THE IMPACTS OF LIBERALISATION ON A BRAZILIAN AIR SHUTTLE MARKET

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ABSTRACT

This paper aims at assessing the impacts of recent economic liberalisation on an important subset of the Brazilian airline industry: the air shuttle market on the route Rio de Janeiro – São Paulo, a pioneer service created in 1959. In order to estimate structural relationships of the competition model, a product differentiated setting with conduct parameter was designed. Results permitted inferring about a rupture in the degree of firms' heterogeneity and in the extent of the deviation from Nash behaviour due to regulatory reform, as well as estimation of pertinent route-level cost information.

Key words: air shuttle - airline industry - competition - deregulation - product differentiation

JEL Classification: L93

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1. INTRODUCTION

This paper aims at developing a competition model in order to assess the impacts of recent economic liberalisation in a relevant subset of the Brazilian airline industry: the air shuttle service on the route Rio de Janeiro - São Paulo. This market was where the first air shuttle in the world, the ‘Ponte Aérea’, was created, in 1959, by an agreement of airline managers, and which dominated the airport-pair linking the city centres of the cities for almost forty years.

Air shuttles are usually characterised by very frequent service, walk-on flights with even intervals, no reservations and short-haul markets. This concept is nowadays widespread in the airline industry, usually providing service for highly time-sensitive passengers, with well-known examples being the Eastern Airlines’ Boston-New York-Washington and the Iberia’s Madrid-Barcelona. These airlines were pioneers in launching air shuttles in the United States (1961) and in Europe (1974), respectively[1].

The competition model presented here was developed to represent the rivalry and strategic interdependence among airlines in a shuttle market with product differentiation. Firms are assumed to play a static oligopoly game in which price is the strategic choice variable. As route level costs are non-observable by the econometrician, the approximation of Brander and Zhang (1990) is then performed in parallel with the estimation of first-order conditions for firm' profit maximisation.

In order to estimate the impacts of liberalisation in the air shuttle market, this paper performs analyses in two main directions: competitive conduct and product differentiation.

Firstly, it makes use of the conduct parameter approach (as in Porter, 1984, and Genesove and Mullin, 1998) to infer the extent of deviation from Nash equilibrium, and the behaviour of airlines during the process of quasi-deregulation, especially with respect to the new strategies emerged in the post-liberalisation period - such as demand segmentation and frequent flyer programmes -, some exogenous shocks - such as a fire in one of the endpoint airports

[1] Eastern Airlines’ shuttle was purchased by Donald Trump in 1989 and became The Trump Shuttle. This service was operated by USAir after it went bankrupt in 1992, and was finally acquired by US Airways in 1998.

(February 1998) and a shift in costs due to currency devaluation (January 1999)-, and the interference of macroeconomic authorities in airline's pricing freedom.

In conjunction with conduct analysis, it also investigates a rupture in the degree of product differentiation due to liberalisation, by making use of an index of heterogeneity (as in Singh and Vives, 1984).

The paper is divided into the following sections: firstly, some characteristics of the Brazilian airline industry are given, along with a historical background of the economic liberalisation performed by country's aviation authorities. Then, main elements of air shuttle markets are provided and the evolution of the Rio de Janeiro - São Paulo air shuttle is described, what is followed by the theoretical structure and empirical model. Finally, main results are presented, along with the conclusions.

2. HISTORICAL BACKGROUND

2.1 The Brazilian Airline Industry

The domestic air transportation in Brazil is a fast-growing industry. According to the Department of Civil Aviation, there were 20.5 million passenger-kilometres flown in 2000 against 11.8 million in 1992, representing growth of more than nine percent per year, a much higher rate than the country's overall economy.

As with most airline industries around the world, Brazilian air transport is rather dependent on both domestic and international economic conditions on account of derived demand characteristics. In fact, this situation is even aggravated due to usual currency exchange instability in the country, which usually affects not only demand for international travel, but also aircraft lease, maintenance, and fuel costs, causing recurrent financial crises. Besides that, airlines face very high taxation, with overall rates around thirty-five percent, compared with 7.5% for North American and 9% for European airlines, and much higher fuel tax[2] (Airfinance Journal, 2000), what makes them usually demanding for governmental help.

One of the most relevant characteristics of Brazilian airline industry is the gradual and continuous process of economic liberalisation that has been undertaken since early nineties. Next section provides details of the measures towards deregulation led by Department of Civil Aviation, the country's aviation authority.

2.2 Economic Liberalisation and the Path Towards Quasi-Deregulation

Economic liberalisation of the industry started at the beginning of the nineties within a broader governmental program for deregulation of country's economy. Most important measures undertaken so far are described in the summary of policies regarding the sector during the past thirty years, in Appendix 1.

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[2] They actually pay twice as much for fuel due to fuel tax (Airfinance Journal, 2000).

The most representative phase of the regulatory period was from 1973 to 1986, where regulation was performed along with mechanisms of development policy. In fact, the government accomplished a framework of "four national airlines and five regional airlines" in order to both regulate and promote industry's development, in a policy completely enacted by 1976. Prices were fixed by authorities, entry was banned, and the country was divided into five main monopolies for regional airlines. Besides that, competition between regionals and national (trunk) airlines was virtually absent.

From 1986 to 1992, the government started being more intrusive in terms of macroeconomic interference in the industry, especially with respect to stabilisation policy targeting. This policy was remarkable in terms of interfering in all infrastructure industries in the country and led to artificially low real prices, which caused great losses for airlines.

Liberalisation effectively started from 1992 on, although some measures of deregulation were already present since 1989 (fare bounds, for example). During this First Round of Liberalisation, regionals' monopolies were abolished, with exception to the airport-pairs linking city centres of four major cities[3] (called "special" airport-pairs, SAP). What is more, the policy of "four nationals & five regionals" was also abolished, and thus entry was stimulated by the authorities, what led to a wave of new small airlines in the market.

Also, there were now reference prices and bounds of -50% up to +32% of their values, and price competition was now seen as "healthy" for the industry, and was therefore encouraged. This can be regarded as a period of inactive stabilisation policy controls, as there was no need for the macroeconomic authorities to interfere in the market: no pressure for price increase due to higher competition, and lower instability in the costs side, as currency exchanges - the main source of variation in costs - were under control.

In the late nineties the aviation authorities decided removing two relevant regulatory devices remaining in the market: the fare bounds and the exclusivity of operations of SAPs by regionals. This generated the Second Round of Liberalisation (enacted in Dec/97-Jan/98), what triggered much strategic interaction by airlines, with intense price and frequency competition.

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[3] São Paulo (CGH), Rio de Janeiro (SDU), Belo Horizonte (PLU) and Brasília (BSB).

This phenomenon was exacerbated on the Rio de Janeiro - São Paulo route, the country's densest flow linking its best known cities. One very relevant subset of this market is the airport-pair Santos Dumont (SDU, Rio de Janeiro) - Congonhas (CGH, São Paulo), the most important of the SAPs. Notably, the SDU-CGH airport-pair is closely associated with the competition of multi-frequency, walk-on, ***air shuttles*** in the market. In fact, it was there was the first air shuttle in the world was created, the 'Ponte Aérea' (airlift[4]), in 1959 - two years before the pioneer service of Eastern Airlines shuttle in the United States.

With the gradual deregulation measures of the nineties, the agreement started losing strength. After years of operations under the approval of the regulators[5], its dominance started being criticised, especially due to fears of market power exercise in the newly liberalised market conditions. In fact, when regional airlines were allowed to enter the route, in 1989, the 'Ponte Aérea' was seen more as a cartel of major airlines than a regular pooling agreement.

With the Second Round of Liberalisation, the consequent increase in the contestability led to relevant boost in price competition, and even the fire at SDU, in February 1998, did not represent an impediment to it[6]. Airlines started having their own strategies on the route, in a process that ultimately led to the dissolution of the forty-year-old cartel, announced in June 1998.

The end of the cartel did not represent an end of air shuttle features on the route. On the contrary, new air shuttles were created by the existing airlines, in order to attract highly time-sensitive demand and to cope with increasingly fiercer competition. The next section provides a more detailed description of market's main characteristics after liberalisation.

Another relevant characteristic of the period was the strong instability of currency exchanges (US dollar), especially the shock of January 1999, which represented major increase in firm's operational costs. As the pressures for price increase in the whole economy were strong,

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[4] The term "airlift" first appeared in the city of Berlin during the Cold War, "by virtue of the necessity created by the blockade imposed by the Soviet Union" (Aviation Daily, 2002).

[5] Since its creation, the Brazilian aviation authorities considered the agreement beneficial for consumers because of the market expansion it generated. As prices were regulated and entry was banned, it operated as a natural, state-controlled, monopoly on the route, being an exception to regional's monopolies in SAP markets.

[6] In fact, prices fell by 27% during the closing of SDU.

macroeconomic authorities started interfering in the industry again. This represented relevant constraint to airlines' strategies, as they could not increase prices whenever they wanted; besides that, antitrust authorities were now closely monitoring the market.

Finally, in 2001, most of the remaining economic regulation was removed, as well as the macroeconomic interference. Thus, airlines could set their prices freely from that period on. It can be called a 'quasi-deregulation' period, as entry, price and frequencies were almost entirely liberalised.

3. MARKET CHARACTERISTICS

3.1 Definitions and General Elements

Air shuttles usually represent major air corridors linking important political, economical, social or cultural centres with a very high traffic density - the reason why they can be very relevant markets to competing airlines. According to Teodorovic (1985) the main characteristics of this sort of routes are:

i. *equal intervals between two successive departures; and*

ii. *the impossibility of reserving tickets in advance.*

Following this definition, it is clear that a typical air shuttle configuration requires the airlines to provide one or more guarantees to passengers, in order to assure that "[either they] will depart on the first departing plane, or that within a certain probability, [they] will depart on the first departing plane, or that [they] will depart on the next departing plane if cannot get a vacant seat on the first departing plane, etc" (Teodorovic, 1985)[7].

