Review of Industrial Organization (2006) 28:379–399
DOI 10.1007/s11151-006-9104-x

Measuring Conduct and Cost Parameters in the Spanish Airline Market

XAVIER FAGEDA
Department of Economic Policy, University of Barcelona, Av. Diagonal 690. 08034 Barcelona, Spain. E-mail: xfageda@ub.edu

Abstract. This paper examines airline competition through an empirical specification of a demand and pricing equation system. The system is estimated for the Spanish airline market using a simultaneous procedure. The suitability of the *Cournot* assumption is tested in a competitive scenario characterized by an asymmetric oligopoly with capacity constraints. In addition, the degree of density economies is analyzed. Results show that Spanish airlines behave in a less competitive way than is implied by the *Cournot* solution. Finally, some evidence on the fact that thin routes can be considered as natural monopolies is found.

Key words: oligopoly, air transportation, multiple equation models.

JEL Classification: D43, L13, L93, C30.

I. Introduction

Worldwide, the liberalization of air transport services has been considered one of the most successful experiences in the wider process of regulatory reform. However, there is strong agreement in the academic literature that the benefits from liberalization depend fundamentally on competition in the air routes that link city pairs. In this context, two typical market structures have emerged in European airline markets.

On the one hand, oligopoly with a dominant firm predominates in thick routes. There are two common features of European domestic markets that allow testing of hypotheses about market power under one strategic scenario. First, flag carriers dominate their domestic markets. And, second, airlines face exogenous capacity constraints from severe congestion at the main European airports. Here it is worth mentioning that Kreps and Scheinkman (1983) show that oligopoly competition with endogenous capacity constraints is equivalent to the traditional one-stage Cournot model. However, Deneckere and Kovenock (1992) find that oligopoly competition can lead to an outcome that is less competitive than the Cournot model predicts. This result arises in markets characterized by exogenous capacity constraints and by a large firm that is a natural price leader, as could happen in European airline markets. However, assuming Cournot competition in oligopoly airline markets has become standard in the literature.

On the other hand, monopoly is the typical market structure in thin routes. Indeed, density economies are accepted as an important feature in airline economics (Caves et al., 1984).[1] Hence, thin routes could be considered natural monopolies. In such a case, Braeutigam (1989) suggests that one must evaluate whether some form of competition for the market, such as potential competition or intermodal competition, might guarantee an efficient allocation of resources.

The primary objective of this paper is twofold. First, we test the suitability of the Cournot assumption in airline markets characterized by an asymmetric oligopoly with capacity constraints. And, second, we examine density economies and the influence of competition for the market.

We deal with all of these issues through an empirical specification of a demand and pricing equation system that is estimated for the Spanish airline market in the period 2001–2002. At this point, it must be pointed out the Spanish domestic market is the largest in the European Union. Thus, it is an important market in the European context.

A few facts about the Spanish air transport market are important to mention for our analysis: The Spanish flag carrier, Iberia, has two major competitors: Spanair and Air Europa. According to the General Directorate of Civil Aviation (Ministry of Transports), the Spanish market is composed of about 100 routes, with Iberia maintaining a monopoly on half of them. In routes where Spanair and/or Air Europa offer services, Iberia's market share lies between 50 and 90%. Additionally, the majority of Spanish routes have one endpoint at the airports of either Madrid or Barcelona. In the period considered, both airports were highly congested.

The remainder of this paper is organized as follows: The second section relates this study to the literature. In the third section, we develop a demand and pricing equation system in a static framework. In the fourth section, we specify the data used in the empirical analysis. In the fifth section, we comment on the results of the estimation. Finally, the last section focuses on the implications of the results.

[1] Density economies in airline economics imply that unit costs fall when route traffic increases.

II. Literature Review

One of the main advances of the New Empirical Industrial Organization (NEIO) framework is to provide econometric techniques to estimate conduct and cost parameters of firms, even when full data on costs are not available. In this way, the conjectural variations approach allows one to measure the market power of a firm or analyze the technology of an industry (Bresnahan, 1989).

There is an extensive empirical literature that analyses market power in the airline industry.[2] Nevertheless, there are very few studies that explicitly estimate the conduct parameters of airlines at the route level, and all of them examine the US domestic market.

Brander and Zhang (1990, 1993), Oum et al. (1993), and Fisher and Kamerschen (2003) estimate such conduct parameters for a group of routes where the competitive scenario is a symmetric duopoly. Thus, it is not surprising that these studies find evidence that airline competition can be explained, on average, by a traditional Cournot model. Moreover, the estimation process is sequential, so that they estimate (or assume) the price elasticity of demand in the first stage, and then estimate the conjectural variations parameter in the second stage. This estimation process could introduce a bias if that both parameters vary in a simultaneous way.

In addition to this, the literature about airlines' conduct generally assumes constant marginal costs regardless of the level of route traffic density. Nevertheless, previous studies (Brueckner et al., 1992; Brueckner and Spiller, 1994) show that marginal costs can decrease.

As has been mentioned above, the existence of density economies is generally accepted, and density economies, which involve decreasing average costs, can come from sharing fixed costs over more units of output or from decreasing marginal costs (Tretheway and Oum, 1992). In airline markets, marginal costs can be understood as the sum of the cost of moving an additional passenger for a given capacity plus the cost of providing additional capacity (Brander and Zhang, 1990). The first of these marginal cost components does not vary with route traffic density. However, the costs of providing additional capacity can be decreasing where adding capacity involves the use of bigger planes or higher service frequency. Efficiency generally increases with a plane's size, while increasing service frequency allows greater annual utilization of planes and the crew. Hence, it is sensible to argue that the shape of an airline's marginal cost function should be tested empirically.

