskow, A. S., G.J.Werden and R.L Johnson (1994) Entry and exit in a liberalised market *International Journal of Industrial Organisation*, 12, 457-471

Lederman, M. and S. Januszewski (2003) Entry Patterns of low-cost airlines, *Massachusetts Institute of Technology*, 1-35.

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

Morrison, S.A (2001), Actual, Adjacent and potential competition: Estimating the full effect of Southwest airlines, *Journal of Transport Economics and Policy*, 35 (2), 239-256.

Morrison, S.A and C. Winston (1990) The dynamics of airline pricing and competition, *American Economic Review* 80, 389-393.

Morrison, S.A and C. Winston (1995), *The evolution of the airline industry*, Washington, DC: The Brookings Institution.

Oum, T.H., W.G. Waters and J.S Yong (1992) Concepts of Price Elasticities of Transport Demand and Recent Empirical Estimates, *Journal of Transport Economics and Policy*, 26, 139-154.

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.

Reiss, P.C. and P.T. Spiller (1989) Competition and entry in small airline markets, *Journal of Law and Economics*, 32, S179-S202.

Reynolds-Feighan, A. and K.J Button (1999) An assessment of the capacity and congestion levels at European airports, *Journal of Air Transport Management*, 5, 113-134.

Schipper, Y., P. Rietveld and P. Nijkamp (2003) European Airline Reform, an empirical welfare analysis, *Journal of Transport Economics and Policy*, 36(2), 189-209.

Strassmann, D.L. (1990) Potential competition in the deregulated airlines, *Review of Economics and Statistics*, 72, 696-702.

Appendix: Variables description and data sources:

- **Prices (*p*):** The lowest mean round trip price charged by airlines offering services weighted by their corresponding market share. Information has been obtained from airlines websites following these homogeneous rules. Price data refer to the city pair link that has as its origin the city with the largest airport. Additionally, it has been collected one month before travelling, the price refers to the first trip of the week, and the return is on Sunday.

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

- **Number of competitors (*Num_competitors*):** Number of airlines offering more than one flight per week in the route. Service frequency of airlines operating in the route has been obtained from Official Airlines Guide (OAG) website.

- **Employment (*emp)*:** Total mean employment in a route's origin and destination provinces. Data has been obtained from the National Statistics Institute (INE).

- **Tourism (*tour*):** Number of tourists per capita in the destination region. Data has been obtained from the Institute of Tourist Studies (IET).

- **Distance (*Dist*):** Number of kilometers that are needed to flown between the origin and destination airport of the route. Data has been collected from WebFlyer site.

- **Route concentration (HHI_{route}):** Index of Herfindahl-Hirschman at the route level. The concentration index is calculated in terms of airlines' departures. Data on departures of each airline in each route have been obtained from Official Airlines Guide (OAG) website.

- **Airport concentration ($HHI_{airport}$):** Index of Herfindahl-Hirschman at the airport level. The concentration index is calculated in terms of airlines' national departures both in the origin and destination airports of the route. Then we obtain the mean value of the Hirschman-Herfindahl index regarding both endpoints. Data on the percentage of departures of each airline in origin and destination facilities have been obtained from Spanish Airports and Air Navigation (AENA) agency

- **Capacity** : Variable that takes value 1 since the winter season of 2004-2005 and that takes value 2 since the summer of 2006, 0 otherwise. A new runway has been fully working in Barcelona airport since october 2004, while two new runways (and a new terminal building) has been fully working in Madrid airport since the beginning of 2006.

- $\mathbf{D}^{oligopoly}$: Dummy variable that takes value 1 for routes with more than one airline offering services

- $\mathbf{D}^{low\_cost}$: Dummy variable that takes value 1 for routes in which at least one low cost airline operates.

- $\mathbf{D}^{hub}$: Dummy variable that takes value 1 for routes with origin in Madrid

- $\mathbf{D}^{modal}$: Dummy variable that takes value for routes with no islands as an endpoint and/or less than 450 kilometers

- $\mathbf{D}^{summer}$: Dummy variable that takes value 1 for the summer season that goes from October 26th to 26th April

Table A1. Descriptive statistics (Number of observations: 821)

Variable	Mean	Standard deviation	Minimum value	Maximum value
prices (*p*) : euros	196.60	98.58	49.85	829.67
demand (*Q*) : Number of passengers	205,926.5	308,017.8	1,361	2,544,290
Num_competitors: Number of airlines	1.89	1.02	1	6
employment (*emp*) : Number of employees	1,216,849	415,519.4	378,750	2,772,809
tourism (*tour*): Number of tourists per capita	2.52	3.40	0.11	11.34
distance (*dist*): Number of kilometers	644.70	485.08	131	2,190
Airport concentration ($HHI_{airport}$): index	0.53	0.12	0.27	0.76
Route concentration ($HHI_{airport}$): index	0.74	0.35	0.21	1
Capacity	0.58	0.76	0	2
$D^{oligopoly}$	0.51	0.50	0	1
D^{hub}	0.41	0.49	0	1
D^{modal}	0.31	0.46	0	1
D^{summer}	0.50	0.50	0	1

