A COMPETITION MODEL FOR
A BRAZILIAN AIR SHUTTLE MARKET

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ABSTRACT

This paper aims at developing a competition model for a relevant subset of the Brazilian airline industry: the air shuttle market on the route Rio de Janeiro – São Paulo, a pioneer service created in 1959. The competition model presented here contains elements of both vertical product differentiation and representative consumer. I also use the conduct parameter approach to infer about the behaviour of airlines in the market under three situations: a quasi-deregulation process (from 1998 on), two price war events (1998 and 2001), and a shock in costs due to currency devaluation (1999). Results permitted making inference on the impacts of liberalisation on competition and investigating an alleged collusive behaviour of 1999.

Key words: air shuttle – competition – deregulation – product differentiation

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1. INTRODUCTION

This paper aims at developing a competition model for 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 frequent service, walk-on flights with no reservations and short-haul markets. This concepts is nowadays very common in the airline industry, usually providing service for highly time-sensitive passengers, with notorious 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 individual air shuttles and coalitions on the route. It contain elements of vertical product differentiation, in a very special case, as it assumes the representative consumer hypothesis, in a framework different from Sutton (1986). It also uses the conduct parameter approach (as in Genesove and Mullin, 1998) to infer about the behaviour of airlines in the market under three conditions found in the sample: a quasi-deregulation process (from 1998 on), two events of price war (1998 and 2001), and a shock in costs (1999).

The methodology permitted making inference on the impacts of liberalisation by authorities, on the competition in the market. Besides that, it also permitted investigating an alleged collusive behaviour in the second semester of 1999, when all airlines set the same price increase on the same day.

2. HISTORICAL BACKGROUND

The domestic air transportation in Brazil is a fast-growing industry. According to the Department of Civil Aviation, there were 27 million seat-kilometres available in 2001 against 12 million in 1992, representing growth of more than ten percent per year, a much higher rate than the country's overall economy.

As with most airline industries around the world, because of derived demand characteristics, Brazilian air transport is rather dependent on both domestic and international economic conditions. 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

[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.

lease, maintenance, and fuel costs. Indeed, recently, it was observed a relevant overshooting of costs in dollars and consequent airline financial crisis, caused by the governmental change in monetary regime allowing fluctuation. Figure 1 permits observing the degree of correlation among the effective exchange rate US$/R$ and unit costs of one of the major airlines:

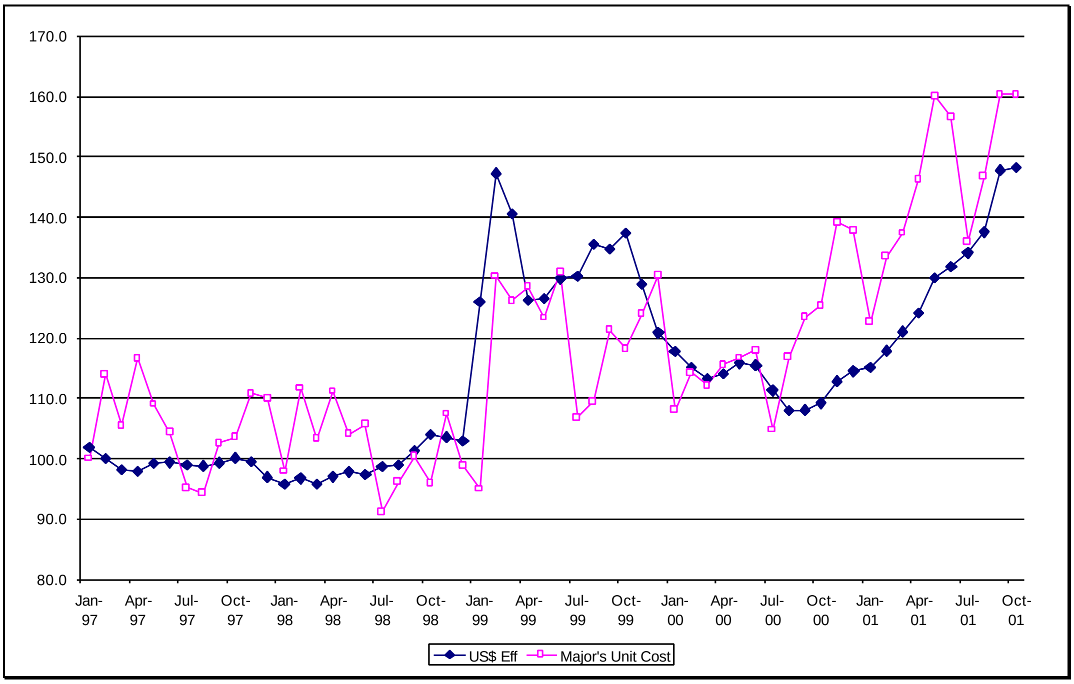

Figure 1 – Evolution of Effective Exchange Rate US$/R$ and Unit Costs of a Brazilian Airline[2]