[2] Relevant contributions are due, among others, to Borenstein (1989), Evans and Kessides (1993), Marín (1995), and Berry et al. (1996). A recent study for European domestic markets is due to Carlsson (2004).

In this paper, we estimate conduct and cost parameters for a group of routes where the competitive scenario is an asymmetric oligopoly with exogenous capacity constraints. Our methodology is based on a simultaneous estimation of demand and pricing equations. We use the information provided by monopoly and oligopoly routes, taking into account the sensitivity of costs to traffic density.

III. The Empirical Model

Typically, the estimation of a demand-supply equation system does not allow identification of conduct and cost parameters without additional assumptions. Our identification procedure takes as a reference the Parker and Roller (1997) study of the US mobile telephone industry, where a semi-logarithmic demand function is assumed.[3]

The demand function (Q) for route k in period t is expressed through a semi-logarithmic function that is derived from a gravity model:

$$\log(Q_{kt}) = a_{kt} + \alpha_k p_{kt}. \quad (1)$$

The intercept term of the demand function includes variables for the mean values of population (pop), income per capita (inc), and tourism intensity of the route city pairs (tour), which approximate its demographic and economic size and traffic generation that comes from tourist activities. Additionally, it includes a dummy variable that takes value 1 for routes with origin in Madrid airport (D^{hub}). Given the value of the other explanatory variables, demand may be higher in routes with origin in Madrid because this airport is the major hub of Iberia and Spanair, so that a network effect could arise due to the exploitation of connecting traffic. Thus, the intercept term of the demand function can be expressed in the following way:

$$a_{kt} = a_0 + a_1 \log(\text{pop}_{kt}) + a_2 \log(\text{inc}_{kt}) + a_3 \log(\text{tour}_{kt}) + a_4 D^{\text{hub}}{}_k. \quad (2)$$

Demand also depends on prices (p). It would be excessively restrictive to assume that the price elasticity of demand does not vary across routes. Indeed, it can be expected that travelers are less sensitive to airline prices on routes where the supply of other transport modes is not available or is available with a much lower quality of service. Hence, the price variable in the demand equation can be expressed as follows:

$$\alpha_k p_{kt} = \alpha_0 p_{kt} + \alpha_1 D^{\text{intermodal}}{}_k p_{kt}, \quad (3)$$

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

where we include a dummy variable for intermodal competition ($D^{\text{intermodal}}$) that interacts with prices. This variable takes the value 1 in routes with an island as an endpoint and/or in routes whose distance is more than 450 km.

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

$$\text{IM}_{ikt} = p_{kt} + \lambda(\partial p_{kt}/\partial q_{ikt})q_{ikt}, \tag{4}$$

where $\lambda = \partial Q_{kt}/\partial q_{ikt}$, which can be interpreted as the average degree of collusion. If $\lambda = 0$ the market is perfectly competitive, if $\lambda = 1$ competition is à la Cournot, and if $\lambda = N$ firms are jointly maximizing profits, where N is the number of firms that operate in the market.

As we mention in Section II, 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. 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:

$$\text{MC}_{ikt} = b_k + \beta q_{ikt}, \tag{5}$$

where $b_k = b_o + b_1 \,\text{dist}_k$.

The intercept term of the MC 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). This variable explains a great part of airline prices. For several reasons costs increase less proportionally than the kilometers flown. Long-haul routes involve higher average speeds, less intense consumption of fuel, and lower per kilometer charges for some fixed cost (such as airport fees). Finally, the sign of the parameter (β) associated with the number of passengers carried by airlines on the route (q_{ikt}) determines the slope of marginal costs.

The equilibrium condition for each airline is the result of equating cost and revenue functions; $\text{IM}_{ikt} = \text{CM}_{ikt}$, which lead to the following oligopoly supply relationship:

$$p_{kt} + \lambda(\partial p_{kt}/\partial q_{ikt})q_{ikt} = b_k + \beta q_{ikt}. \tag{6}$$

The equilibrium condition at the market level comes from the aggregation of the individual equilibrium conditions in (6):[4]

$$N_{kt} p_{kt} + \lambda(\partial p_{kt}/\partial Q_{kt})Q_{kt} = N_{kt} b_k + \beta Q_{kt}. \tag{7}$$

[4] In the aggregation process, we assume cost symmetry across airlines. In fact, the Spanish flag carrier has a much higher market share than its rivals in the majority of oligopoly routes. In order to test the possible bias of assuming symmetry, we also estimate the equation system using flag carrier data exclusively.

Hence, the price equation can be expressed as follows:

$$p_{kt} = b_k + \beta Q_{mkt} - \theta(\partial p_{kt}/\partial Q_{kt})Q_{kt}, \tag{8}$$

where $\theta = \lambda/N$ and Q_{mkt} is the average market demand. The demand term of the mark-up expression in (8) should be dropped in order to identify conduct and cost parameters. The price elasticity of demand in a semi-logarithmic equation is: $\eta_{\alpha k} = \alpha_{kt} p_{kt}$. This is the case due to the fact that $\alpha_k = \partial \log(Q_{kt})/\partial p_{kt}$ and so $\alpha_k = \partial Q_{kt}/\partial p_{kt} Q_{kt}$ given that $\partial \log(Q_{kt}) = \partial Q_{kt}/Q_{kt}$ Thus, Equation (8) can be expressed in the following way:

$$p_{kt} = \mathrm{MC}_{kt} - \theta(1/\alpha_k), \tag{9}$$

where prices (p_{kt}) are a function of the mark-up [$\theta(1/\alpha_k)$] on marginal costs (MC_{kt}). The mark-up is composed of the conduct parameter (θ), and the parameter that determines the price elasticity of demand (α_k) that should take a negative value.

