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

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A B S T R A C T

We analyze the influence of increases in airport capacity and the entry of low-cost carriers on airline competition. We use parametric and non-parametric techniques to analyze a sample of Spanish routes. We find that capacity increases in large airports produce more competitive airline conduct only in routes departing from non-hub airports. Also, we find that the natural monopoly threshold decreases with time. Finally, low-cost carriers have a moderate but still significant effect on prices and increase alternatives even in low-density routes.

1. Introduction

Airline competition across European markets in the immediate post-liberalization period was heavily affected by airport capacity constraints and the dominance of former flag carriers. This is particularly true for routes departing from large hub airports. On the other hand, low traffic routes tend to be seen as natural monopolies because of the substantial density economies enjoyed.

Here, we analyze the influence of two factors driving change in the competitive scenario. Increasing the capacity of the largest airports has been the object of considerable investment throughout Europe. Over the same time, low-cost carriers have expanded their presence in most European markets. These factors may influence both overall prices and the number of effective competitors on many routes. We examine which types of routes benefit from increases in airline competition, focusing attention on the originating airport and traffic density as major route factors.

The analysis uses data from the Spanish domestic market, which allows quantification of the influence of key drivers of competition. The two main Spanish airports, Madrid and Barcelona, were subjected to strong capacity constraints until 2004 (Reynolds-Feighan and Button, 1999; Spanish Ministry of Transports-Orders of October, 2002). Since then, huge investments made in these airports by AENA, the Spanish airport operator, has led to considerable increases in their capacity. Simultaneously, low-cost carriers have increased their presence. While business models across different types of airlines have converged, we identified low-cost carriers as those airlines that use a single-fare class over their whole network of routes.

We look at several issues. First, we quantify how airline 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.[1] Second, we re-examine the question of traffic thresholds for natural monopolies. This has received little attention regarding literature on the airline industry. Finally, we quantify the influence of low-cost carriers on prices and natural monopoly thresholds in a European market.

2. Airline conduct following airport expansions

Spain is the largest domestic air transport market in the European Union and is third in terms of total traffic. Additionally, its two main airports are among the 10 largest, with Madrid acting as a major hub. Since 2001, data on Spanish air traffic are available for 74 non-stop pair links up to the summer of 2007, where the origin is the city with the largest airport. Semi-annual data allows differentiation between the summer and the winter seasons. Several types of airlines operate in the Spanish domestic market.[2] The two with the largest market share, Iberia and Spanair, are network carriers that belong to Oneworld and Star Alliance, respectively. The Iberia group also includes a large regional airline, Air Nostrum. The third largest carrier, Air Europe, is owned by a tourist operator.

[1] Note that airport dominance in a context of capacity constraints provides several demand and cost advantages to larger airlines but this may not be the case after airport capacity expansions (Fageda, 2008).

[2] See Rey (2003) for an analysis of Spanish airline strategies in the first years of the post-liberalization period, 1993–1997.

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Three low-cost carriers have also an increasing presence, Air Berlin, Clickair and Vueling.[3] Additionally, the two largest low-cost carriers in Europe, Ryanair and Easyjet, began operating a few domestic links in Spain in 2007.

A demand-supply system is used to estimate changes in airline conduct after airport capacity expansions. The demand for route k in period t is based on a typical gravity model using a semi-logarithmic specification to identify the conduct parameter in the pricing equation (Fageda, 2006)[4]:

$$\log(Q_{kt}) = a_0 + a_1 \log(\text{pop}_{kt}) + a_2 \log(\text{GDPc}_{kt}) + a_3 \log(\text{tour}_{kt}) + a_4 D_k^{\text{hub}} + a_5 D_k^{\text{modal}} + a_6 p_{kt} + a_7 \text{trend}_t + a_8 D_t^{\text{summer}} + e_{kt}^d \quad (1)$$