What is more, Brazilian's domestic segment has been inserted in a gradual and continuous process of economic liberalisation. Initiated at the end of the eighties within a broader governmental program for deregulation of country's economy, this series of changes in the authorities' policy can be divided into three main periods: the first phase, with the stimulus of new airlines to enter the market and the introduction of lower and upper bounds for prices (1989-1997); the second phase, with more liberalisation of route entry and bounds (1998-2001); and the third phase, with virtually fully deregulation (from August 2001). As a result, it was recently observed a remarkable increase in the degree of industry's competitiveness; notably, the rivalry among airlines led to relevant price reductions and market expansion since 1998.

This phenomenon was exacerbated on the Rio de Janeiro - São Paulo route, the country's densest flow linking its most known cities. One important subset of this market is the airport-pair Santos Dumont (SDU, Rio de Janeiro) - Congonhas (CGH, São Paulo), one of the so-called 'direct-to-centre flights' - DCFs, that is, composed by airports located close to the city centre, in the main cities of the southeast of Brazil and of them to Brasília. Notably, the SDU-

[2] Index with both series equal to 100 in Jan-97. Source: IPEA and Department of Civil Aviation.

CGH airport-pair is closely associated with the competition of no-reservations, walk-on, ***air shuttles*** in the market. In fact, it was there were the first air shuttle in the world was created, the ‘Ponte Aérea’, in 1959 - two years before the pioneer service of Eastern Airlines shuttle in the United States.

Since its creation, the air shuttle had a remarkable feature that helps understanding market dynamics nowadays: it was formed by an alliance of airlines, in a codeshare agreement by Varig, Cruzeiro and Vasp, in order to compete with the dominant firm in the market (Real). In the medium term, however, it became the dominant airline itself, with a considerable stake for almost forty years, constituting one of the most durable alliances of commercial air transport.

With the gradual deregulation measures of the nineties, the agreement started losing strength. After years of operations under the approval of the regulators[3], 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 common pooling agreement.

It was only in 1998, however, that competition was finally introduced in the SDU-CGH airport-pair. This was stimulated by another step towards deregulation by the authorities, which put an end to the regulatory barriers to entry in all DCF routes and thus permitted a rupture in the quasi-monopoly structure of the market, in January 1998. This process ultimately led to the cartel’s dissolution, announced in June.

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 fierce competition. Next section provides a more detailed description of market’s main characteristics.

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[3] 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.

3. MARKET CHARACTERISTICS

In general, air shuttle markets are characterised by very frequent service[4], with hourly (or less-than-hourly) walk-on flights, which usually do not require reservations. There might be slight variations due to country-specific airline legislation but, basically, the main idea of shuttles is to serve a very time-sensitive demand[5]. What is more, air shuttles commonly operate on short-haul routes, such as Washington-New York, Madrid-Barcelona, etc.

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 kilometres). This 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:

Table 1 – Demand Distribution across Airport-Pairs[6]

AIRPORT-PAIR	1SEM 1997		1SEM 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	+61%

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. The latter is usually reported as relevant by the transport literature: "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"; and "(...) the demand for business and some personal air travel will be diminished in future years, to a degree that is hard to predict, as these technologies are improved and become less expensive" (O'Connor, 1995). Besides that, it must be emphasised that the telecommunication industry was privatised and liberalised during the mid nineties in Brazil, and the consequent fall in tariffs made this alternative even more attractive to consumers of the SDU-CGH market.

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[4] 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).

[5] For example, in the Eastern Air Shuttle case, passengers could buy tickets on board, whereas in the 'Ponte Aérea' this was not permitted by authorities.

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

Demand for air transport in Brazil has some peculiarities, which are well described by Franco et al. (2002): "The price elasticity of demand for domestic flights is low. A study carried out by the Airlines Labour Union -SNEA indicates that 71% of the passengers in Brazil between 1980 and 1996 were in business trips, while the international average is 55%, according to the IATA. Most of the passengers are middle age businessmen (74%) with a high purchasing power. According to a survey of the Brazilian Newspaper Gazeta Mercantil, the three most important factors taken into account by businessmen when choosing the companies are the existence of direct flights, the time of departure and the number of frequencies. Prices of air tickets came only in the fourth place"[7].