The empirical implementation of this model requires simultaneous estimation of Equations (1) and (9) given Equation (5). Thus, the equation system is:

$$\begin{aligned} \log(Q_{kt}) = a_0 + \log(\mathrm{pop}_{kt}) + a_2 \log(\mathrm{inc}_{kt}) + a_3 \log(\mathrm{tour}_{kt}) + a_4 D_k^{\mathrm{hub}} \\ + \alpha_0 p_{kt} + \alpha_1 D_k^{\mathrm{intermodal}} p_{kt} + e_{kt}^d, \quad (10) \\ p_{kt} = b_0 + b_1 \mathrm{dist}_k + \beta Q_{mkt} - \theta(1/\alpha_k)_+ e_{kt}^s, \quad (11) \end{aligned}$$

where e_{kt}^d and e_{kt}^s are random error terms. The main parameters estimated are θ, which measures the average degree of collusion, and β, which measures the amount of decreasing MCs. The value of θ should be ranked from 0 (prices equal to MCs) to 1 (prices set on a joint profit maximization setting). Under the Cournot assumption, θ would take a value equal to the inverse of the number of competitors. Thus, in our context, in cases where θ takes a value greater than 0.38, which is the inverse of the mean number of competitors in the oligopoly routes of our sample, conduct would be inferred to be less competitive than predicted by a Cournot model.

Our data do not allow testing explicitly whether the alternative competitive scenario, a price-leadership scheme, applies. However, rejection of the Cournot model would provide some empirical evidence for the predictions contained in the Deneckere and Kovenock (1992) model. Additionally, a negative value of β would be consistent with a hypothesis of decreasing marginal costs.

The functional form of the demand equation allows identification of the conduct and cost parameters. Additionally our identification procedure relies on the assumption, which is discussed in the next section, that $\theta = 1$

in monopoly routes. Indeed, the supply relationship can be expressed as follows:[5]

$$p = b_0 + b_1\text{dist} + \beta Q_m - D^M\alpha^{(-1)} - D^{NM}\theta^{NM}\alpha^{(-1)} + e^s_{kt}, \tag{12}$$

where D^M and D^{NM} are dummy variables that refer to monopoly and oligopoly routes, respectively. The intercept term (c_o) in monopoly routes is $c_o^M = b_0 - \alpha^{(-1)}$, whereas it is $c_o^{NM} = b_0$ in oligopoly routes. For this reason, the term $D^{NM}\alpha^{(-1)}$ should be added to Equation (12) in order to express properly the intercept term:

$$p = b_0 + b_1\text{dist} + \beta Q_m - D^M\alpha^{(-1)} - D^{NM}\theta^{NM}\alpha^{(-1)} + D^{NM}\alpha^{(-1)} + e^s_{kt}. \tag{12'}$$

Rearranging terms, the pricing equation can be expressed as follows:

$$p = c_0 + b_1\text{dist} + \beta Q_m + D^{NM}\gamma + e^s_{kt}, \tag{13}$$

where $\gamma = \alpha^{(-1)}(1 - \theta^{NM})$, and $c_0 = b_0 - D^M\alpha^{(-1)}$ that cannot be identified.

The conduct parameter will depend on the price difference between monopoly and oligopoly routes that determines the coefficient γ, and on the price elasticity of demand that determines the coefficient α. Note here that parameter θ^{NM} will take a different value in two different categories of markets ($m = a, b$): a market based on mainland routes with a distance of less than 450 km ($m = a$), and a market based on routes with an island as an endpoint and/or routes whose distance is more than 450 km ($m = b$). Indeed, according to Equation (3) $\alpha = \alpha_0$ for market a and $\alpha = \alpha_0 + \alpha_1$ for market b. Since $\theta^{NM} = 1 - \gamma\alpha$, conduct parameter will differ across the two types of markets. Hence, θ takes the following form:

$$\theta \left| \begin{array}{ll} \theta^M & = 1, \\ \theta^{NM} & = \theta^{NM}_m \quad m = a, b. \end{array} \right. \tag{14}$$

It is of interest to analyze not just the degree of market power and density economies but also the determinants of conduct parameters. Indeed, airlines behavior should depend on market structure variables and on market characteristic variables. Hence, the conduct parameter considered in (14) could be also expressed as follows:

$$\theta \left| \begin{array}{ll} \theta^M & = 1, \\ \theta^{NM}_m & = \left(\theta^{NM}_{mo} + \theta^{NM}_{m1} HH + \theta^{NM}_{m2}\text{tour}\right), \end{array} \right. \tag{15}$$

where HH is the Hirschman–Herfindahl index at the airport level and tour is a variable for tourism intensity. In this case, the supply relationship is as follows:

$$p = c_0 + b_1\text{dist} + \beta Q_m - D^{NM}\alpha^{(-1)}(\theta_{m1}HH + \theta_{m2}\text{tour}) + e^s_{kt}, \tag{16}$$

[5] For simplicity, subindexes k and t are omitted.

where $c_0 = b_0 - \alpha^{(-1)}$ (D^M+$D^{NM}\theta_{mo}$). Thus, we cannot identify θ_{mo}. Our goal here is not measuring the average degree of collusion but the influence of different market features on it.

The effect of airport dominance on airline prices is one of the main issues analyzed in the literature on airline competition. Indeed, airport dominance can imply the exploitation of market power due to the privileged access to airport facilities (slots, gates, and so on) and to the use of marketing practices such as frequent flyer programs. These aspects are considered to be relevant entry barriers, particularly in case of congestion. We capture the effect of airport dominance through the Hirschman–Herfindahl index at the airport level. This variable is constructed as follows: we calculate the concentration index in terms of airlines' 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. This formulation could carry an endogeneity bias if concentration levels depend on the pricing choices of firms. However, this bias should be greatly diluted for concentration at the airport level because pricing choices refer to the route level while concentration at the airport level refers to all the routes departing from a given airport. Furthermore, it must be recognized that European allocation rules for slots, where the main airports are congested, are very rigid.