Demand (Q_{kt}) is the number of passengers carried by airlines on the route, including direct and connecting traffic. The mean values of population (pop_{kt}), gross domestic product per capita (GDPc_{kt}), and tourism intensity (tour_{kt}) of the route city-pairs are explanatory variables. Population and GDP per capita capture the demographic and economic size of the city-pairs. The variable for tourism captures traffic generated by tourist activities.[5]

The demand function also includes a dummy variable that is set at unity for routes originating in Madrid (D_{kt}^{hub}) – connecting traffic represents a much higher proportion of traffic at that airport than any other Spanish airport. It also includes a dummy variable set at unity for routes of less than 450 km that do not have an island as one endpoint (D_{kt}^{modal}) – these may be subjected to competition from other modes.

Demand also depends on price (p_{kt}), which is usually considered in a demand equation for any service. The lowest mean round trip price charged by airlines offering services on the route weighted by each airline's corresponding market share is used to reflect this. Information on prices were obtained from airline websites and it refers to the city pair link with its origin in the city with the largest airport. Additionally, prices are for tickets purchased 1 month in advance for the first flight on Monday with the return on the following Sunday. Finally, we include a time trend (trend_t) because both air traffic demand and its explanatory variables tend to increase with time.

Following Fageda (2006), the pricing equation can be expressed as:

$$p_{kt} = c_0 + b_1 \text{dist}_{kt} + \beta Q_{mkt} + \gamma D_{kt}^{\text{oligopoly}} + b_2 D_t^{\text{Barcelona\_capacity}} + b_3 D_t^{\text{Madrid\_capacity}} + b_4 D_t^{\text{summer}} + e_{kt}^s, \quad (2)$$

where prices (p_{kt}) are a function of the mark-up [$\gamma D_{kt}^{\text{oligopoly}}$] on marginal costs [$\text{MC}_{kt} = c_o + b_1 \text{dist}_{kt} + \beta Q_{mkt}$].

The mark-up is composed of two terms: 1) the parameter $\gamma = [(1-\theta_{kt}^{\text{oligopoly}})/\alpha_k]$, α being the price elasticity of demand, and $\theta_{kt}^{\text{oligopoly}}$ the conduct parameter in oligopoly routes. In turn, $\theta_{kt}^{\text{oligopoly}} = \lambda/N$, with $\lambda = \partial Q_{kt}/\partial q_{ikt}$ and N being the number of route competitors and 2) $D_{kt}^{\text{oligopoly}}$ which is a dummy variable for any route where more than one airline offers services.

Estimating γ and α allows $\theta_{kt}^{\text{oligopoly}}$ to be found, which measures differences between monopoly and oligopoly routes in terms of the mark-ups over costs charged by that airline. The value $\theta_{kt}^{\text{oligopoly}}$ should range from zero (prices equal to marginal costs) to unity (prices set on a joint profit maximization setting) and it would take a value equal to the inverse of the number of competitors under the *Cournot* assumption.[6]

The marginal cost function includes a parameter (c_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 that an airline must cover when providing services on a route. Finally, the sign of the parameter (β) associated with the average number of passengers carried by airlines on the route (Q_{mkt}) determines the slope of marginal costs.

We include a dummy variable that takes value unity for the summer season ranging from April 26th to October 26th (D^{summer}), both for demand and pricing equations. The analysis reveals, reassuringly since Spain is largely a tourist-oriented market that demand and prices are higher for the summer.

To examine changes in airline conduct in the event of airport capacity expansions we include in Eq. (2), two dummy variables as indicators of airport capacity expansion. The variable $D^{\text{Barcelona\_capacity}}$ takes the value unity from the winter season of 2004 to 2005 to the end of the study period and $D^{\text{Madrid\_capacity}}$ takes a unity value from the summer season of 2006 to the end of the summer season of 2007. A new runway became fully functional at Barcelona airport in October 2004, while two new runways (and a new terminal building) became fully operation in Madrid airport in February 2006. These variables are aimed at capturing the effects of alleviation of capacity constraints at the two main Spanish airports.