Basically, there were 5 airlines operating in the airport-pair in the period under analysis: Varig, Vasp, and Transbrasil (trunk), and Tam and Rio-Sul (regional). Recently, a low-cost carrier (Gol) has entered the market and Transbrasil has exited on account of bankruptcy. Besides that, Tam has become one of the country's majors along with Varig and Vasp. All airlines operate the route using B737-200 (132 seats), except from Rio-Sul (B737-500 and ERJs) and Tam (A319)[8].

Table 2 provides an idea of the evolution of codeshare agreements in the market. It can be inferred that, except from Vrg-Rsl, which is an agreement of a major airline with its subsidiary, other formal coalitions have not been permanent after the Ponte Aérea's dissolution. On the contrary, both Vsp-Tba shuttle (Sep/98-May/99) and Tam-Tba agreements (May/00-Jan/01) were unstable and short-lived.

Table 2 – The evolution of Agreements in the Airport-Pair CGH-SDU

Codeshare	1997				1998				1999				2000				2001			
Agreements	1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q	1Q	2Q	3Q	4Q
Ponte Aerea	■	■	■	■	■	■														
Vrg-Rsl							■	■	■	■	■	■	■	■	■	■	■	■	■	■
Tba-Vsp							■	■	■	■										
Tam-Tba														■	■	■				

Finally, one word about concentration levels: it was observed a considerable decrease in the flight frequency concentration since the liberalisation measures of 1998. This can be seen in Figure 2, which depicts the evolution of the Herfindhal-Hirschman index:

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[7] A recent research performed by Sao Paulo's aviation authorities (DAESP, 2002) revealed the following characteristics for the passengers of the state's airports: 65 % male; 54 % aged between 21 and 40; 77 % with graduation and/or post-graduation; 40 % earning between US$ 300 and 1,500 per month; 37% earning between US$ 1,501 and 3,000 per month; 58 % with business purposes; 29 % travel by air between 2 and 5 times per year; According to research performed by the Department of Civil Aviation, passengers in the air shuttle market have the following average profile: 89% of trips have business purposes; 90% of travellers earn more than twenty minimum wages; 60% stay one day or less at the destination.

[8] From now on it will be considered the following codes of the airlines: Vrg (Varig), Vsp (Vasp), Tba (Transbrasil), Tam, and Rsl (Rio-Sul).

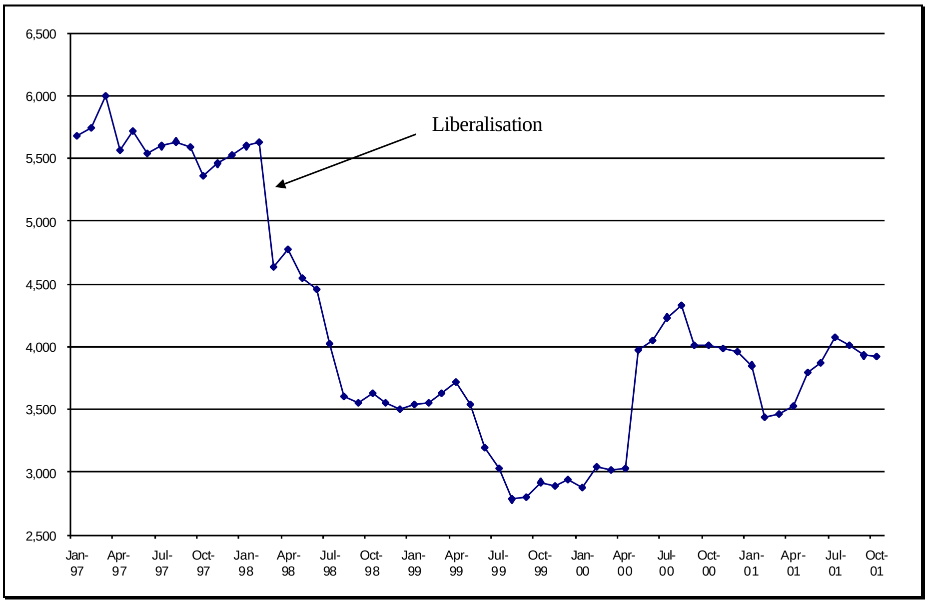

Figure 2 – Herfindhal-Hirshman Index Path[9]

4. THEORETICAL MODEL

The following subsections contain the proposed theoretical framework for modelling competition in air shuttle markets such as the Brazilian 'Ponte Aérea': demand (4.1), costs (4.2) and pricing/conduct sides (4.3); its empirical counterpart is found in section 5.