It must be remarked that the estimated coefficients of the variables of concentration at the airport level and tourism intensity for oligopoly routes, [$D^{NM}HH, D^{NM}$ tour], should take negative values. According to Equation (16), these coefficients are $\gamma_{m1} = \alpha^{(-1)}\theta_{m1}$ and $\gamma_{m2} = \alpha^{(-1)}\theta_{m2}$, respectively. Since the price elasticity of demand should be negative, the parameters that measure the influence of concentration at the airport level and tourism intensity on airlines' conduct [$\theta_{m1,}\theta_{m2}$], will be positive only if γ_{m1} and γ_{m2} take a negative value.

IV. Data

The sample used in the empirical analysis includes observations for the Spanish market of regular flights in the period 2001–2002. Data are available for 67 pair links, where the origin is the city with the largest airport. Madrid is the origin in 27 routes, Barcelona in 26, Palma de Majorca in 6, Bilbao in 3, and other airports in 5. Our sample represents all of the routes of the Spanish market with a traffic density of more than 50,000 passengers per season and 55% of routes with a traffic density between 10,000 and 50,000 passengers per season.

The frequency of the data is semi-annual. Thus, we differentiate between the summer and winter, and we include dummy variables for season (win01, sum02) in all of the equations.[6] In general terms, the structure of prices (in the full fare classes) and flight schedules of airlines vary between but not within seasons. Such inter-season variation is especially important in the Spanish case because this market is strongly oriented toward tourism.

Information about the total number of passengers carried by airlines has been obtained from the "Boletín de la Oferta por Tramos y Mercados del Programa de Vuelos Regulares", published by the General Directorate of Civil Aviation (Ministry of Transport). Service frequency and aircraft size data have been obtained from Official Airlines Guide (OAG) website. The round trip prices charged for each airline have been obtained from their respective websites.[7] Data on frequency, aircraft size, and prices have been obtained for a representative sample week of each season.

The population variable is the total mean population in a route's origin and destination provinces, following the census of the first of January published by the National Statistics Institute (INE). Data on the percentage of departures of each airline in origin and destination facilities have been obtained from the "Anuario Estadístico de Tráfico", published by Spanish Airports and Air Navigation (AENA) agency.

The variable for tourist activity is an index that is calculated according to the tariff share that the provinces of the route city pairs have regarding revenues from the Economic Activity Tax (IAE) associated with tourist establishments. The tariff of this tax depends on the number of rooms and the category of tourist establishments for each province. The data for constructing this variable have been obtained from the "Anuario Económico de España", published by the private financial entity "La Caixa".

Demand data are restricted to non-stop services, without distinguishing between connecting and final traffic. Services with intermediate points in a market based fundamentally on short-haul routes have much higher demand inconvenience and higher costs than non-stop services.[8]

The fare class used to approximate the average prices charged by airlines presents special difficulties. First, a weighted distribution of passengers

---

[6] In this regard, it must be said that we consider the summer in 2001 as the baseline period, whereas data for the winter in 2002 are not available.

[7] Price data refer to the city pair link that has as its origin the city with the largest airport. Round-trip prices charged by Spanish airlines in the considered period were identical for the full fare classes regardless of the origin airport, but some differences could arise for the lowest fare class. This means that what we are specifically analyzing is the pricing policy in, for example, the route Madrid–Barcelona–Madrid but not in the route Barcelona–Madrid–Barcelona.

[8] Results do not change substantially when the sample considered is reduced to routes with their origins in Madrid airport only. This airport is the main hub of Iberia and Spanair and is in the geographic center of Spain, so that all domestic flights that depart from Madrid airport are direct flights. Thus, the possible effect of services with intermediate points does not seem to be relevant.

carried for the different fare classes paid is not available. If this distribution varies substantially across routes and airlines, our results could be affected. The use of variables that are connected to route characteristics can help in controlling for these differences. In any case, the interpretation of the results should take this possible bias into account.

Second, we can distinguish between three different fare classes: the lowest fare class, the full economy fare class, and the business class. Prices in the full fare classes usually do not vary in the same season, but there is a high variability in the prices charged by airlines in the lowest fare class because the amount of discounts depend on the evolution of load factors.[9]

Prices in the lowest fare class and the business class can be understood respectively as a discount and mark-up on the economy class, so prices in the full economy fare class can be considered a reference for all fare classes. In addition, the amount of that discount and mark-up is determined by demand, rather than cost, features. Hence, the use of prices in the full economy fare class would seem to be suitable in approximating the mark-up that airlines try to charge on marginal costs. However, the majority of passengers obtain some discount when purchasing airfares. Thus, we use an average of prices in the lowest fare class and prices in the full economy fare class in order to have the closest available approximation to the mark-ups that airlines effectively charge on marginal costs. In any case, we present the results of the estimates of the equation system when using prices in the full economy fare class and prices in the business class in an Appendix. Such estimates will allow us to infer the sensitivity of our results to the fare class used. Table I shows the descriptive statistics of the variables used in the empirical analysis.

V. Estimation and Results

Our estimation procedure for identifying the conduct parameter in oligopoly routes relies on the information provided by monopoly routes. Indeed, we impose a conduct parameter of 1 in monopoly routes. To what extent is this assumption correct? It can be argued that competition for the market disciplines the behavior of monopolist firms. In order to tackle this question, we estimate the supply relationship for the subsample of Iberia's monopoly routes through the Two Stage Least Squares (TSLQ) estimator.

[9] In order to account for this variability in the lowest fare class, we have obtained these data in homogeneous conditions for each airline. That is, data have been collected one month before travelling, the price refers to the first trip of the week, and the return is on Sunday.