In practice, air shuttle markets are characterised by very frequent service[8], with intervals between flights from fifteen minutes to an hour (multi-frequency markets), depending on the

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[7] Airlines can add other operational guarantees to the typical air shuttle guarantee. For example, in the Boston-New York-Washington market Delta Shuttle commits with 3 guarantees (Triple Guarantee Policy), whereas US Airways Shuttle with five.

[8] US Airways Shuttle, for example, flies 24 daily roundtrips between Boston and LaGuardia, and 14 daily roundtrips between LaGuardia and Ronald Reagan Washington National Airport (October 2002).

time of day, and commonly operated on short-haul domestic routes, such as Boston-New York (258 km, with Delta and USAirways Shuttles), Madrid-Barcelona (483 km, with Iberia's "Puente Aéreo"), Paris Orly-Toulouse (574 km, with the extinct Air Inter Europe's "La Navette"), etc.

It is important to notice that one might find slight variations in air shuttles around the world, specially related to the "walk-on" features - that is, the last-minute availability without having to book -, due to country-specific airline legislation, which may impose relevant constraints[9]. In order to cope with that, airlines have nowadays developed mechanisms of increasing customer's flexibility of time, by introducing automatic ticketing machines and dedicated boarding gates available at airports. Irrespective of these variations, the main idea of shuttles is still to serve a demand that is very time-sensitive and business-purposes related, in a relatively ordered way (equal intervals).

The air shuttle market SDU - CGH is formed by central airports in Rio de Janeiro and São Paulo, in a non-stop flight of approximately 50 minutes (365 km). As with most dense routes, it is notable for its very high service levels, with average distance between flights being lower than 25 minutes (August 1998); actually, this could be down to 17 minutes during peak hours.

The airport-pair is a subset of the market consisted of the route linking the cities, which includes International Airports of Galeão / Antônio Carlos Jobim (GIG, in Rio de Janeiro) and Guarulhos (GRU, in São Paulo). Nevertheless, among the four possible airport-pair compositions, GIG-GRU is the most relevant alternative to SDU-CGH. Table 1 presents how demand distributes across airport-pairs in the city-pair market:

[9] For example, in the Eastern Air Shuttle case, passengers could buy tickets on board, whereas in the Brazilian 'Ponte Aérea' this was not permitted by authorities (nowadays it is possible to make reservations in CGH-SDU market, but it is still not allowed to make purchases on board).

Table 1 – Demand Distribution across Airport-Pairs[10]

Airport-Pair	1 SEM 1997		1 SEM 2001	
GIG-GRU	396,889	*26.4%*	359,777	*14.8%*
GIG-CGH	3,793	*0.3%*	183,935	*7.6%*
SDU-GRU	3,166	*0.2%*	7,010	*0.3%*
SDU-CGH	1,101,390	*73.2%*	1,879,428	*77.3%*
Total RJ-SP	1,505,238		2,430,150	

Other alternatives for travellers in the airport-pair include coach and telecommunications. The former represents the only transport alternative to air travel, due to non-availability of a rail system for passengers[11]. The latter is usually reported as relevant by the transport literature, and air shuttles may be especially influenced: "During the economic downturn of the early 1990s [in the United States] (...) many businesses were relying on facsimile machines, electronic mail, and videoconferences in place of air travel" (O'Connor, 1995). Besides that, telecommunication industry was privatised and liberalised during the mid nineties in Brazil, and the consequent fall in tariffs made this alternative even more attractive.

Although indeed relevant, the three aforementioned alternatives (GIG-GRU, coach and telecommunications) were not explicitly regarded in this study, and the main reason is the following: to be able to focus on the behaviour of the typical traveller of SDU-CGH market, which means a given (and homogeneous) standard of disutility to travel times. Besides that, considering GIG-GRU would cause estimation problems due to the great amount of passengers in flight connections (domestic and international) observed[12]. Coach travellers can be disregarded using the same reasoning, especially if one takes into account that travel time is more than seven times longer (almost six hours). Finally, telecommunication effects can be seen as affecting only in the long run, whereas present analysis deals with short run only.

[10] In number of passengers; source: Department of Civil Aviation.

[11] A very different situation when compared to the competition provided by train operators in the shuttle markets New York-Washington (Amtrak's "Acela Express") and Tokyo-Osaka (Shinkansen "bullet trains").

[12] Unfortunately, the data provided by DAC does not disaggregate traffic into direct trips and flight connections.

3.2 Evolution from "Classic" to Product-Differentiated Air Shuttle

The main reasons of establishing an air shuttle service are the provision of higher service levels to passengers, and the soothing of competition between flights[13]. The former is reached by providing departure times closer to passengers' preferred times due to the more even spread (and dominance) of schedule over an operating day. The latter is reached by the increase in departure-time differentiation, that is, instead of having clusters of similar departure times, there is an increase in the distance between them, in order to maximise spatial product differentiation (as described by Borenstein and Netz, 1999).

On the other hand, however, air shuttle operations may be a very relevant source of product homogeneity in a given market: one can hypothesise the representative consumer for air shuttle service as the one *who is always interested in getting the first flight available*. As Teodorovic (1985) describes: "After establishing the air shuttle, a large number of passengers will become familiar with the services offered. Most of them will adjust their arrival at the airport to the service, trying to minimize waiting time". This interaction between supply and demand can, *ceteris paribus*, make airlines' products homogeneous by letting passengers make their choice based only in their desired departure time, regardless the name and specific attributes of the airline they are travelling with.

Therefore, one should expect the degree of product differentiation in an air shuttle market to be determined by the combination of the two aforementioned effects, that is, the increase of departure-time differentiation and the increase in passengers' desire to get the first flight irrespective of the airline. What is more, the existence of price regulation and additional airline coordination (eg. by ticket endorsement[14]), can be decisive in terms of determining market outcome, ie., either product homogeneity or product heterogeneity.

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[13] One can observe that air shuttles are very likely to engender competitive advantage for participant firms, as they create reputation of very frequent and flexible service; this can be demonstrated by Iberia's legal battle of eight years in Spain's Supreme Court in order to be allowed to use the term "Puente Aereo" as its own brand name, and then, preventing its competitors from using it, on the route between Madrid and Barcelona (Aviation Daily, 2002). The air shuttle concept, in this case, represented first mover advantage.

[14] That is, a common policy between existing competitors permitting any traveller holding a ticket issued by one airline to be able to go to the ticket counter of any airline, have the ticket endorsed (acknowledged), and board a flight provided by this airline.

Indeed, one can observe that air shuttles are potential candidates for coordination of flight schedules among airlines, mainly because it requires large scale of operations in terms of very frequent service. In order to spread flight times in an evenly way across the relevant time period of a day, without causing much increase in departure intervals, conjoint operations is usually considered a reasonable alternative, either by airlines or even by regulators. For example, the Tokyo-Osaka shuttle service is performed jointly by All Nippon Airways, Japan Airline and Japan Air System, with codeshare agreement, ticket endorsement and specific website for e-ticketing.

If we consider a shuttle route with price regulation (equal fares across airlines) and full ticket endorsement, this could be undoubtedly regarded as market with homogeneous product. This situation is defined here as *"classic" air shuttle market*.

In the CGH-SDU case, the aviation authority indeed allowed the shuttle agreement since its creation, and, what is more, made it an official monopoly for years. During the eighties, VRG, TBA, VSP and CRZ operated this market with full ticket endorsement and common ticket counters at both airports, and in a pooling agreement, the "Ponte Aérea". This could be undoubtedly considered a "classic" shuttle period.

In the nineties, however, with the liberalisation measures and the allowed entry of regionals on the route, the market gradually evolved from "classic" to a more modern concept of shuttle. Especially in 1998, with the Second Round of Liberalisation and the fare war of March, airlines started introducing several elements of product differentiation, launched after the post-fire restoration of SDU[15]: firstly, "Ponte Aérea" was split into individual shuttles; and secondly, explicit efforts of segmentation were then performed. Indeed, one could observe VRG and TAM offering frequent flyer programmes, more flight time options, higher peak-dominance, better service levels at the airports, newer aircrafts, etc., focusing on the more frequent consumers - which can be called *"loyal" travellers segment* -, whereas VSP and TBA providing a basic service with deep discounts, focusing on the less frequent consumers - *"non loyal" travellers segment*. For more details of firms' products in the market since August 1998, check Appendix 2.

[15] SDU was closed for almost six months due to a fire in February 1998. Airlines were then transferred to GIG until SDU's fully restoration, which happened in August 1998.

In order to reveal the major elements of product differentiation in the post-liberalisation period, a survey was performed with passengers on the route (described in Oliveira, 2003). Results of the field research were very supportive of the idea of the existence of two segments of passengers. They are detailed in Appendix 3.