4.1 Demand Side

Suppose a market with both *vertical product differentiation* and *representative consumer*. These assumptions form the core of present model and can be regarded as reasonable representation of the Brazilian air shuttle market, as discussed below.

Firstly, the use of vertical product differentiation features for modelling competition in the airline industry follows Marín (1995)[10], an there is clear evidence that this assumption makes

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[9] In terms of flight frequency shares.

[10] Seminal papers on vertical product differentiation are Shaked and Sutton (1983) and Gabszewicz and Thisse (1979). By considering the consumer representative hypothesis, however, the present paper assumes a simpler case of vertical product differentiation, without recurring to arbitration of densities of consumers in a quality space. It could be used passengers' income distribution for this purpose, as in Sutton (1986), but this variable wouldn't be adequate for a good representation of such a market, specially because corporations, rather than individuals (businessmen), are the main airline's clients.

even more sense in this particular sort of market (air shuttles). If we consider *flight frequency* as the most relevant competitive variable here, then it seems coherent to suppose that an increase in the level of this characteristic represents gain for all passengers and not only a subgroup of them. Therefore the benefit in terms of timesaving due to additional flights is global and relevant, and this is due to a decrease in passengers' average schedule delay[11].

Secondly, in terms of the representative consumer hypothesis, as in Spence (1976) and Dixit and Stiglitz (1977): if we consider that this particular shuttle service market has the majority of consumers with the same features in terms of trip purpose, stay timing, reservation habits, sensitivity to time, then it is also reasonable to consider that an aggregation of them would not cause much loss of generality. Indeed, even when the modelling of consumer segments for this specific market was performed (Oliveira, 2003), the results did confirm the relatively high homogeneity of consumers preferences[12]. Besides that, one relevant result of using this assumption is (as in any non-address approach) that a variety of products will be consumed by the representative consumer; this also seems reasonable if we think the air shuttle as having "walk-on" features, that is, passengers usually choose the next available flight in the overall timetable, what guarantees that each firm will have positive market shares, and also very correlated to flight frequency.

Consider then the following utility function $u_r(.)$ for the representative consumer[13]:

$$u_r(i) = d_0 \left(\frac{f\, f_i}{p_i} \right)^{d_r} \quad , \quad f > 0 \quad , \quad 0 < d_r < 1 \tag{1}$$

Where f_i, f and p_i, are, respectively, firm i and market's flight frequencies, and firm i's price; ϕ represents the value attributed to frequency (value of waiting time, as in Berechman and Oz, 1995). $<\delta_0, \delta_r>$ is a vector of unknown parameters.

Term δ_r contains three main characteristics: first, it is positive and lower than unity in order to represent diminishing marginal utility; second, it is decreasing in firm i's market supply share (f_i/f, from now on called ν_i); and third, it is decreasing in a measure of airport dominance, ψ_i[14], based on Borenstein (1991). For the present case, these variables are developed focusing only

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[11] The delay, measured in time units, that the flight departure time represents in relation to the passenger desired departure time.

[12] That is, with market and firms' demand very price-inelastic and time-sensitive for all segments. However, results may be different if we consider a disaggregation of weekdays and weekend, a task not yet performed because of lack of disaggregated data.

[13] This is similar to the scheme of Cobb-Douglas utility functions, as in Lancaster (1971), Lane (1980) and Caplin and Nalebuff (1986). This paper considers only one characteristic (flight frequency), however.

[14] Borenstein (1991, p. 1248) uses the variable APTDOM, measured as 'an airline's share of the passengers who originate their trip at a given airport and travel on any route other than the route in the observation'.

on the traffic originated at one airport for other DCF routes[15], because they tend to be more homogeneous and they account for the effect of regional airline monopoly previous to the liberalisation of 1998.

Thus, δ_r can was modelled as in (2):

$$d_r = d_1 - d_2 n_i - d_3 y_i \tag{2}$$

Where $<\delta_1, \delta_2, \delta_3>$ is a vector of unknown parameters.