Table I. Descriptive statistics (number of observations: 190)

Variable	Description (mean values in the route city-pair)	Mean	Standard deviation	Minimum value	Maximum value
Prices (p)	Average prices in lowest fare and full economy fare classes (euros)	281.63	95.82	120.84	530
Demand (Q)	Number of passengers	204,044	322,423	2,662	2,413,967
Population (pop)	Number of inhabitants	2,756,264	788,071	841,668	5,216,635
Income (inc)	Gross Domestic Product per capita (euros)	18,297	1,837	14,153	22,376
Tourism (tour)	Index of tourism actitivity	1.85	2.31	0.26	7.45
D^{hub}	Dummy variable for routes with origin in Madrid	0.42	0.49	0	1
$D^{intermodal}$	Dummy variable for routes with islands and/or more than 450 km	0.67	0.47	0	1
Distance (dist)	Number of kilometers	650	510	131	2,190
D^{nm}	Dummy variable for oligopoly routes	0.49	0.50	0	1
Potential competition	Number of potential competitors	1.58	0.71	0	2
HH	Herfindahl–Hirschman index at the airport level	0.53	0.11	0.32	0.74
Prices (p^{eco})	Prices in full economy class	337.80	102.74	122.05	629
Prices (p^{bu})	Prices in business class	368.95	113.40	122.05	721.17

The variables that capture competition for the market are, first, the dummy variable that distinguishes the possibility of intermodal competition ($D^{\text{intermodal}}$). And, second, we include a variable for potential competition (potential-comp.) that refers to the number of potential competitors. Potential competitors are defined as airlines that serve both endpoints of the route but do not serve the route. In this scenario, those airlines should not incur in any significant costs of setting-up operations in an airport to be able to offer services in the route. Since the origin airports in our sample are large airports, airlines that operate in the Spanish market will simply not offer services in some destination airports. Our sample of monopoly routes contains 96 observations. According to our definition of potential competitors, there are not potential competitors in 25 cases, one potential competitor in 19 cases, and two potential competitors in 52 cases.

The results of the equation estimated (with the standard errors in parenthesis) are as follows:[10]

$$\begin{aligned} p_{kt} = {} & \underset{(21.45)}{263.92} + \underset{(0.02)^{**}}{0.14}\text{dist}_k - \underset{(0.0002)^{**}}{0.0007}Q_{kt} - \underset{(10.79)}{12.05}\text{potential-comp} \\ & + \underset{(18.99)}{21.70}D^{\text{intermodal}} - \underset{(16.12)}{13.40}\text{win01} + \underset{(14.32)^{*}}{37.43}\text{sum02} + e^s_{kt} \end{aligned}$$

$R^2 = 0.55$

Number of observations: 96

Note: Significance at the 1% (**) and 5% (*).

Our results show that variables for competition for the market are not significant. Thus, we find some evidence against the Spanish air transport market as a contestable market[11] and an indication of the weakness of other transport modes in competition with Iberia. We also find that density economies can be strong. Indeed, prices fall by about 2% for every 10% increase in route traffic. Of course, our finding of substantial density economies could mean that monopoly routes are natural monopolies because these routes show a low traffic density.[12]

Furthermore, the imposition of the value 1 in the conduct parameter of monopoly routes is correct to the extent that competition for the market does not play an important role. Additional data in the period 1997–2002

[10] Instruments for the variable of demand are population, income per capita, tourism intensity, and a dummy variable for routes with origin in Madrid.

[11] Empirical studies for the US air transport market also tend to reject the contestability hypothesis. See, for example, Morrison and Winston (1987) or Whinston and Collins (1992). Pitelis and Schnell (2002) infer similar results in an analysis focused on European markets.

[12] Indeed, the mean number of passengers carried for the full sample of routes is 200,000 passengers, while it is 50,000 passengers for the subsample of monopoly routes.

for our sample of monopoly routes also support this argument. There have been new entries in 3 of the 37 monopoly routes in the winter season and in 7 of the 35 monopoly routes in the summer. All of these new entries were followed by the exit of the entrant the following year. Thus, it seems that Iberia is quite protected (and so should be able to charge effectively monopolistic prices) in a context characterized by increasing congestion in the main Spanish airports. Indeed, airport congestion along with density economies prevents entrants from developing a sufficient scale of operations to be competitive.

It can be easily shown that our system of equations is identified because excluded exogenous variables from one equation in the system identify the other equations. It is common to estimate identified systems through some method based on the instrumental variables technique.

We estimate the demand and pricing equation system through Three Stage Least Squares (3SLS) estimator. Estimation of conduct parameters through a simultaneous procedure has an important advantage with respect to a consecutive one. High mark-ups on costs may be a consequence of either low price elasticities or of non-competitive conduct. Both causal factors can differ across markets. Thus, when one factor gets fixed across markets, the contribution of each of them could not be appropriately distinguished.[13]

Additionally, it is worth noting that our estimation procedure takes into account the possible endogeneity of the dummy variable for oligopoly routes in the pricing equation. To this regard we include as an additional instrument to the exogenous variables of the system, the variable for the mean Hirschman–Herfindahl index at both the origin and destination airports 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.

Table II shows the results of the demand and pricing equation system estimates, while Table III shows the corresponding structural parameters that can be inferred from the estimates.

In specification (1), we analyze the degree of market power and density economies. All the explanatory variables have the expected signs, except the variable for income per capita, which is not significant. Regarding the demand equation, population and tourism intensity have a positive influence on airlines' demand. In addition to this, the positive sign of the dummy variable for routes with origins in Madrid show that this airport generates more traffic than the other variables would explain. Price

[13] In any case, results do not change substantially when using the two stage least squares (TSLQ) estimator.