In summary, one can observe the existence of two major periods in the air shuttle market after the first liberalisation measures of the early nineties: one, with competition between "Ponte Aérea" and the regionals, prevailing until mid 1998; and the other, with competition between firms in two niches: the "loyal" and the "non-loyal" travellers segment. Both periods represented a complete rupture with "classic" standards of operations. Table 2 permits comparisons between periods:

Table 2 - Evolution of Product Differentiation in the Market

Characteristic	**1. "Classic" Air Shuttle**	**2. Air Shuttle with Some Product Differentiation**	**3. Air Shuttle with Higher Product Differentiation**
Period	*Eighties*	*Nineties Until Mid 1998*	*From Mid 1998 on*
Groups of Competitors	*Only "Ponte Aérea"*	*"Ponte Aérea" versus Regionals*	*Loyal versus Non-Loyal Segment*
Full endorsement	*Present*	*Present only among "Ponte Aérea" airlines*	*Absent*
Common Counters	*Present*	*Present only among "Ponte Aérea" airlines*	*Absent*
Price Competition	*Absent*	*Present*	*Present*
Frequent Flyer Programs	*Absent*	*Absent*	*Present*

Although it is clear from the discussion above that product differentiation was present both before and after the Second Phase of liberalisation (in the first case, between Ponte Aérea and the regionals, and in the second case, between VRG-TAM and VSP-TBA), the *degree of product differentiation* and the *existence of a rupture in it* due to the Second Round of Liberalisation is still an empirical matter. They will be key points of investigation in the theoretical and empirical modelling of Sections 4 and 5.

4. THEORETICAL STRUCTURE

Consider static price competition in a product-differentiated setting, with two groups of firms. Prices as choice variables are also assumed by Berry, Carnall and Spiller (1996)[16], and "duopoly" assumption is directly derived from the grouping of competitors described in last section (Table 2). Demand function of each firm is the following:

$$q_{ki} = q\left(p_{ki}, p_j, Y_{ki}, H, b, e_d\right), \text{ i} = \{1,2\} \qquad (1)$$

Where q_{ki} is quantity of firm k of group i, p_{ki} and p_j are, respectively, own and rival's prices, Y_{ki} is a vector of firm-specific demand shifters, H is a vector of market demand shifters, β are unknown parameters and e_d are disturbances.

Let us define Ψ as the measure of the degree of firm's homogeneity in the market, as in Dixit (1979) and Singh and Vives (1984):

$$\Psi = \frac{b_{12} b_{21}}{b_{11} b_{22}} \qquad (2)$$

Where β_{11} and β_{22} are own-price sensitivity of demand, β_{12} and β_{21} are cross-price sensitivity of demand, for firms on groups 1 and 2, respectively. Ψ is assumed to be between 0 (completely independent groups) and 1 (completely homogeneous groups), and thus the higher is the index, the higher is the degree of product homogeneity in the market. Ψ permits checking for rupture in perceived differentiation among groups due to liberalisation - one of the main targets of this paper.

Suppose now that each firm faces a total cost function, TC, in the sistemwide level, that is, in the whole industry, considering an aggregation of all domestic routes:

$$TC_{ki} = TC\left(Q_{ki}, W_{ki}, Z_{ki}, g, e_c\right) \qquad (3)$$

[16] In opposition to Marín (1995), Captain and Sickles (1997), Brander and Zhang (1990), which assume competition in quantities.

Where Q_{ki} is the systemwide quantity (measured in the whole domestic segment of Brazilian airline industry) of firm k of group i, W_{ki} is the vector of factor prices paid by firm ki, Z_{ki} is a firm-specific cost shifter vector, γ are unknown parameters and e_c are disturbances.

Marginal cost can therefore be developed as:

$$MC_{ki} = TC_1(Q_{ki}, W_{ki}, Z_{ki}, g) \tag{4}$$

Whereas in this case one can observe marginal cost at the sistemwide level, this is not true at the route level[17]. As the observable variables are only those related to the total cost function in the systemwide level, that is, the global figures for the domestic airline market provided by DAC, some sort of approximation is needed. The approach used was to "convert (...) overall cost per passenger to a route specific cost" of Brander and Zhang (1990)[18]. Suppose the following (non-observable) route-level marginal cost:

$$mc_{ki} = mc(MC_{ki}, l) = mc(Q_{ki}, W_{ki}, Z_{ki}, g, l) \tag{5}$$

Where λ provides the conversion of MC_{ki} (overall marginal cost) to mc_{ki} (route-level marginal cost), developed in the following way:

$$mc_{ki} = MC_{ki} d \left(\frac{d}{\bar{d}_{ki}} \right)^{-l} \tag{6}$$

Where d is the airport-pair distance and $\bar{d}_{ki}$ is firm ki's average stage length. λ is a route-specific parameter; it accounts for the phenomenon of "cost taper" and means that "total cost per passenger-*mile* drops as the length of the trip grows" (O'Connor, 1995). Cost taper may be a relevant feature especially within the context of short-hauls, due to higher costs per seat-mile – known as the "short-haul problem" and which usually affects air shuttle markets[19].

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[17] Usually, as Brander and Zhang (1990) describe, the appropriate operational definition of route-specific marginal costs is "far from obvious", and one has to develop proxies for it, as for ex., Douglas and Miller (1974).

[18] Also in Oum, Zhang and Zhang (1997).

[19] O'Connor (1995) mentions the demand and costs side of the short-haul problem: "Not only is the cost per seat-mile higher for shorter stage lengths, but the demand is highly elastic (...) since alternative modes of transportation, notably the private automobile, are relatively attractive over shorter distances". Air shuttle markets, however, may not feel the demand effect so intensively, as they are characterised by highly time-sensitive and price-inelastic passengers.

Following Bresnahan (1989), I define perceived marginal revenue (pmr)[20] as:

$$pmr_{ki} = q_{ki} + q_{ki} D_1^{-1} p_{ki} \quad , \quad D_1 = \partial q_{ki} / \partial p_{ki} \tag{7}$$

Where θ_{ki} is the conduct parameter, an index of the competitive nature of firm k in a given group i. θ is usually known as the firm's conjecture, although here I interpret it in the same way as Slade (2001), that is, "as misspecification parameter that measure the extent of the deviation from the null hypothesis of static Nash-equilibrium behavior".

Basically, if firms' conduct is consistent with Nash behaviour, then one would expect each firm's marginal revenue to equate marginal costs ($\theta_{ki} = 1$, for all i). The lower the θ, the more competitive firms are and, in one extreme, $\theta = 0$ represents marginal cost pricing. On the other hand, the higher θ, the more collusive firms are and, in the limit, there will be perfect collusion. Both cases (that is, $\theta < 1$ and $\theta > 1$) shall be regarded as deviations from non-cooperative Nash equilibrium.

By developing the profit maximisation problem in a similar way of Porter (1984), and using (1), (6) and (7) one can reach the following first-order condition[21]:

$$p_{ki} = MC_{ki}\, d\left(\frac{d}{\bar{d}_{ki}}\right)^{-l}\left(1 - \frac{q_i}{|h_{ii}|}\right)^{-1} \tag{8}$$

Where η_{ii} is the own-price elasticity of demand of firms belonging to group i.

Equations (1), (3) and (8) can be estimated as a system and conduct parameters are identified and can be then compared with Nash benchmark. Above all, if one considers an empirical matter to infer the behaviour of firms after liberalisation, as discussed before, this framework proves to be quite useful, as it permits checking for structural changes in θ before and after the regulatory reform, in the same approach of the analysis of Ψ.

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[20] It is "perceived" because it depends on the extent to which firms recognise the distinction between its demand, its marginal revenue, and market marginal revenue functions, what is captured by θ. Check Bresnahan (1989) and Appendix 4.

[21] Algebraic developments can be checked in Appendix 4.

5. EMPIRICAL MODEL AND ESTIMATION

5.1 Data Discussion

Data for this model is composed by a cross section of airlines in the airport-pair CGH-SDU, over time, in a panel, as described in Table 1. All information - published and non-published - was kindly supplied by Brazil's Department of Civil Aviation (DAC) and collected in the period Oct/2001 - Jan/2002. Descriptive statistics of most relevant variables can be found in Appendix 7 (Tables A.3 and A.4).

Table 3 - Data Details

Characteristic	Description
Market	Two directional one-way airport-pairs: SDU-CGH and CGH-SDU (single trips).
Period	Jan/1997 - Oct/2001 (58 months).
Missing Data	months of SDU closed: filled with GIG data (Feb/1998-Jul/1998)
Observations	466 (Pre-Liberalisation:190, Post-Liberalisation:276)
Firms	VRG (116 Obs.), VSP (116), TAM (116), TBA (80), RSL (38)

Here I follow the approach of directional origin-destination markets of Berry, Carnall and Spiller (1996), that is, considering both CGH-SDU and SDU-CGH data. However, it must be emphasised that in that paper they could observe round-trip traffic, which is not the case in the present data sample. By having that kind of disaggregation, the authors were able to allow for "characteristics of the origin city to affect demand" - a phenomenon considerably less visible in this case.

Therefore, as the data set permits observing only single trip, one-way markets, one has to be aware of inevitable crossed-effects in traffic generation, that is, the characteristics of the demand in one one-way market having considerable influence in the demand for the other one-way market. This is explained as part of the traffic observed in one market not being generated there, but being merely an extension of the traffic originated in the other market, and vice versa.

This can be illustrated with a simple example. Suppose two round-trip markets unobserved by the econometrician: A-B-A (with, say, 70% of total traffic on the route A-B) and B-A-B (with 30%). If, as in the present case, data available only permits observing the one-way markets A-B and B-A, then it is clear that, under normal circumstances, the composition of both A-B and B-A will be approximately 35% and 15%, that is, respectively, half of A-B-A and half of B-A-B[22]. Thus there is strong tendency for the markets to be homogeneous, and then, to have the same O-D composition in terms of round-trip markets. The example permits arriving at the conclusion that having the disaggregation into one-way markets permits the econometrician to duplicate her sample size (and then having higher statistical significance), without loosing information or deteriorating characteristics of the whole market. In this sense, having data for two one-way markets is the same of having data for one market for twice the period, with the advantage that the second (extended) period does not contain other exogenous shocks than the ones that already exist in the first one.