Additionally, we estimate the equation system for sub-sample of routes: routes that originated in Barcelona airport during the period in which capacity constraints were not binding and for routes originating in Madrid over the period in which capacity constraints were not binding.[7] These additional estimations of the pricing equation allow assessment of the specific competitive scenario in these two large airports.

Table 1 shows the results of the system equation estimates (Eqs. (1) and (2)) using the two-stage least square procedures (2SLS-IV). The endogenous explanatory variable in the demand equation is the variable for prices, while the endogenous explanatory variables in the pricing equation are those for demand and the dummy variable for oligopoly routes. Each equation of the system provides instruments for demand and prices, respectively. Additionally, we use a variable for airport concentration at the endpoints of the route as an additional instrument for the dummy variable for oligopoly routes.[8]

From the demand equation, we find that air traffic on a route is greater for city-pairs with larger populations and higher intensities of tourism. Additionally, air traffic in a route is less where another transport mode is able to offer competitive conditions. The exploitation of connecting traffic in Madrid airport also seems to be statistically relevant. Moreover the price elasticity of demand, −1.24 at sample means, is consistent with values found in previous studies (Brons et al., 2002; Oum et al., 1992). Finally, GDP per capita and the time trend are not statistically significant.

3 Vueling and Clickair have recently announced their merge that will be effective at the end of 2008. At July 2008, British Airways and Iberia announced a plan to merge.

4 See Oum (1989) for an analysis of the soundness of semi-logarithmic functions in transport markets.

5 Information on demand has been obtained from the website of Spanish Airports and Air Navigation (AENA) Agency. Regional data (at NUTS 2 level) for population and gross domestic product per capita have been obtained from the National Statistics Institute (INE), while the variable for tourism has been constructed from information provided by the Spanish Institute of Tourist Studies (IET).

6 Our identification procedure of conduct and cost parameters relies on the assumption that $\theta = 1$ for monopoly routes. Fageda (2006) shows that the assumption that $\theta = 1$ in monopoly routes is essentially correct in a scenario where capacity constraints are binding. However, the conduct parameter in a period with no capacity constraints for monopoly routes may be less than unity.

7 Madrid is the origin for 30 routes of our sample, Barcelona in 24 and Palma de Majorca, Valencia, Bilbao, and Seville for 20 routes.

8 This variable is constructed as the Herfindahl-Hirschman Index in terms of mean airlines' national departures both in the origin and destination airports of the route. Data on the percentage of departures of each airline in origin and destination facilities have been obtained from Spanish Airports and Air Navigation (AENA) Agency.

Table 1
Demand and pricing equation estimates (2SLS-IV).

	(1) Baseline: whole sample period (N = 894)	(2) Period without capacity restrictions in routes with origin in Barcelona (N = 137)	(3) Period without capacity restrictions in routes with origin in Madrid (N = 88)
Demand equation (dependent variable: Q)			
Prices (p)	−0.0063 (0.0006)***	−0.0029 (0.0009)***	−0.0027 (0.001)
Population (pop)	1.33 (0.09)***	7.20 (1.29)***	5.93 (0.73)***
GDP per capita (GDPc)	0.07 (0.37)	0.81 (0.88)	−0.98 (1.01)
Tourism (tour)	0.39 (0.02)***	0.38 (0.07)***	0.27 (0.09)***
D^{modal}	−0.78 (0.08)***	−0.71 (0.21)***	−0.64 (0.17)***
D^{hub}	0.35 (0.09)***	–	–
D^{summer}	0.53 (0.07)***	0.35 (0.14)**	0.31 (0.23)
Trend	0.01 (0.02)	–	–
Intercept	−7.84 (3.71)**	−103.83 (24.20)***	−66.87 (11.40)
R^2	0.34	0.60	0.47
χ^2 (joint sig.)	88.81***	29.06***	19.51***
Pricing equation (dependent variable: p)			
Demand (Q_m)	−0.00017 (0.5e-4)***	0.00055 (0.0003)	0.00006 (0.0001)
Distance (dist)	0.12 (0.006)***	0.14 (0.01)***	0.16 (0.03)***
$D^{\text{oligopoly}}$	−49.11 (10.57)***	−159.58 (34.87)***	−66.18 (53.50)
D^{Summer}	58.01 (5.37)***	75.30 (15.07)***	47.05 (17.62)***
$D^{\text{Barcelona\_capacity}}$	−29.56 (6.93)***	–	–
$D^{\text{Madrid\_capacity}}$	7.42 (7.91)	–	–
Intercept	140.81 (6.95)	103.96 (24.07)***	78.29 (24.79)***
R^2	0.44	0.33	0.46
χ^2 (joint sig.)	89.19***	24.67***	8.05***