Table II. System equation estimates (3SLQ); $N = 190$

	Baseline (1)	Conduct determinants (2)	Iberia's data (3)
Demand equation (dependent variable: Q)			
Prices (p)	−0.0039 (0.0016)*	−0.0068 (0.0015)**	−0.0039 (0.0016)*
$D^{\text{intermodal}*}p$	0.0006 (0.0008)	0.0021 (0.0008)*	0.0002 (0.0008)
Population (pop)	1.26 (0.22)**	1.32 (0.22)**	1.54 (0.21)**
Income (inc)	0.17 (0.83)	0.35 (0.82)	−0.92 (0.80)
Tourism (tour)	0.56 (0.07)**	0.50 (0.07)**	0.44 (0.07)**
D^{hub}	0.36 (0.16)*	0.40 (0.16)*	0.29 (0.16)$^+$
Winter01	−0.55 (0.17)**	−0.56 (0.17)**	−0.51 (0.16)**
Summer02	0.05 (0.17)	0.10 (0.17)	0.12 (0.16)
Intercept	−7.95 (8.96)	−10.13 (8.96)	−1.58 (8.66)
R^2	0.49	0.51	0.49
χ^2 (joint sig.)	170.83**	184.21**	166.37**
Pricing equation (dependent variable: p)			
Demand (Q_m)	−0.00015 (0.7e−4)*	−0.00015 (0.7e-4)*	−0.9e−04 (0.4e−04)$^+$
Distance (dist)	0.16 (0.007)**	0.16 (0.007)**	0.15 (0.008)**
D^{nm}	−70.16 (13.07)**	–	−59.31 (14.91)**
Tourism$^{\text{nm}}$ (tour)	–	−3.25 (1.65)*	–
HH^{nm}	–	−84.71 (20.90)**	–
Winter01	−23.12 (8.83)**	−21.33 (8.51)*	−29.98 (9.81)**
Summer02	17.69 (8.59)*	19.68 (8.21)*	11.74 (9.47)
Intercept	229.44 (9.73)**	217.15 (9.39)**	233.80 (10.25)**
R^2	0.74	0.76	0.68
χ^2 (joint sig.)	555.77**	605.75**	403.48**

Notes: Standard errors in parentheses.
Significance at the 1% (**), 5% (*), 10% ($^+$)

elasticity of demand lies between −1.12 and −0.93. This result is consistent with previous studies, taking into account that we are not able to separate, in an appropriate way, leisure and business passengers.[14]

Regarding the pricing equation, we find evidence of decreasing marginal costs. Indeed, an increase in the mean number of passengers of one standard deviation would result in average prices falling by about 16 euros. Although this price reduction seems small, it is the result of a conservative measure of density economies. Indeed, we are not able to capture how fixed costs are shared between more units of output, and so our results indicate

[14] See Oum et al. (1992).

Table III. Estimated structural parameters (evaluated at sample means)

	Baseline (1)	Conduct determinants (2)	Iberia's data (3)
Demand equation			
Price elasticity of demand: $\eta_{\alpha}(m=a)$	-1.12^{**}	-1.88^{**}	-1.11^{**}
Price elasticity of demand: $\eta_{\alpha}(m=b)$	-0.93^{**}	-1.27^{**}	-1.03^{**}
Pricing equation			
Density parameter: η_{β}	-0.05^{*}	-0.05^{*}	-0.04^{+}
Price elasticity to distance: η_{b1}	0.36^{**}	0.37^{**}	0.34^{**}
Conduct parameter: $\theta(m=a)$	0.72	–	0.77
Wald test $(\chi^2_{(1)})$			
Test $\theta_a=0$	33.98^{**}		46.67^{**}
Test Cournot $(\theta_a=0.38)$	7.61^{**}		11.89^{**}
Test collusion $(\theta_a=1)$	5.07^{**}		4.29^{*}
Conduct parameter: $\theta[m=b]$	0.77	–	0.78
Wald test $[\chi^2_{(1)}]$			
Test $\theta_b=0$	88.74^{**}		95.63^{**}
Test Cournot $(\theta_b=0.38)$	22.68^{**}		25.43^{**}
Test collusion $(\theta_b=1)$	8.04^{*}		7.21^{**}
Conduct determinants $(m=a)$	–		–
$\mathrm{HH}^{\mathrm{nm}}(\theta_1)$		0.57^{**}	
$\mathrm{tour}^{\mathrm{nm}}(\theta_2)$		0.02^{+}	
Conduct determinants $(m=b)$	–		–
$\mathrm{HH}^{\mathrm{nm}}(\theta_1)$		0.38^{**}	
$\mathrm{tour}^{\mathrm{nm}}(\theta_2)$		0.01^{+}	

Notes: We consider two different markets $(m=a,b)$: Index a refers to the market based on peninsular routes where distance is less than 450 km; index b refers to the market based on routes with an island as an endpoint and/or routes where distance is more than 450 km. Significance at the 1% (**), 5% (*), and 10% ($^{+}$).

that density economies can be substantial. In turn, we also find evidence of distance economies such that costs increase less than proportionally to kilometers flown. The estimated elasticity of 0.36 is similar to the result obtained in Brueckner and Spiller (1994) but lower than the estimates in Oum et al. (1993).

Importantly, the conduct parameter estimated, which is larger than 0.70, shows that the market power of Spanish airlines is strong. In Table III, we show the results of the Wald tests concerning different hypothesis of the conduct parameter value, $\theta^{NM}=1-\gamma\alpha$, which ranges from 0 to 1. $\theta^{NM}=0$ when prices equal marginal costs; $\theta^{NM}=1$ when prices are set on a joint profit maximization basis. The conduct parameter takes a value equal to the inverse of the number of competitors under a Cournot framework. The inverse of the mean number of competitors in the oligopoly routes of our sample is 0.38, so that the Cournot assumption will be rejected if θ^{NM} is significantly different from 0.38. We find that the Spanish airlines behavior is less competitive than predicted by a Cournot model but more competitive than the joint profit maximization case.