Another very important peculiarity of the data set is the existence of a gap due to the fire in SDU in Feb/1998, as mentioned before; this forced the airport to be closed for six months and airlines to cease virtually all operations from or to it. In the majority of the cases (air shuttle included) the alternative was to transfer flights to the international airport, GIG, what made CGH-GIG data potential candidate for data filling purposes.

Actually, the only reason of not taking into account GIG-CGH data would be related to the bias that could have been caused by the competition with the existing airlines in the airport-pair. This matter is not relevant, however, because GIG-CGH was relatively unexplored before the fire at SDU (the only airline that operated in that market in Jan/1998 was VSP with less than 300 pax, a very small figure if compared to more than 85,000 total pax in February).

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[22] What is meant by "normal circumstances" here is the number of people travelling only one-way - and then not returning - in one given month not being significant. Of course it is important to be aware of the fact that a small amount of trips always begin in one month and end in one of the immediate ones, but this phenomenon tends to happen in a reduced scale in such a market where passengers usually have very short stay at destination.

Another very important caution about the data is related to codeshare agreements: actually, when two airlines form an alliance on the route, the econometrician cannot observe how many passengers carried by one were really this firm's buyers, simply because here data only permits observing traffic by airline and not revenue tickets by airline (as in most US studies of airline industry).

5.2 Empirical Specification, Estimation and Results

5.2.1 Model Specification and Estimation

I assume log-linear versions of (1), (3) and (8). Empirical counterparts of those equations are presented below, and details of variables can be found in Appendix 5.

Demand function is estimated as follows:

$$\ln NPAS_{ki} = b_0 - b_1 \ln P_{ki} + b_2 \ln P_j + b_3 \ln GDP + b_4 \ln SHSEATS_{ki} + \\ + b_5 CDSHVPTB1 - b_6 CDSHVPTB2 + \sum_{h=7}^{7+N} b_h DFIRM_h + e_d \qquad (9)$$

Where $NPAS_{ki}$ is the number of passengers carried by firm k of group i; P_{ki} is the price of firm ki; P_j is the average price of firms in group j; GDP is an index of real gross domestic product; $SHSEATS_{ki}$ is firm ki's share of total seats available; CDSHVPTB controls for the effects of the codeshare VSP-TBA (Aug/98-May/99), on, respectively, their own and rivals' demand. Finally, the $DFIRM_h$ variables are used to control for inter-firm heterogeneity in the fixed-effects procedure; e_d are disturbances.

In order to estimate total costs as in equation (2), I employed a less general concept of "sistemwide level". By taking the advantage of the fact that DAC provided sistemwide data disaggregated by aircraft type, the procedure followed here was to only consider the flight equipment specific for the air shuttle market (B737-300, B737-500, A-319 and FK-100). This permitted avoiding bias due to different firm-specific fleet composition in the whole-system level, which could be especially harmful to the estimation of λ in the pricing equation[23]. Total costs are then estimated as Cobb-Douglas functions:

$$\ln TC_{kim} = g_0 + g_1 \ln FUEL_{kim} + g_2 \ln MAINT_{kim} + \\ + g_3 \ln CREW_{kim} + g_4 \ln RENTAL_{kim} + g_5 \ln CHARGES_{kim} + g_7 \ln Q_{kim} + \\ + g_8 AB \ln Q_{kim} + g_9 FK \ln Q_{kim} + \sum_{h=10}^{10+N} b_h DFIRM_h + e_c \quad (10)$$

Where TC_{kim} is total cost of firm k of group i, for the aircraft m, and $FUEL_{kim}$, $MAINT_{kim}$, $CREW_{kim}$, $RENTAL_{kim}$, and $CHARGES_{kim}$ represent, respectively, proxies for (aircraft-specific) unit price of fuel, maintenance, labour, aircraft rental, and airport charges for firm ki. Q_{kim} is sistemwide output (measured in available seat-kilometres) of firm ki for the aircraft m. AB and FK are dummy variables to control for changes in output elasticity due to different aircrafts (Fokker FK-100 and Airbus A-319). I also include dummies for firm-specific fixed effects. Disturbances are denoted by e_c.

And finally, the empirical counterpart of the first-order condition (8) is the following:

$$\ln PM = \left(\ln P_{ki} - \ln \hat{MC}_{ki}\, d \right) = n_0 - l \ln RELDIST_{ki} + n_1 FIRE + n_2 ALWDISC97 + \\ + n_3 HHISEATS + n_4 SHSEATS_{ki} + n_5 CURDV99 + n_6 NLTSCURDV99 + \\ + n_7 COORDBEHV + n_8 ALWDPRINCR + \sum_{h=9}^{9+N} b_h DFIRM_h + e_p \quad (11)$$

Where $RELDIST_{ki}$ represents $d / \bar{d}_{ki}$ of (8); FIRE is a dummy that controls for the period of closed SDU; ALWDISC97 accounts for the period of discounts by Ponte Aérea before the Second Round of Liberalisation, in 1997; HHISEATS is the Herfindhal index of

[23] Brander and Zhang (1990) mention that "(...) marginal cost may vary across routes on the basis of other factors aside from distance. It might be argued that the marginal opportunity cost of a passenger depends on how well the route fits into the airline's overall network, on average load factors, on the type of aircraft used, etc.". On the other hand, they suggest that "This problem should not greatly affect the estimation of average conduct parameters, however, provided that the routes we have selected [in their study] are **representative (from the cost point of view) of each carrier's total traffic** (...)". By using the data disaggregation provided by DAC, and by correcting CHARGES variable (in the way I will show below), it is possible to have this representative-route assumption without being much arbitrary.

concentration, measured at the route level and considering shares of seats available; $SHSEATS_{ki}$ is firm ki's share of seats available at route level; CURRDEV99 is a dummy controlling for periods after the currency devaluation of Jan/1999 (considered as once and for all supply shock); NLTSCURDV99 is a dummy that allows for different conduct of the firms in the non-loyal-travellers niche after the currency devaluation of Jan/1999; COORDBEHV accounts for the period of alleged tacit collusion (Aug/99 up to Dec/99); ALWDPRINCR represents the months subsequent to the general price increase allowed by regulators and macroeconomic authorities; finally, firm-specific fixed-effects are included and disturbances are denoted by e_p.

$\hat{MC}_{ki}$ d represents estimated marginal cost of firm k of group i - calculated as in (4) - multiplied by the airport-pair distance. Although it represents system-wide (and not route level) costs, relevant problems of measurement may arise when performing the transformation of the left-hand side of (11); this is particularly true for the variable CHARGES. It would be difficult to defend that sistemwide-level airport charges are a good proxy for route-level charges. On the contrary, both SDU and CGH airports have specific taxes levied by authorities, which could be considerably higher than average, making the estimation of λ partially biased, as discussed before. In order to correct this problem, I use airport-specific information on taxes (provided by DAC) in order to calculate $\hat{MC}_{ki}$ (check Appendix 5 for more details on CHARGES and MC).

As one can see, empirical counterpart (11) makes use of variables of route concentration (indicating structure of the market) and route market shares (indicating relative market positions). This is also performed by other studies, such as Borenstein (1989) and Evans and Kessides (1993). By having both variables as regressors it is possible to check the traditional theory that high concentration at the route level facilitates collusion, and that dominance over available seats and/or flight frequencies gives competitive advantage to carriers[24].

[24] One could also consider dominance at the endpoint airports as conferring market power to airlines, as most US studies, for ex. Borenstein (1989) and Berry (1990); however, hub-and-spoke systems are still not widespread in Brazil, what surely makes this variable less significant than in the United States. Besides that, as airports are state-owned, access to sunk facilities at the endpoints is much easier and less subject to private dominance than in the US.

Estimation of competition models like (9), (10) and (11) is usually performed in the literature by taking into account of the potential endogeneity of some of the variables in the system of simultaneous equations. This is especially true for $NPAS_{ki}$, P_{ki}, P_j, $SHSEATS_{ki}$, and HHISEATS[25]. OLS estimation in this case would generate biased estimates, and therefore two-stage least squares were performed, using as instruments some of the exogenous demand and cost variables (GDP, the dummies of code share agreements, and the input prices). Actually, one may argue that labour's prices could be endogenous in such a market with highly skilled workforce; however, this effect is certainly not observed in the short-run, especially in a period of financial difficulties of all airlines, with recurrent cuts in the workforce and control of labour expenditures. Another instrument, used when estimating demand, was USDEFF, an index of the price of real US dollar.

Instruments for available seat market share and concentration were the same measures for another market: the airport-pair PLU-BSB, linking the city centre of Belo Horizonte to Brasília. Shocks in demand would be correlated with these variables only in case it would be possible to transfer flights from one airport-pair to the other in the short-run. This practice is more difficult to be performed, however, since airlines may lose conceded slots in case they are left vacant.

One much more reasonable (and allowed) alternative would be to exchange slots in one of the endpoints CGH/SDU from or to other origin/destination, in response to a given shock. This certainly provides greater flexibility to the airline, besides not letting it lose valuable flight time positions. By considering this tactics as more usual in the market, it is possible then to defend that instruments can be generated by using an airport-pair that does not have any of the endpoints in common with CGH-SDU - in this case, PLU-BSB was chosen. Measures of SHSHARE and RHHI on this route were then considered reasonable instruments.

Estimation results for (8), (9) and (10), are presented in Appendix 5. Results are discussed in the next section.

[25] Check, for example, Evans, Froeb and Werden (1993).