Instruments for prices in the demand equation: distance, airport concentration.
Instruments for demand and $D^{oligopoly}$ in the pricing equation: population, GDP per capita, tourism, D^{modal}, airport concentration, and D^{hub} in specification 1.
Standard errors in parentheses.
Significance at the 1% (***), 5% (**) and 10% (*).

If we look at the pricing equation, we find some evidence of density economies since the variable for demand in the pricing equation is statistically significant and carries a negative sign. In terms of elasticities, a 10% increase in route traffic density implies about a 1% decrease in prices charged; this gain is consistent with previous work (Brueckner et al., 1992; Caves et al., 1984). We also confirm the existence of distance economies, and the elasticity of about 0.40 at sample means is similar to that found in Brueckner and Spiller (1994), Fageda (2006) and Oum et al. (1993).

The increase in capacity has a statistically significant and negative effect on prices in the case of Barcelona airport. Additional capacity at Madrid does not seem to have any statistically significant effect. This suggests that capacity expansion has led to an increase in airline competition only for Barcelona.

Table 2 shows the conduct parameter for the system equation estimates. For the whole period this has a value of 0.69 implying substantial market power is held by Spanish airlines. In this way, we find that mark-ups in oligopoly routes are just 30% less than for monopolies. Additionally, we reject that the conduct parameter taking a value of 0.52 (the inverse of the mean number of competitors) and a value of 1 indicating conduct is less competitive than predicted by the *Cournot* solution.

Table 2
Conduct parameters (evaluated at sample means).

	(1) Baseline: whole sample period (N = 894)	(2) Period without capacity restrictions in routes with origin in Barcelona (N = 137)	(3) Period without capacity restrictions in routes with origin in Madrid (N = 88)
Conduct parameter: θ	0.69	0.53	0.82
Test $\theta = 0$	105.63***	27.12***	31.02***
Test $\theta = (1/\text{number of competitors})$	6.34**	0.65	7.35***
Test $\theta = 1$	21.57***	20.94***	1.53

Significance at the 1% (***), 5% (**) and 10% (*).

Since there are differences for conduct parameters for routes departing from each of these airports, it is useful to estimate the separate sub-samples of routes departing from Madrid and Barcelona airports. In fact, results for the conduct parameter are substantially different for routes originating from them after following capacity expansions. The conduct parameter is 0.53 for routes starting in Barcelona and 0.82 for Madrid's routes. Airlines seem to behave approximately along *Cournot* lines in the case of Barcelona, with the conduct parameter equal to the inverse of the mean number of competitors. In Madrid's case, airlines' conduct does not differ between monopoly and oligopoly routes.

Madrid airport is the main hub of the former Spanish flag carrier, while the presence of other airlines, including low-cost carriers, is increasing at Barcelona. It is a general trend in European airline markets for network carriers to concentrate operations at their main hubs, thus strengthen their dominance there, while reducing operations at other airports. Hence, the result that airline competition remains soft on routes departing from hub airports has a rational basis.