It is worth mentioning the results of the dummy variables for seasonality, taking into account that the baseline period, summer of 2001, encompasses the period just previous to the events of September 11. Given the value of the other variables, demand and prices are lower in the winter season, while demand remains stable and prices are higher in the summer of 2002. Thus, the reaction of airlines to the downturn of demand was to reduce prices in the season that followed September 11 and then to increase prices afterwards. Overall, these results suggest that airlines' conduct in the Spanish market may have been less collusive just after September 11.

Tables AI and AII in the Appendix show the results of specification (1) when the price variable used refers to prices in the full fare classes. Results are similar with regard to conduct parameters, while the value of the coefficient that measures density economies, β, is lower when using prices in the full economy fare class and not significant when using prices in the business fare class. Thus, prices in the business class do not seem to be sensitive to cost economies derived from traffic densities. Prices in this fare class could be more responsive to quality features, such as time schedule flexibility.

In specification (2), we analyze the influence of market specific variables on airlines' behavior. Such specification refers to the expression of the conduct parameter outlined in Section III in Equation (15). We find that conduct is slightly more collusive in tourist-oriented routes. This result could be explained by the fact that many tourist routes have an island as an endpoint. We also find that airport dominance greatly influences airline conduct.[15]

In the aggregation process of the individual equilibrium conditions, we make the assumption of symmetry across airlines. In specification (3), we use data for Iberia exclusively in order to assess whether this assumption could distort our results. The estimates of this specification confirm our two basic results. We reject the hypotheses that Iberia behaves as the Cournot assumption predicts and that density economies arises in the Spanish market.

[15] Additionally, the dummy variable for routes with an origin in Madrid was also considered as a possible determinant of airlines' conduct if this airport is the major hub of Iberia and Spanair. However, the coefficient associated with this variable was not significant.

Given that our conduct parameter identification is based on the information provided by monopoly routes, we are not able to identify it for Spanair and Air Europa.[16] Although assertions about the relationship between the airlines cannot be explicitly tested, it is sensible to claim that Iberia is the airline that really has market power, while its rivals behave as followers. The good financial performance of Iberia since 1999, in contrast to that of many other airlines, also supports this argument. Indeed, the weight of the domestic market in the total activity of Iberia is substantial. According to the data provided by Iberia in its annual accounts, the domestic market represented 60% of total passengers and 38% of total revenues in the period 2001–2002. Additionally, in this period the growth rate of the yield per passenger was 5.55% for the domestic market, while it was 2.40% for all of Iberia's markets.

VI. Concluding Remarks

In this paper, we analyze Spanish airlines' behavior in monopoly and oligopoly strategic scenarios. Cost and demand information for a representative sample of routes is used to estimate demand and pricing equations.

A well-known result in the industrial organization literature is that oligopoly competition in markets characterized by endogenous capacity constraints leads to Cournot outcomes. With regard to the airline industry, previous empirical studies of air transport competition find that, on average, airlines compete à la Cournot. However, the most frequent oligopoly setting in those studies is a symmetric duopoly. Deneckere and Kovenock (1992) show that oligopoly competition in a market with exogenous capacity constraints and a natural leader in prices can lead to an equilibrium that is less competitive than the Cournot solution, regardless of whether any form of collusion exists. European domestic airline markets for the period analyzed could meet the assumptions of the model of Deneckere and Kovenock. Our findings could be capturing the prediction of such model, taking into account that the Spanish market appears to be an important market in the European context.

Indeed, we find evidence that the conduct of Spanish airlines in oligopoly routes is less competitive than is predicted by a Cournot model. In addition to this, airport dominance arises as a relevant determinant of airline mark-ups. The results of our analysis also show that density economies are substantial. Thus, routes with low traffic densities can be

[16] Spanair does not offer services exclusively in any route, and Air Europa has the monopoly in a small group of routes characterised by very low and fluctuating traffic. We consider that it would be biased to identify the conduct parameter for Spanair and Air Europa using data from Iberia's monopoly routes.

considered as natural monopolies. Furthermore, the two main forms of competition for the market in the air transport industry, potential competition or intermodal competition, do not seem to impose a disciplining effect on airline behavior.

The existence of a natural monopoly in thin routes along with generally non-competitive conduct among airlines in thick routes could justify an economic regulation process in the former case and a more proactive competition policy in the latter case. Regardless of the suitability of these two policy measures, we claim that the improvement of competition conditions in the Spanish market requires a more balanced allocation of newly available airport slots. In this way, the capacity constraints that create airport congestion will likely be alleviated by the plan to double the capacity of the main airports of the Spanish network. In turn, given that a high proportion of monopoly routes are short-haul routes, it could be desirable to promote intermodal competition.

Acknowledgements

The author would like to thank Germà Bel, Joan Ramon Borrell, Javier Campos, Antón Costas, Ginés de Rus, Laura Fernàndez, Robin Lindsey, Pedro Marín, Anna Matas, Gustavo Nombela, the editor and two anonymous referees for their useful suggestions. The usual disclaimer applies.