5.2.1 Discussion of Results

Results of the estimation of demand equation are found in Table A.5. One can see that there was notable decrease in price elasticities after the Second Round of Liberalisation ("POSLIB" column). Indeed, both own and cross-price elasticities decreased by thirty percent on average (-26% and -34%, respectively). As emphasised before, in Section 3.2, this is certainly due to the effects of explicit efforts of product differentiation and segmentation in the market after August 1998.

Therefore, the observed decrease in price elasticities along with the higher reduction of cross-price elasticity when compared to own-price elasticity, are phenomena clearly related to the observed increase in perceived heterogeneity. This can be seen when extracting the estimated measure of product homogeneity - the index Ψ of equation (2) -, as in Table 4:

Table 4 - Evolution of Product Differentiation

Coefficients	Pre-Liberalisation	Post-Liberalisation	Variation (%)
b_{ki}	-1.4409	-1.0600	-26%
b_j	1.0784	0.7163	-34%
y	**0.5601**	**0.4566**	**-18%**

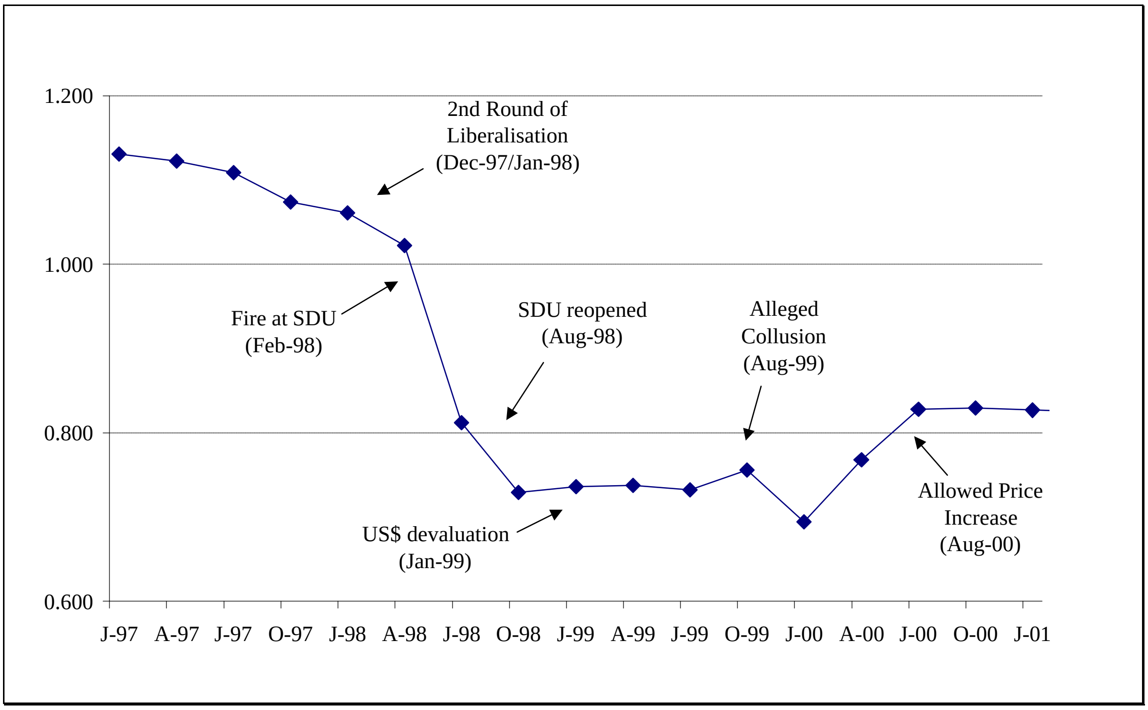
As can be inferred by Table 4, there was a clear rupture in the degree of product differentiation after the Second Round of Liberalisation, as coefficient Ψ decreased from 0.56 to 0.46 (-18%). This result is consistent with the emergence of the elements of differentiation presented in Appendix 2.

By analysing the pricing equation of Table A.6 one can extract conclusions on three major issues: 1. route-specific costs, 2. the impacts of liberalisation on competitive conduct; and 3. the influence of structure on performance.

Firstly, it is important to remember that the coefficient of $RELDIST_{ki}$, λ, represents the link between sistemwide and route-level costs, adjusting the former for "cost-tapering" effects and then permitting the analysis of non-observable marginal costs. As one would expect, signals are negative, which means that the lower is route's distance when compared to firm ki's average stage length, the higher are route-specific costs when compared to systemwide level. Also, the expected value of λ is close to -0.5, defined as the base-case of Brander and Zhang (1990). Moreover, one can analyse that for the air shuttle market, in which the average RELDIST is 0.60, λ being approximately equal to -0.7 means that for each marginal unit spent in sistemwide costs there is 1.43 marginal units spent in that specific market.

Secondly, it is possible to analyse the path of conduct in the market, and to make explicit its main determinants found in the sample. Figure 1 below presents the estimated average conduct parameter, identified as shown in Appendix 5.

Figure 1 - Evolution of estimated average conduct parameter ($\hat{q}$)



The main point of Figure 1 is related to the impact of the Second Round of Liberalisation on conduct: it is quite clear by inspecting the path of $\hat{q}$, that the "average degree of competitiveness" (Bresnahan, 1989) has increased. Actually, the conduct parameter plunged from an average of 1.105 to 0.773 (-30.1%). Results visibly indicate a slightly below-Nash-equilibrium conduct, what could be related to some (or a mix of) the following factors: interference of macroeconomic authorities not allowing free upward price movements after the US dollar shock; the fact that TBA became bankrupt and VSP had severe financial difficulties after 1999, and forced prices downwards; the entry of a budget airline in the GIG-

CGH market, from 2001 on; and the pressure caused by the close monitoring of competition policy authorities.

Three additional results deserve special comments: the effects of FIRE, CURDEV99 and COORDBEHV on conduct. The dummy FIRE represented the periods in which SDU was closed (Feb/98 - Jul/98) and when operations were fully transferred to GIG; the observed decrease in conduct during this period is related to the price war of March, triggered by the expansion of TAM's flight frequencies and deep discounts concession, in a more than proportional when compared to the effects of HHISEATS - what is captured by the estimated pricing equation (Table A.6).

With respect to CURDV99 and NLTSCURDV99, one can observe how the supply shock caused by the devaluation of the US dollar had different impacts for each group of firms: on the one hand, it permitted an increase in conduct for the firms serving the loyal traveller segment (marginal effects of 0.227), but, on the other hand, it caused a decrease in conduct for firms in the non loyal traveller segment (effects of +0.227-0.450). This was consistent with observed pricing policies on the route, and may be due to the aforementioned financial difficulties of the latter group, meaning it needed making cash in the short run, despite of lower-than-optimum margins.

Last but not least, the positive marginal effects of the dummy variable COORDBEHV means that firms did increased conduct from August 1999, as was alleged by antitrust authorities on the occasion[26]. However, as Figure 1 permits observing, this price coordination was actually ineffective, as it did not represented collusive behaviour in terms of a conduct parameter much higher than Nash equilibrium benchmark. On the contrary, $\hat{q}$ was still lower than optimum, and, what is more, it decreased again in January 2000, when VSP cheated the tacit agreement and conceded 50% of discounts.

A final comment must be made regarding the estimated coefficients of HHISEATS and SHSEATS in Table A.6. One can observe that, although the former is significant for both periods in the sample, that is, pre and post-liberalisation, the later was found significant only

[26] Actually, all airlines in the market increased prices by the same percentage (10%), on the same day (04-08-1999).

during the liberalised regime. Besides that, marginal effects of SHSEATS became slightly higher. This may represent that route dominance became much more relevant after liberalisation, especially with the explicit accomplishments of product differentiation in the market.

CONCLUSIONS

The present paper developed a competition model to investigate the impacts of the Second Round of Liberalisation of airline industry in Brazil, on one of its most relevant markets: the air shuttle service linking Rio de Janeiro to São Paulo. Structural parameters were then estimated in a fixed-effects procedure, in order to permit inference over the degree of product differentiation and the pattern of firms' conduct before and after the measures undertaken by authorities in the late nineties.

The main conclusions were a relevant increase in both the degree of competitiveness (the estimated conduct parameter decreased by 30%) and the degree of product differentiation in the market (the estimated index of homogeneity decreased by 18%), due to regulatory reform.

The main explanation for the market changes caused by liberalisation were: on the one hand, the explicit efforts of demand segmentation and incentives for brand loyalty (especially by means of frequent flyer programmes) by a group of airlines, which started offering better service levels in conjunction with higher dominance on the route; and, on the other hand, other airlines started specialising in providing service to a less loyal segment, with basic service and deep discounts.

Besides that, a supply shock represented by the US dollar devaluation, in January 1999, greatly affected the extent to which conduct deviated from Nash behaviour. As firms were not able to promptly adjust prices upwards on account of the interference of macroeconomic authorities, conduct remained slightly lower than what should be expected in equilibrium. Other factors keeping the conduct parameter depressed were the monitoring of antitrust authorities and the observed financial difficulties and state of bankruptcy of some of the airlines.

Moreover, estimation permitted analysing the effects of concentration levels and route dominance on the pricing of airlines in the shuttle market; both variables indeed proved to permit significant competitive advantage, especially in the new liberalised environment, a fact consistent with traditional wisdom in the industry.

REFERENCES

Airfinance Journal, *Boardroom battle could force Brazilian government's ha*nd, 2000. Coggeshall.

Aviation Daily, *Spanish Court Rules Against Iberia In 'Airlift' Name Battle*, 2002. Washington, The McGraw-Hill Companies.