Firm i's market share[16] can then be developed as in (3):

$$s_i = s\left[\frac{u_r(i)}{u_r(i^-)}\right] = b_0\left[\frac{u_r(i)}{u_r(i^-)}\right]^{b_1} = b_0\left[\frac{p_i / f_i}{p_{i^-} / f_{i^-}}\right]^{-b_1^* + b_2^* n_i + b_3^* y_i}$$
$$\text{with } \left\langle b_1^*, b_2^*, b_3^* \right\rangle = b_1 \langle d_1, d_2, d_3 \rangle \tag{3}$$

Where index i^- is used for firm i's *average opponent*, as in Slade (1986); s_i is firm i's market share, and $<\beta_0, \beta_1>$ is a vector of unknowns.

Let's now consider the following market demand function:

$$q = a_0 p^{-a_1} \prod_{k \geq 2} X_k^{a_k} \tag{4}$$

Where q, p and X are, respectively, market size, overall price, and a vector of demand shifters. Price p is generated as a geometric average of firms' prices, p_j, weighted by their shares of total flight frequencies, ν_j (j = 1,2,...,N), as in (5):

$$p = \prod_{1 \leq j \leq N} p_j^{n_j} \quad , \quad n_j = \frac{f_j}{f} \quad , \quad \sum_{1 \leq j \leq N} n_j = 1 \tag{5}$$

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[15] As mentioned in last section, DCF (direct-to-centre flights) routes are the city centre airport pairs of the following cities: São Paulo, Rio de Janeiro, Belo Horizonte; Brasília's international airport is usually included within this definition as well.

[16] This approach for modelling market share functions can also be found in Roberts and Samuelson (1988) and Marín (1995).

By using (3), (4) and (5) it is possible to extract own and cross price-elasticities of firm i's demand:

$$h_{ii} = -b_1^* - n_i\left(a_1 - b_2^*\right) + b_3^* y_i \quad \text{and} \quad h_{i\bar{i}} = +b_1^* - b_2^* n_i - a_1 n_{\bar{i}} - b_3^* y_i \tag{6}$$

4.2 Cost Side

Suppose the following Cobb-Douglas total (short-run) variable cost function:

$$TC_i = C_{i0} K_i^{\nu_k} Q_i^{\nu_0} \prod_g \Gamma_{ig}^{\nu_g} \tag{7}$$

Where TC_i, K_i and Q_i are, respectively, firm i's total variable cost, capital level, and production *for all routes*, C_{i0} is firm-specific fixed cost (within variable categories), Γ_{ig} is the price of production factor g paid by firm i, and ω_g is firm i's cost elasticity of production.

The marginal cost function associated with (7) is the following:

$$MC_i = \frac{\partial TC_i}{\partial Q_i} = \nu_0 C_{i0} K_i^{\nu_k} Q_i^{\nu_0 - 1} \prod_g \Gamma_{ig}^{\nu_g} \tag{8}$$

In order to provide a link between MC_i (overall marginal cost) with c_i (route-level marginal cost), let's use Brander and Zhang's (1990) definition[17]:

$$c_i = MC_i d \left(\frac{d}{\bar{d}_i} \right)^{-l} \tag{9}$$

Where d is the airport-pair distance and $\bar{d}_i$ is firm i's average stage length. λ is a route-specific parameter, usually equal to 0.50 in transport economics literature, what is followed here[18]; 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] Used also by Oum, Zhang and Zhang (1997).

[18] This is also the base-case investigated by Brander and Zhang (1990).

[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

4.3 Pricing and Conduct Relations

This paper follows Berry (1990) and Berry, Carnall and Spiller (1996) which assume static price competition for an airline market with product differentiation[20]. First-order condition then can be developed in the following way:

$$\underset{p_i}{Max}\left(p_i q_i - tc_i\right) \Rightarrow p_i \frac{\partial q_i}{\partial p_i} + q_i \frac{\partial p_i}{\partial p_i} - \frac{\partial tc_i}{\partial p_i} = 0 \Rightarrow$$

$$\Rightarrow p_i \frac{\partial q_i}{\partial p_i} + q_i - c_i \frac{\partial q_i}{\partial p_i} = 0 \Rightarrow p_i = c_i - \left(\frac{\partial q_i}{\partial p_i}\frac{\partial p_i}{\partial p_j}\right)^{-1} q_i = c_i - \left(\frac{\partial q_i}{\partial p_i} q_i\right)^{-1} q_i \frac{\left(p_i q_i\right)}{\left(p_i q_i\right)} \Rightarrow \qquad (10)$$

$$\Rightarrow p_i = c_i - q_i \frac{\partial p_i}{\partial q_i}\frac{q_i}{p_i} p_i \Rightarrow p_i - c_i = \frac{q_i}{h_{ii}} p_i \Rightarrow \frac{p_i - c_i}{p_i} = \frac{q_i}{h_{ii}} = \ell_i$$