Appendix

Table AI. System equation estimates (3SLQ); $N = 190$

	Price variable (p^{eco}): prices in the full economy class	Price variable (p^{bu}): prices in the business class
Demand equation (dependent variable: Q)		
Prices (p)	−0.0029 (0.0013)*	−0.0031 (0.0012)*
$D^{intermodal*}p$	0.0003 (0.0006)	0.0009 (0.0006)
Population (pop)	1.27 (0.22)**	1.34 (0.23)**
Income (inc)	0.18 (0.84)	0.63 (0.88)
D^{hub}	0.36 (0.17)*	0.38 (0.17)*
Winter01	−0.52 (0.17)**	−0.50 (0.17)**
Summer02	0.06 (0.17)	0.12 (0.17)
Intercept	−8.26 (9.07)	−13.73 (9.33)
R^2	0.48	0.47
χ^2(joint sig.)	175.55**	154.73**

Table AI. Continued

Pricing equation (dependent variable: p)		
Demand (Q_m)	−0.00011 (0.6e−4)*	0.4e−4 (0.7e−4)
Distance (dist)	0.18 (0.006)**	0.21 (0.006)**
D^{nm}	−95.83 (11.68)**	−92.71 (12.16)**
Winter01	−15.59 (7.93)*	−4.80 (8.19)
Summer02	24.19 (7.70)**	24.34 (7.97)**
Intercept	276.88 (8.72)**	267.09 (9.03)**
R^2	0.82	0.84
χ^2 (joint sig.)	868.48**	1,043.31**

Notes: Standard errors in parentheses.
Significance at the 1%(**), 5% (*), and 10% (+).

Table AII. Estimated structural parameters (evaluated at sample means)

	Price variable (p): prices in the full economy class	Price variable (p): prices in the business class
Demand equation		
Price elasticity of demand: $\eta_\alpha(m=a)$	−0.99*	−1.15*
Price elasticity of demand: $\eta_\alpha(m=b)$	−0.87*	−0.82*
Pricing equation		
Density parameter: η_β	−0.03+	0.01
Price elasticity to distance: η_{b1}	0.34**	0.37**
Conduct parameter: $\theta(m=a)$	0.72	0.71
Wald test ($\chi^2_{(1)}$)		
Test $\theta_a=0$	29.00**	33.84**
Test Cournot ($\theta_a=0.38$)	6.46**	7.32**
Test Collusion ($\theta_a=1$)	4.39*	5.63*
Conduct parameter: $\theta(m=b)$	0.75	0.80
Wald test [$\chi^2_{(1)}$]		
Test $\theta_b=0$	68.09**	96.29**
Test Cournot ($\theta_b=0.38$)	16.73**	26.25**
Test collusion ($\theta b=1$)	7.28**	6.39*

Notes: We consider two different markets ($m=a,b$): Index a refers to the market based on peninsular routes where distance is less than 450 km; index b refers to the market based on routes with an island as an endpoint and/or routes where distance is more than 450 km.
Significance at the 1%(**), 5% (*), and 10% (+).

References

Berry, Steven, Michael Carnall, and Pablo T. Spiller (1996) 'Airline Hubs: Costs, Markups and the Implications of Customer Heterogeneity'. NBER Working Paper, **5561**, 1–38.

Borenstein, Severin (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, James A. and Anming Zhang (1990) 'A Market Conduct in the Airline Industry: An Empirical Investigation', *Rand Journal of Economics* **21**, 567–583.

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

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.

Brueckner, Jan K. and Pablo T. Spiller (1994) 'Economies of Traffic Density in the Deregulated Airline Industry', *Journal of Law and Economics* **37**, 379–415.

Brueckner, Jan K., Nichola J. Dyer, and Pablo T. Spiller (1992) 'Fare Determination in Airline Hub-and-Spoke Networks', *Rand Journal of Economics* **23**, 309–333.

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

Caves, Douglas W., Laurits R. Christensen, and Michael 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, Raymond J. and Dan Kovenock (1992) 'Price Leadership', *Review of Economic Studies* **59**, 143–162.

Evans, William N. and Ioannis N. Kessides (1993) 'Localized Market Power in the U.S. Airline Industry', *The Review of Economics and Statistics* **75**, 66–75.

Fisher, Thorsten, and David 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.

Kreps, David M. and Jose A. Scheinkman (1983) 'Quantity Precommitment and Bertrand Competition Yield Cournot Outcomes', *Bell Journal of Economics* **14**, 326–337.

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

Morrison, Steven A. and Clifford Winston (1987) 'Empirical Implications and Tests of the Contestability Hypothesis', *Journal of Law and Economics* **30**, 53–66.

Oum, Tae H. (1989) 'Alternative Demand Models and Their Elasticity Estimates', *Journal of Transport Economics and Policy* **23**, 163–187.

Oum, Tae H., William G. Waters, and Jong-Say Yong (1992) 'Concepts of Price Elasticities of Transport Demand and Recent Empirical Estimates', *Journal of Transport Economics and Policy* **26**, 139–154.

Oum, Tae H., Anming Zhang, and Yiming Zhang (1993) 'Interfirm Rivalry and Firm-Specific Price Elasticities in Deregulated Airline Markets', *Journal of Transports Economic and Policy* **27**, 171–192.

Parker, Philip M. and Lars-Hendrik Roller (1997) 'Collusive Conduct in Duopolies: Multimarket Contact and Cross-Ownership in the Mobile Telephone Industry', *Rand Journal of Economics* **28**, 304–322.

Pitelis, Christos N. and Mirko C. A. Schnell (2002) 'Barriers to Mobility in Europe's Civil Aviation Markets: Theory and New Evidence', *Review of Industrial Organization* **20**, 127–150.

Tretheway, Michael W. and Tae H. Oum (1992) *Airline Economics: Foundations for Strategy and Policy*. Vancouver: The Centre for Transportation Studies (University of British Columbia).

Whinston, Michael D. and Scott C. Collins (1992) 'Entry and Competitive Structure in Deregulated Airline Markets: an Event Study Analysis of People Express', *Rand Journal of Economics* **23**, 445–462.