Berry, S. "Airport Presence as Product Differentiation." *American Economic Review,* Vol. 80, No. 2, 1990, pp. 394-399.

Berry, S., Carnall, M. and Spiller, P. "Airline Hubs: Costs, Markups and the Implications of Customer Heterogeneity." *NBER Working Paper Series*, Vol. 5561, 1996, pp. 41.

Borenstein, S. "Hubs and High Fares: Dominance and Market Power in the U.S. Airline Industry" *Rand Journal of Economics*, Vol. 20, No. 3, 1989, pp. 344-365.

Borenstein, S. and Netz, J. "Why Do All the Flights Leat at 8 am?: Competition and Departure-Time Differentiation in Airline Markets" *International Journal of Industrial Organization*, Vol. 17, 1999, pp. 611-640.

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

Bresnahan, T. "Empirical Studies of Industries with Market Power." *Handbook of Industrial Organization.*edited by R. Schmalensee and R. Willig, Vol. II, Elsevier Science Publishers, Amsterdam, 1989, pp. 1012-1057.

Captain, P. and Sickles, R."Competition and Market Power in the European Airline Industry: 1976-1990" *Managerial and Decision Economics*, Vol. 18, 1997, pp. 209-225.

Dixit, A. "A Model of Duopoly Suggesting a Theory of Entry Barriers" *Bell Journal of Economics,* Vol. 10, No. 1, 1979, pp. 20-32.

Douglas, G. and Miller, J.*Economic Regulation of Domestic Air Transport: Theory and Policy*, Brookings Institute, Washington, DC.

Evans, W., Froeb, L. and Werden, G. "Endogeneity in the Concentration-Price Relationship: Causes, Consequences, and Cures" *Journal of Industrial Economics*, Vol. 41, No. 4, 1993, pp. 431-438.

Evans, W. and Kessides, I. "Localized Market Power in the U.S. Airline Industry" *Review of Economics and Statistics*, Vol. 75, No. 1, pp. 66-75.

Genesove, D. and Mullin, W. "Testing Static Oligopoly Models: Conduct and Cost in the Sugar Industry, 1890-1914" *Rand Journal of Economics*, Vol. 29, No. 2, 1998, pp. 355-377.

Marín, P. "Competition in European Aviation: Pricing Policy and Market Structure." *Journal of Industrial Economics*, Vol. 43, No. 2, 1995, pp. 141-159.

O'Connor, W. *An Introduction to Airline Economics*, 5th Edition ed.Praeger, Westport, Connecticut, 1995.

Oliveira, A. "Simulating revenue management in an airline market with demand segmentation and strategic interaction" *Journal of Revenue and Pricing Management*, Vol. 1, No. 3, 2003.

Oum, T., Zhang, A. and Zhang, Y. "Inter-Firm Rivalry and Firm-Specific Price Elasticities in Deregulated Airline Markets" *Transport Economics - Selected Readings*, edited by T. e. a. Oum Harwood Academic Publishers, Amsterdam, 1997, pp. 691.

Porter, R. "A Study of Cartel Stability: The Joint Executive Committee, 1880-1886." *Bell Journal of Economics*, Vol. 14, 1984, pp. 301-314.

Singh, N. and Vives, X. "Price and Quantity Competition in a Differentiated Duopoly" *Rand Journal of Economics*, Vol. 15, No. 4, 1984, pp. 546-554.

Slade, M. *Assessing Market Power in UK Brewing*. Department of Economics Discussion Paper: 01/04, University of British Columbia. 2001.

Teodorovic, D. "Multicriteria Ranking of Air Shuttle Alternatives" *Transportation Research - B*, Vol. 19B, No. 1, 1985, pp. 63-72.

APPENDIX 1 - EVOLUTION OF REGULATION IN THE BRAZILIAN AIRLINE INDUSTRY

Phase		Regulation with Industrial Policy	Regulation with Active Stabilisation Policy Controls	Liberalisation with Inactive Stabilisation Policy Controls	Liberalisation with Stabilisation Policy Constraint	Current Status of Liberalisation
Period		1973-1986	1986-1992	1992-1997	1998-2001	2001-
Economic Policy in the Sector	***Regulation***	Present	Present	Partially removed: First Round of Liberalisation	Partially Removed: Second Round of Liberalisation	Removed: Quasi-deregulation
	Macroeconomic Interference	Active	Very Active	Possible, but not Active	Active	Absent
Fares	***Reference Price***	Imposed by DAC	Imposed by DAC	Not imposed by DAC	Not imposed by DAC	Absent
	Price Increase Control	Present	Present, with stabilisation policy targeting	Present, but associated with industry's inflation	Present: mix of stabilisation policy targeting and industry's inflation	Absent
	Registration	Absent	Absent	ex-ante: 48 hours of advance, and automatically approved if no answer by DAC	ex-ante: only in case of more than 65% discount	ex-post: only for monitoring purposes
	Fare Bounds	Absent	Absent until 1988; [-25%,+10%] in 1989; [-50%,+32%], from 1990 on (only for discount fares);	[-50%, +32%] (both full and discount fares)	Unbounded	Unbounded

Phase		Regulation with Industrial Policy	Regulation with Active Stabilisation Policy Controls	Liberalisation with Inactive Stabilisation Policy Controls	Liberalisation with Stabilisation Policy Constraint	Current Status of Liberalisation
Period		1973-1986	1986-1992	1992-1997	1998-2001	2001-
Entry	***New Firms***	Not allowed: "4 nationals & 5 regionals" policy	Not allowed: "4 nationals & 5 regionals" policy	Allowed, both in national and regional levels	Allowed	Allowed
	Regional Monopolies	Present	Present	Absent, with the exception of SAP routes	Absent	Absent
Competition	***Authority's attitude***	Avoid	Avoid	Stimulate	Stimulate but with antitrust controls	Stimulate but with antitrust controls
	Among Nationals and Regionals	Absent	Absent	Allowed, with the exception of SAP routes	Allowed	Allowed
Capacity and Infrastructure	***Frequency, Airways and Aircrafts***	Controlled based on load factors; requests needed ex-ante authorisations to CLA	Controlled based on load factors; requests needed ex-ante authorisations to CLA	Ex-ante authorisation (CLA); no economic control; priority to existing airlines	Ex-ante authorisation (COMCLAR); no economic control; simpler and faster process	Ex-ante authorisation (COMCLAR); no economic control; simpler and faster process
	Airports and Terminals	State-owned enterprise: INFRAERO	State-owned enterprise: INFRAERO	State-owned enterprise: INFRAERO; equal access to airport facilities and terminals.	State-owned enterprise: INFRAERO; equal access to airport facilities and terminals.	State-owned enterprise: INFRAERO; some congested airports causing problems of access and entry.

APPENDIX 2 - PRODUCT DIFFERENTIATION ELEMENTS EMERGED AFTER LIBERALISATION

Characteristics		**Loyal Traveller Segment**		**Non Loyal Traveller Segment**	
		VRG	**TAM**	**VSP**	**TBA**
Frequent Flyer Advantages	***Mileage Program***	"SMILES"	"FIDELIDADE"	-	-
	Alliances and Mileage Exchange	Star Alliance: Air Canada, Lufthansa, SAS, Thai e United Airlines	American Airlines	-	-
	Counting Scheme	Miles	Trips	-	-
	Mileage Scheme	2000 miles = 20 trips = 1 free travel to any city served in Latin America	10 trips = 1 free trip to any city served in Brazil	-	-
	Elite Status	4 Categories; Discounts in taxis and car rentals at CGH; express check-in	3 Categories; 12 parking hours free at CGH; express check-in	-	-
Preassigned seats at Check-in		Permitted	Permitted	Not Permitted	Not Permitted
Departure Lounge		Exclusive	One Exclusive / One Shared (TAM/VSP/TBA)	Shared (TAM/VSP/TBA)	Shared (TAM/VSP/TBA)
Average Distance Between Flights (mins)		42	48	149	146
Average Distance Between Flights in Peak Hours (mins)		27	29	90	113
Average Price (Aug/98-Jul/99)		135	134	111	113
Aircraft Type		B737-300; B737-500; ERJ145	FK-100	B737-300	B737-300

APPENDIX 3 - SUMMARY OF THE SURVEY OF OLIVEIRA (2003)

In this survey, 402 passengers were interviewed at CGH airport and were asked about their preferences when choosing an airline in the market.