3. Entry patterns and route traffic density

In liberalized markets, travelers on high-density routes usually benefit from multiple airlines offering services. However, some routes may not be able to generate enough traffic to attract more than one carrier and thus travelers on these low density routes may not benefit from airline competition.

To this point, the main challenge is to identify natural monopoly thresholds where the market tips from competition. Density economies imply that average costs decrease as long as the number of passengers on a route level increases, implying that competition may be neither efficient nor possible for thin routes. However, competitive pressures for cost reduction could, to the benefit of travelers, reduce the amount of traffic needed to make the multiple airline operations over such routes feasible.

Natural monopoly feature is a property of the cost function in relation to the demand curve but we are not able to identify whether a route with low traffic density is a natural monopoly, but can observe if more than one airline is operating at a particular traffic level. The analysis is made using spline regressions, a non-parametric tool in which one or more of the relevant variables are discrete.

Fig. 1 shows the spline regression relating the number of competitors with traffic levels on low-density routes (routes with less than 211,120 passengers per season; the mean number of passengers on a route over the study period). To look at the evolution of natural monopoly thresholds over time, the spline regression results for the mean values of demand and number of competitors for both the beginning of the sample period (summer of 2001) and end of the period (summer of 2007), well after capacity expansions at Madrid and Barcelona airports are given.

For 2001, the natural monopoly threshold seems to break up at a traffic level of about 130,000 passengers per season; above that the mean number of competitors tends to exceed two. On routes with passenger levels between 110,000 and 130,000, the mean number of competitors is about one so that most routes within this traffic level are monopolies. Routes with fewer than 110,000 passengers are monopolies in most cases. For the Summer 2007 period, the natural monopoly threshold seems to break up at a much lower traffic level, about 70,000 passengers, although this trend becomes consistent only on routes of more than 110,000 passengers.

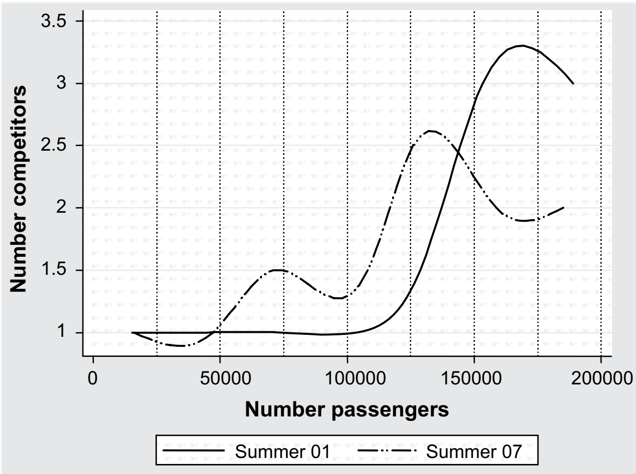

Fig. 1. Evolution of the natural monopoly threshold: spline of number of competitors respect to route traffic density (if route traffic less than 211,120).

Thus, increasing competition in the Spanish market after the expansion of capacity at main airports has reduced the traffic thresholds that determine monopoly on a route.

Lower prices and increases in the number of competitors seems to be the outcome of a liberalized airline market in which airport congestion is not a significant entry barrier. Capacity expansions at major airports, however, have not been the only driver of competition. The European airline industry has seen a large inflow of low-cost carrier services on short-haul routes and this needs to be considered.