TABLES AND FIGURES

Table 1. Pricing Equation Estimates (G2SLQ random effects – IV regression);

	(1) Baseline N = 821	(2) Period with capacity restrictions N = 460	(3) Period without capacity restrictions N = 361
Demand equation (dependent variable: Q)			
prices (*p*)	-0.0032 (0.0011)***	-0.041 (0.0015)***	-0.057 (0.002)***
employment (*emp*)	0.40 (0.17)**	1.15 (0.22)***	0.81 (0.21)***
tourism *(tour)*	0.06 (0.07)	0.30 (0.07)***	0.31 (0.08)***
D^{modal}	-0.35 (0.20)*	-0.78 (0.24)***	-0.50 (0.21)**
D^{hub}	0.64 (0.28)**	0.47 (0.22)**	0.36 (0.23)
D^{summer}	0.36 (0.07)***	0.35 (0.08)***	0.57 (0.14)***
capacity	0.10 (0.02)***	-	
Intercept	6.02 (2.44)**	-3.88 (3.08)	0.9 (2.94)
R^2 c^2 **(joint sig.)**	0.25 214.46***	0.47 117.88***	0.29 70.69***
Pricing equation (dependent variable: p)			
demand (Q_m)	-0.00017 (0.7e-4)***	-0.00024 (0.7e-4)***	-0.00006 (0.0001)
distance (*dist*)	0.12 (0.008)***	0.12 (0.008)***	0.10 (0.010)***
$D^{oligopoly}$	-52.58 (13.16)***	-33.92 (13.86)**	-65.74 (18.81)***
D^{Summer}	63.87 (5.02)***	51.39 (6.53)***	73.65 (7.84)***
capacity	-11.37 (3.52)***	-	-
Intercept	137.58 (8.48)***	141.42 (8.99)***	120.00 (11.75)***
R^2 c^2 **(joint sig.)**	0.43 461.87***	0.47 337.00***	0.37 187.70***

Note 1: Instruments for prices in the demand equation: Distance, Airport concentration
Note 2: Instruments for demand and $D^{oligopoly}$ in the pricing equation: employment, tourism, D^{modal}, D^{hub}, Airport concentration
Note 3: Standard errors in parentheses
Note 4: Significance at the 1% (***), 5% (**), 10% (*)

Table 2. Estimated structural parameters (Evaluated at sample means)

	(1) Baseline N = 821	(2) Period with capacity restrictions N = 460	(3) Period without capacity restrictions N = 361
Price elasticity of demand to prices: h_a	-0.64***	-0.89**	-1.00**
Price elasticity to density: h_b	-0.08***	-0.10***	-0.03
Price elasticity to distance: h_{b1}	0.39***	0.38***	0.39***
Conduct parameter: q	0.73***	0.83***	0.66***

Note: Significance at the 1% (***), 5% (**), 10% (*)

Table 3. Number of competitors equation estimates

(Random effects ordered probit). N= 688

demand (Q_m)	4.95e-06 (6.15e-07)***
prices (p)	0.006 (0.001)***
D^{hub}	-0.54 (0.20)***
capacity	0.71 (0.08)***
D^{Summer}	-0.10 (0.14)
route Concentration (HHR_{route})	-3.45 (0.41)***
Intercept	0.70 (0.04)***
Log likelihood	-439.38
LR c^2 (joint sig.)	287.04***

Note 1: Instruments for prices and demand: distance, employment, tourism, D^{modal}. Variable for route concentration is instrumented with data of the previous period.
Note 2: Significance at the 1% (***), 5% (**), 10% (*)

Figure 1. Evolution of the natural monopoly threshold: Spline of number of competitors respect to route traffic density (if route traffic less than 205,926)

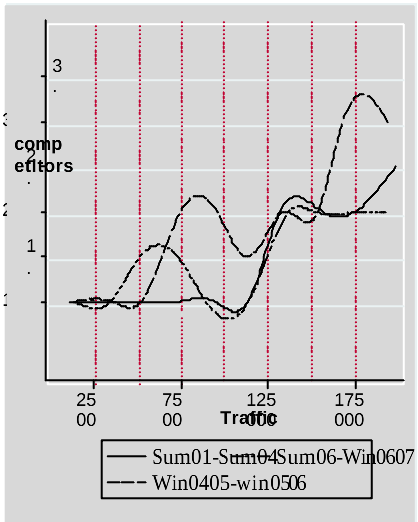

Table 4. Pricing equation Estimates (G2SLQ random effects – IV regression);

	Non monopoly routes N = 422
demand (Q_m **)**	-00006 (0.2e-4)***
distance (*dist*)	0.11 (0.007)***
D^{low_cost}	-33.88 (16.47)**
D^{Summer}	78.66 (5.75)***
Intercept	93.81 (10.73)***
R^2	0.61
c^2 **(joint sig.)**	459.25***

Note 1: Instruments for demand and D^{low_cost} in the pricing equation: employment, tourism, D^{modal}, D^{hub}, Airport concentration

Note 2: Standard errors in parentheses

Note 3: Significance at the 1% (***), 5% (**), 10% (*)

Figure 2. Comparison between low cost and all carriers: Spline of number of competitors respect to route traffic density (if route traffic less than 205,926)