Table A . 1 - Main Results of the Survey - Disaggregated by Airline

Do you always travel with this airline (LOYAL)?	TOTAL	%	VRG	TAM	TBA	VSP
Yes	**251**	***62%***	80%	70%	33%	36%
No	**151**	***38%***	20%	30%	67%	64%

Who payed for the flight ticket?	TOTAL	%	VRG	TAM	TBA	VSP
Myself	**144**	***36%***	24%	34%	57%	48%
The institution I represent	**256**	***64%***	76%	66%	43%	52%

How do AIRLINE CHARACTERISTICS influence your choice ?	TOTAL	%	VRG	TAM	TBA	VSP
Very Much / Much Influence	**316**	***79%***	87%	87%	64%	62%
No / Medium Influence	**84**	***21%***	13%	13%	36%	38%

How does PRICE influence your choice ?	TOTAL	%	VRG	TAM	TBA	VSP
Very Much / Much Influence	**228**	***57%***	41%	51%	83%	79%
No / Medium Influence	**174**	***44%***	59%	49%	17%	21%

How does AVAILABLE FLIGHT TIME influence your choice ?	TOTAL	%	VRG	TAM	TBA	VSP
Very Much / Much Influence	**306**	***77%***	80%	76%	70%	75%
No / Medium Influence	**95**	***24%***	20%	24%	30%	25%

Table A . 2 - Segments' Different Views about Price

Segment	Influence of Price					
	Very High or High		**Very Low or Low**		**Overall**	
Loyal Traveller	122	*49%*	127	*51%*	**249**	***100%***
Non-Loyal Traveller	104	*69%*	47	*31%*	**151**	***100%***
TOTAL	**226**	***57%***	**174**	***44%***	**400**	***100%***

APPENDIX 4 - PRICING EQUATION AND CONDUCT PARAMETER

Consider the following first-order conditions for profit maximisation:

$$\underset{p_{ki}}{Max}\left(p_{ki}q_{ki} - tc_{ki}\right) \longrightarrow q_{ki} + p_{ki}\frac{\partial q_{ki}}{\partial p_{ki}} - \frac{\partial tc_{ki}}{\partial q_{ki}}\frac{\partial q_{ki}}{\partial p_{ki}} = 0 \qquad (12)$$

Then, let us isolate the price term in the left-hand side of the equation:

$$q_{ki} + p_{ki}\frac{\partial q_{ki}}{\partial p_{ki}} = mc_{ki}\frac{\partial q_{ki}}{\partial p_{ki}} \longrightarrow p_{ki} + \frac{1}{D_{1i}}q_{ki} = mc_{ki}\,,\; D_{1i} = \frac{\partial q_{ki}}{\partial p_{ki}} \qquad (13)$$

Suppose now there is a parameter θ that measures the extent of deviation from Nash behaviour (which would be represented by equating marginal revenue to marginal cost):

$$p_{ki} + q_{ki}\frac{1}{D_{1i}}q_{ki} = mc_{ki} \longrightarrow pmr_{ki} = mc_{ki} \qquad (14)$$

Considering then the following developments:

$$p_{ki} = mc_{ki} - \frac{q_{ki}}{D_{1i}}q_{ki}\frac{\left(p_{ki}q_{ki}\right)}{\left(p_{ki}q_{ki}\right)} \longrightarrow p_{ki} = mc_{ki} + \frac{q_{ki}}{\left|h_{ii}\right|}p_{ki} \qquad (15)$$

One can reach the following relation:

$$p_{ki} = mc_{ki}\left(1 - \frac{q_{ki}}{\left|h_{ii}\right|}\right)^{-1} \qquad (16)$$

By considering equation (5) of Section 4:

$$p_{ki} = MC_{ki}d\left(\frac{d}{\overline{\overline{d_{ki}}}}\right)^{-l}\left(1 - \frac{q_{ki}}{\left|h_{ii}\right|}\right)^{-1} \qquad (17)$$

Then it is possible to make the following development. Firstly:

$$\ln p_{ki} = \ln MC_{ki} d - l \ln\left(\frac{d}{d_{ki}}\right) - \left(1 - \frac{q_{ki}}{|h_{ii}|}\right) \tag{18}$$

And then:

$$\ln p_{ki} - \ln MC_{ki} d = -\ln\left(1 - \frac{q_{ki}}{|h_{ii}|}\right) - l \ln\left(\frac{d}{d_{ki}}\right) \tag{19}$$

By renaming some terms, one can obtain:

$$\ln PM_{ki} = j_{ki} - l \ln RELDIST_{ki} \tag{20}$$

Equation (20) is precisely the pricing equation considered for estimation purposes, as one can observe in Table A.6 (Appendix 5).

By regressing (20), it is possible to calculate the estimated conduct parameter for each group of firms:

$$\exp\left(-\hat{j}_{ki}\right) = 1 - \frac{q_{ki}}{|h_{ii}|} \longrightarrow \hat{q}_{ki} = |\hat{h}_{ii}|\left(1 - \exp\left(-\hat{j}_{ki}\right)\right) \tag{21}$$

APPENDIX 5 - LIST OF VARIABLES IN THE EMPIRICAL MODEL[27]

Code	Name	Main Source	Details
ALWDISC97	Period of 1997 Summer Discounts	Midia	Dummy variable that accounts for the periods of Summer discounts permitted by the pooling agreement on the route.
ALWDPRINCR	Allowed Price Increase	DAC	Represents the months subsequent to the general price increase allowed by regulators and macroeconomic authorities (from Aug/2000).
ASZ	Average Aircraft Size	DAC	Calculated using the size (number of seats) of each aircraft model in the market, and kilometres flown as weights. DAC provides the information of aircraft types and kilometres flown disaggregated by flight.
CDSHVPTB 1,2	Codeshare agreement	Media	Dummies for the periods of codeshare agreements VSP-TBA. CDSHVPTB1 accounts for effects in VSP-TBA's demand and CDSHVPTB2, in TAM-VRG's demand.
CHARGES	Unit Cost of Airport Charges	DAC	A proxy for unit price of airport changes. Calculated by dividing expenditures on airport charges by LANDINGS. Check CREW for information on disaggregation, deflation process, and currency. Specific CGH and SDU charges were calculated by using method provided by DAC, which considers the class of the airport, the maximum takeoff weight of aircrafts, the usual number of hours of parking during a night, and the usual waiting gate time.
COORDBEHV	Effect of Coordinated Behaviour	Media	Dummy variable to accounts for the period of alleged tacit collusion (Aug/99 up to Dec/99) by all firms in the market. They all increased their price on the same day (4-Aug) by the same amount (10%).

[27] Every variable is available in a monthly basis (period: Jan/1997 - Oct/2001) and is disaggregated by airline. When calculations were performed, they were made by the author, and not by the main source. Note that some variables may not be found in the empirical model, but instead, were used to calculate other variables.

Code	Name	Main Source	Details
CREW	Unit Cost of Labour	DAC	A proxy for unit price of crew. Calculated by dividing expenditures on crew wages by NCREW. Information on expenditures disaggregated by airline is provided by DAC for the sistemwide, domestic, level. Expenditures are deflated by a general wholesale price index (FGV's IPA) in order to represent current figures of Jan/2002. Figures are in Brazilian currency (R$, reais).
CURDV99	Currency Devaluation	Central Bank	Dummy variable controlling for periods after the currency devaluation, from Jan/1999 on. Variables are built considering shocks as once and for all. Check NLTSCURDV99.
F	Flight Frequency	DAC	Number of flight frequencies on an average day. Calculated by using the expression: F = kilometres flown / (stage length x number of days in a given month). Kilometres flown disaggregated by airline is available by DAC, and the stage length is 365 km.
FIRE	Effects of Closed SDU	Media	Dummy that controls the period of closed SDU(Feb/1998 - Jul/1998), due to a fire.
FUEL	Unit Cost of Fuel	DAC	A proxy for unit price of fuel. Calculated by dividing expenditures on fuel by FUELCONS. Check CREW for information on disaggregation, deflation process, and currency.
FUELCONS	Consumption of Fuel	DAC	Thousands of litres of aviation fuel (mainly aviation kerosene). Information disaggregated by airline. Not route-specific, but sistemwide (domestic) level.
GDP	Gross Domestic Product Index	IPEA DATA	Index of real gross domestic product (Jan/1997 = 100)
HOURS	Number of Flight Hours	DAC	Information disaggregated by airline. Not route-specific, but sistemwide (domestic) level.
LANDINGS	Number of Landings	DAC	Information disaggregated by airline. Not route-specific, but sistemwide (domestic) level.

Code	Name	Main Source	Details
MAINT	Unit Cost of Maintenance	DAC	A proxy for unit price of maintenance. Calculated by dividing expenditures on maintenance by HOURS. Check CREW for information on disaggregation, deflation process, and currency.
MC	Marginal Cost		Marginal cost - calculated as in function (4) of Section 4, and measured in the sistemwide (aircraft-specific) level. Check Q for the unit of measurement.
NTLSCURDV99	Currency Devaluation	Central Bank	Dummy variable controlling for different conduct of VSP-TBA in the periods after the currency devaluation, from Jan/1999 on. Check CURDV99.
NCREW	Number of Crew Staff	DAC	Headcount of flight crew (deck and attendants), published yearly by DAC. Monthly data was built by arithmetic extrapolation.
NPAS	Number of passengers carried	DAC	The airline revenue traffic excluding people travelling for free for any reason.
P	Average market price	ATPCO	Real prices, that is, prices deflated by a general consumer price index (IBGE's IPCA) in order to represent current figures of Jan/2002. Prices are expressed in Brazilian currency (reais, R$). Average market price, P, is calculated by weighting airline's average prices by their respective NPAS and is measured at the route level.
P_{ki}	Price of firm k in group i	ATPCO	Airline-specific average real prices, calculated by weighting the peak price (full fare) and off-peak prices (simple average of available discounts) by respective NPAS. DAC provides the information of NPAS disaggregated by airline / flight / day / departure time. For information on peak hours, check PDOM. For information on the deflation process, check P.
P_j	Price of rival airlines (group j)	ATPCO	Group-specific average real prices, calculated by the prices of each airline in group j by respective NPAS. Check P and Pki for more information.
PDOM	Peak Dominance	DAC	Peak dominance index, that is, the share of flight frequencies during peak time (all flights except those with departure from 10am to 4.30pm on weekdays, those on Saturdays, and those with departure from 7pm on Sundays). DAC provides the information of flight number / weekdays / departure times, which made possible the segregation into two periods.