4. The impact of low-cost carriers

In Europe, former flag carriers and other airlines integrated in international alliances have progressively focused their main business on long-haul air services, whereas low-cost carriers are exploiting cost advantages to be competitive on short-haul routes.[9] A major factor in the ability of a low-cost carrier to be competitive on these routes can be the exploitation of density economies through high utilisation of planes and crew. This, however, is done operating on routes with high traffic. While it is generally accepted that low-cost carriers contribute to lower fares on routes they operate (Dresner et al., 1996; Morrison, 2001; Hofer et al., 2008), some studies of entry patterns of low-cost carriers indicate that they prefer to operate on high-density routes, particularly in the first years of operation (Bogulaski et al., 2004; Gil-Moltó and Piga, 2005). Here we analyze not only the impact of low-cost carriers on fares but also their influence on the relationship between traffic and the number of competitors on low-density routes.

The price effects of low-cost carriers looked at using a price equation for oligopoly routes k'. We focus on non-monopoly routes to isolate the low-cost carriers' impacts on fares from the global effect of increase in the number of airlines offering services on the route (with respect to a monopoly scenario). The equation accounts for the main cost determinants; demand at the route level, $Q_{k't}$, and route distance, $\text{dist}_{k't}$. In addition, it includes a dummy variable set at unity for routes with low-cost carriers, $D_{k't}^{\text{low\_cost}}$:

$$p_{k't} = e_0 + e_1 \text{dist}_{k't} + e_2 Q_{k't} + e_3 D_{k't}^{\text{low\_cost}} + e_{k't}^{e}, \quad (3)$$

[9] See Alves and Barbot (2007) for an empirical analysis of differences in corporate governance models between full service and low-cost carriers.

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

	Non-monopoly routes ($N = 474$)
Demand (Q_m)	−00002 (0.4e−4)***
Distance (dist)	0.11 (0.006)***
$D^{\text{low\_cost}}$	−47.62 (13.61)***
D^{Summer}	70.08 (6.14)***
Intercept	102.94 (10.58)***
R^2	0.58
χ^2 (joint sig.)	120.14***

Instruments for demand and $D^{\text{low\_cost}}$ in the pricing equation: population, GDP per capita, tourism, D^{modal}, D^{hub}, airport concentration.
Standard errors in parentheses.
Significance at the 1% (***), 5% (**) and 10% (*).

Table 3 shows the results of the pricing equation estimates using two-stage least squares estimation techniques. We take into account the possible endogeneity of the variables for demand and presence of low-cost carriers. As before, we include a dummy variable for the summer season, D_t^{summer}.

For oligopoly routes, the presence of low-cost carriers reduces fares in a statistically significant way. In terms of elasticities evaluated at sample means, the decrease in fares on oligopoly routes due to the presence of low-cost carriers is 6.5%. This seems modest, but we must take into account that the measure refers to the mean average fares weighted by the market share of each airline. Since the market share of low-cost carriers on Spanish routes is generally low, the discounts offered by low-cost carriers must be substantial. Thus, travelers may benefit from very low prices on specific flights. Additionally, the aggregate effect on fares associated with the presence of low-cost airlines may be higher as these carriers enter a variety of routes, including those previously operated under monopoly conditions. According to Eq. (2), the mark-ups charged on oligopoly routes are only 70% of those in monopoly routes.

Fig. 2 shows the spline regression results relating the number of competitors to traffic levels for low-density routes. We differentiate routes with low-cost carriers. The analysis covers the period after the increase in capacity at major airports when most low-cost carriers have entered the market.

From the figure, it can be seen that low-cost carriers substantially alter the relationship between the number of competitors and traffic levels on a route. This is true on routes with traffic of over 75,000 passengers per season and even more dramatically so where passenger traffic exceeds 170,000. Indeed, the presence of low-cost carriers corresponds to a consistently higher mean number of competitors on such routes than is found on those serviced by traditional carriers. This pattern fits well with the