Code	Name	Main Source	Details
Q	Sistemwide Output	DAC	Number of available seat-kilometres (ASK) in the domestic segment of the Brazilian airline industry. DAC provides information disaggregated by airline.
RELDIST	Distance over Average Stage Length	DAC	RELDIST represents $d / \overline{d}_{ki}$ of equation (7), that is, an index of airport-pair distance divided by firm's average stage length. Average stage length data is provided by DAC.
RENTAL	Unit Cost of Aircraft Rental and Insurance	DAC	A proxy for unit price of flight equipment rental and insurance. Calculated by dividing expenditures on rental plus insurance by HOURS. Check CREW for information on disaggregation, deflation process, and currency.
RHHI	Industry Concentration	DAC	Herfindhal index of concentration. Calculated by using airlines' RPK market shares.
SEATS	Number of Available seats	DAC	Available seats carried are calculated multiplying ASZ by F by the number of days in a given month.
SHSEATS	Share of Available Seats	DAC	Firm's share of available number of seats (check SEATS).
USDEFF	Real US Dollar	IPEA DATA	Index of real currency exchange US dollar / real (Jan 1997 = 100).

APPENDIX 6 - LIST OF ABBREVIATIONS AND CODES

Code	Description
BSB	Brasília Airport
CGH	Congonhas Airport, São Paulo (the closest to the city centre)
DAC	Department of Civil Aviation of Brazil
GIG	Galeão /A.C.Jobim Airport, Rio de Janeiro (outskirts, international gateway)
PLU	Pampulha Airport, Belo Horizonte (the closest to the city centre)
RJ	Rio de Janeiro (city)
SDU	Santos Dumont Airport, Rio de Janeiro (the closest to the city centre)
SP	São Paulo (city)
TAM	Tam (airline)
TBA	Transbrasil (airline)
VPTB	Revenue pooling/codeshare agreement between VSP and TBA
VRG	Varig (airline)
VSP	Vasp (airline)
CRZ	Cruzeiro (airline)

APPENDIX 7 - DESCRIPTIVE STATISTICS BY GROUP OF AIRLINES

Table A . 3 Statistics - Pre Liberalisation

Variable	Ponte Aérea				Regionals			
	MEAN	STDEV	MIN	MAX	MEAN	STDEV	MIN	MAX
$NPAS_{ki}$ (thousands)	*23.1*	*9.1*	*10.2*	*42.5*	*9.0*	*5.0*	*4.0*	*29.0*
$SHSEATS_{ki}$ (%)	*24.4*	*2.2*	*17.6*	*27.1*	*14.3*	*7.4*	*6.9*	*37.7*
P_{ki}	*174.7*	*23.1*	*135.9*	*199.5*	*179.1*	*27.8*	*124.5*	*199.5*
P_j	*179.5*	*27.1*	*127.6*	*199.5*	*174.9*	*23.2*	*135.9*	*199.5*
$RELDIST_{ki}$	*0.636*	*0.209*	*0.405*	*0.981*	*0.621*	*0.041*	*0.523*	*0.700*
TC_{ki} (millions)	*64.0*	*23.4*	*32.0*	*105.8*	*69.7*	*13.5*	*48.2*	*108.8*
$FUEL_{ki}$ (cents)	*45.5*	*6.3*	*29.6*	*56.8*	*54.5*	*13.8*	*40.5*	*91.2*
$MAINT_{ki}$	*1,260.8*	*326.1*	*477.0*	*1,836.3*	*620.4*	*198.3*	*373.0*	*1,456.5*
$CREW_{ki}$ (thousands)	*17.7*	*5.0*	*8.0*	*26.6*	*13.7*	*2.8*	*9.5*	*22.5*
$RENTAL_{ki}$	*1,061.6*	*596.6*	*265.7*	*2,222.9*	*1,356.6*	*191.1*	*1,012.4*	*1,792.1*
$CHARGES_{ki}$	*1,073.5*	*258.0*	*528.8*	*1,670.7*	*507.9*	*50.0*	*344.9*	*608.0*
Q_{ki} (millions)	*618.4*	*217.3*	*381.1*	*1050.7*	*313.6*	*61.3*	*213.8*	*450.9*

Table A . 4 - Statistics - Post Liberalisation

Variable	FF Segment				NFF Segment			
	MEAN	STDEV	MIN	MAX	MEAN	STDEV	MIN	MAX
$NPAS_{ki}$ (thousands)	*50.9*	*18.6*	*20.3*	*91.2*	*18.1*	*7.4*	*5.7*	*31.6*
$SHSEATS_{ki}$ (%)	*38.9*	*7.7*	*22.2*	*56.9*	*14.5*	*3.9*	*7.7*	*25.6*
P_{ki}	*173.4*	*38.6*	*123.6*	*267.7*	*109.3*	*15.5*	*76.2*	*135.9*
P_j	*107.3*	*13.5*	*76.9*	*135.9*	*163.3*	*34.2*	*130.8*	*243.8*
$RELDIST_{ki}$	*0.574*	*0.142*	*0.418*	*0.914*	*0.592*	*0.110*	*0.472*	*0.868*
TC_{ki} (millions)	*107.2*	*17.9*	*79.4*	*156.1*	*47.5*	*10.0*	*28.9*	*93.5*
$FUEL_{ki}$ (cents)	*51.2*	*16.3*	*26.0*	*88.9*	*53.9*	*15.9*	*33.3*	*94.6*
$MAINT_{ki}$	*1,188.8*	*214.5*	*761.6*	*1,635.9*	*1,356.5*	*517.9*	*423.2*	*2,692.3*
$CREW_{ki}$ (thousands)	*13.4*	*3.3*	*9.2*	*24.4*	*17.2*	*5.3*	*2.6*	*38.1*
$RENTAL_{ki}$	*1,302.6*	*416.3*	*438.6*	*2,394.7*	*1,118.6*	*705.9*	*200.9*	*2,817.1*
$CHARGES_{ki}$	*568.6*	*103.9*	*351.5*	*800.1*	*773.9*	*205.7*	*490.3*	*1,668.0*
Q_{ki} (millions)	*727.1*	*257.8*	*358.9*	*1091.8*	*506.8*	*87.0*	*245.6*	*629.0*

APPENDIX 8 - RESULTS OF ESTIMATION

Table A . 5 - Demand Equation

Dependent Variable	**ln $NPAS_{ki}$**	
	PRELIB	POSLIB
Constant	-10.565 ***	-16.205 ***
	(1.722)	(2.438)
ln P_{ki}	-1.441 **	-1.060 ***
	(0.638)	(0.231)
ln P_j	1.078 *	0.716 ***
	(0.624)	(0.168)
ln GDP	2.715 ***	3.464 ***
	(0.299)	(0.502)
ln $SHSEAT_{ki}$	0.901 ***	1.582 ***
	(0.135)	(0.300)
CDSHVPTP1		0.344 ***
		(0.114)
CDSHVPTB2		-0.336 ***
		(0.085)
TAM	-0.920 ***	-0.699 ***
	(0.040)	(0.044)
TBA	-0.924 ***	-0.670 ***
	(0.033)	(0.192)
VSP	-0.505 ***	-0.758 ***
	(0.033)	(0.227)
RSL	-0.696 ***	
	(0.128)	
ADJ. R-SQUARED	0.946	0.827
OBS	190	276

Standard errors in parentheses.

* Significant at 10% level, ** Significant at 5% level, *** Significant at 1% level.

Table A . 6 - Pricing Equation

Dependent Variable	ln PM_{ki}		
	PRELIB with SHSEATS	PRELIB without SHSEATS	POSLIB
Constant	0.391	1.853 ***	-0.798 *
	(1.112)	(0.099)	(0.458)
ln $RELDIST_{ki}$	-0.721 ***	-0.671 ***	-0.717 ***
	(0.054)	(0.031)	(0.088)
ln ALWDISC97	-0.195 ***	-0.170 ***	
	(0.035)	(0.025)	
ln HHISEATS	0.607 **	0.557 ***	0.549 **
	(0.243)	(0.193)	(0.267)
ln $SHSEATS_{ki}$	0.463		0.674 ***
	(0.360)		(0.104)
FIRE	-0.144 ***	-0.132 ***	
	(0.048)	(0.042)	
CURDV99			0.227 ***
			(0.042)
NLTSCURDV99			-0.450 ***
			(0.064)
COORDBEHV			0.197 ***
			(0.061)
ALWDPRINCR			0.107 ***
			(0.033)
TAM	-0.150 *	-0.258 ***	0.147 ***
	(0.087)	(0.020)	(0.046)
TBA			0.775 ***
			(0.127)
VSP			0.972 ***
			(0.143)
RSL	0.407	-0.072 ***	0.549 **
	(0.375)	(0.020)	(0.267)
ADJ. R-SQUARED	0.701	0.788	0.545
OBS	190	190	276

Standard errors in parentheses.

* Significant at 10% level, ** Significant at 5% level, *** Significant at 1% level.

Table A . 7 - Total Costs Equation

Dependent Variable	**ln TC_{ki}**
Constant	-6.074 ***
	(0.212)
ln $FUEL_{ki}$	0.246 ***
	(0.013)
ln $MAINT_{ki}$	0.175 ***
	(0.012)
ln $CREW_{ki}$	0.068 ***
	(0.021)
ln $RENTAL_{ki}$	0.200 ***
	(0.011)
ln $CHARGES_{ki}$	0.058 ***
	(0.015)
ln Q_{ki}	0.787 ***
	(0.009)
TBA	-0.295 ***
	(0.014)
VSP	-0.386 ***
	(0.019)
TAM	-0.693 ***
	(0.098)
*DAB*ln Q_{ki}*	0.093 ***
	(0.023)
*DFK*ln Q_{ki}*	0.130 ***
	(0.017)
ADJ. R-SQUARED	0.994
OBS	300

Standard errors in parentheses.

* Significant at 10% level,   ** Significant at 5% level,   *** Significant at 1% level.