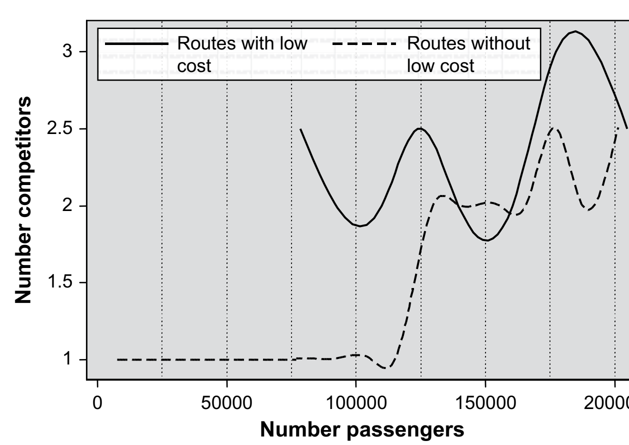

Fig. 2. Comparison between low-cost and all carriers: spline of number of competitors respect to route traffic density (if route traffic less than 211,120).

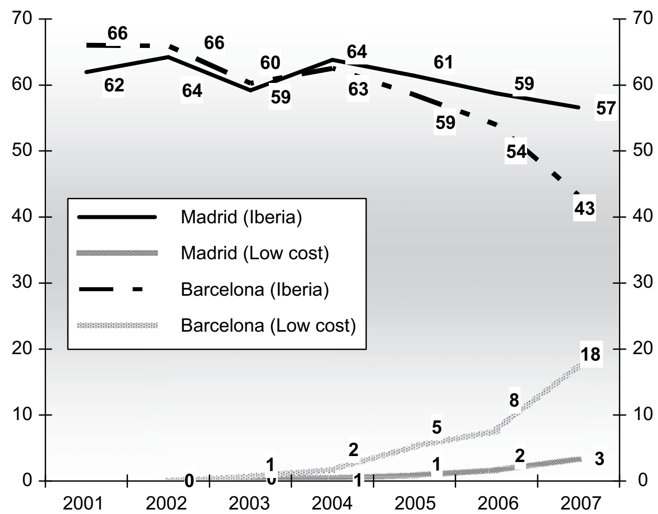

Fig. 3. Evolution of airline's market share in Madrid and Barcelona airports in terms of national departures. Source: website of AENA.

previous finding that the mean number of competitors increased on low-density routes after airport capacity expansions. It seems that low-cost carriers have played a major role in this effect. However, routes with less than 75,000 passengers per season are still monopolies.

Low-cost carriers may also explain why there is a more competitive environment in Barcelona than in Madrid after their increases in capacity. Fig. 3 shows that the presence of low-cost carriers has increased substantially at Barcelona airport since 2004, while their presence is modest at Madrid, even in the last period studied. Iberia retains a large market share at Madrid airport, but its share has been significantly fallen at Barcelona. Additionally, Iberia together with its partners in the Oneworld Alliance, enjoy a privileged access to new facilities (terminal building and the two new runways) at Madrid.

In summary, travelers have obtained several benefits from the assent of low-cost carriers in the Spanish market. They may take advantage of lower fares for specific flights, and the low-cost carriers offer more alternatives even on low-density routes. However, those benefits may be limited to travelers flying from specific airports. Among the large airports, benefits seem to be concentrated in non-hub facilities, at least over the period studied.

5. Concluding remarks

We have looked at the dynamics of airline competition in the Spanish airline market, one of the largest in Europe, to assess the role of two major factors leading to increased competition; the removal of capacity constraints at major airports and the increasing presence of low-cost carriers. We find that airline conduct became more competitive after capacity expansion only at large airports that are not hubs of network carriers. Price-sensitive travelers flying from large hub airports do not, however, derive any significant benefit from this increase in capacity. Otherwise, business travelers living in the local urban areas may benefit from non-stop flights to a greater number of intercontinental destinations.

We also find that natural monopoly threshold seems to break up at lower traffic density levels after the increases in airport capacity. The thinnest routes, however, remain monopolies so that some competition concerns remain in the post-liberalization period. Finally, we find that low-cost carriers reduce mean prices on the routes where they operate and increase alternatives even in low-density routes.

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