Where tc_i, c_i, θ_i and ℓ_i are, respectively, firm i's total cost, marginal cost, conduct parameter (in a conjectural variations framework), and Lerner index. An estimated conduct function can be directly identified by calculating the *elasticity-adjusted Lerner index*, $LI_i^h = \ell_i h_{ii} = q_i$, as in Genesove and Mullin (1998). The present paper follows Oum, Park and Zhang (1996) and assumes the following linear relationship for the conduct function:

$$LI_i^h = q_i = j_0 + \sum_k j_k Z_k^1 + \sum_l j_l Z_l^2 + \sum_m j_m Z_m^3 \qquad (11)$$

Where Z^1, Z^2, and Z^3 are variables that account for, respectively, (firm and market) demand, costs and market structure[21].

Basically, there are three notable benchmarks for θ_i to assume and that can be compared to estimated conduct:

- If $\theta_i = 0$, then p = c and then we have Bertrand conduct for homogeneous;
- If $\theta_i = 1/N$, then we have Cournot conduct for homogeneous product;
- If $\theta = 1$, there is matching behaviour in prices ($\partial p_i / \partial p_j = 1$);

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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.

[20] In opposition to Marín (1995), Captain and Sickles (1997), Brander and Zhang (1990), which adopts the hypothesis of quantity competition.

[21] For more details on what variables were used, check both equation (15) in section 5.

Equations (3), (4), (7) and (11) constitute a system of equations that form the model of competition proposed here, which is estimated in next section.

5. EMPIRICAL MODEL

This section provides an empirical counterpart of the model developed last section: equations (12), (13), (14) and (15) below.

$$\ln s_i = b_1 - b_2 \ln r_i + b_3 n_i \ln r_i + b_4 y_i \ln r_i - b_5 \ln s_0 + \sum_k c_{1k} d_{1k} + e_1 \tag{12}$$

Where $r_i = [(p_i/f_i)/(p_{i-}/f_{i-})]$; σ_0 is the market share of an *outside alternative* (in this case it is the market share of the alternative airport-pair GIG-GRU[22]) and σ_i is the market share of firm i. The outside alternative is used here in order for the adding-up restriction to be imposed: σ_i is equal to q/q* (where q* is the market as a whole), and σ_0 is a dropped equation, calculated as a residual $(1 - \sigma_i)$[23]. For a discussion of outside alternative see Anderson, de Palma and Thisse (1992). The χ_{1k}'s and the d_{2k}'s are, respectively, unknowns and dummy variables that account for firm-specific shifts in the market share equation.

Total demand is estimated using the following relation:

$$\ln q^* = \begin{cases} a_0 - a_1 \ln p + a_2 \ln gdp_{t-1} - a_3 \ln irate_{t-1} + a_4 coach_{t-1} + \\ + a_5 tel_{t-3} + a_6 dlowcst - a_7 dfire + e_2 \end{cases} \tag{13}$$

Where p is an overall price variable (for both the inside and outside alternative, weighted by its passenger-kilometres); gdp is a gross domestic product index, irate is an interest rate index, coach is an average index of coach prices in Rio de Janeiro and São Paulo states, and tel is an average index of telecommunication prices at the same area; dlowcost and dfire are dummy variables to account for, respectively, the entry of a low cost carrier at the international airport, GIG, in 2001, and the fire in the SDU airport, in 1998.

Total variable cost function associated with (7) is the following:

$$\ln TC_i = \ln C_{i0} - w_k \ln K_i + v_0 \ln Q_i + v_1 \ln L_i + v_2 \ln F + v_3 \ln USD + e_3 \tag{14}$$

[22] GIG and GRU are, respectively, Rio de Janeiro and Sao Paulo International Airports. As seen in section 3, this airport-pair is usually considered an alternative to CGH-SDU.

[23] This procedure is similar to the one used in translog market share systems for estimating cost functions.

Where L_i is the average labour prices of firm i; F and USD are, respectively, overall fuel prices in dollars and average exchange rate real/dollar.

And, finally, the Lerner Index equation becomes as in (15):

$$LI_i^h = \left\{ g_0 + g_1 hhi + g_2 q^* + g_3 d_i + g_4 dagr + g_5 dus_{99} + g_6 dfire + \sum_m c_{2m} d_{2m} + e_4 \right. \tag{15}$$

Where hhi is the Herfindhal-Hirschman index of concentration, dagr is a dummy for shifts due to code-share agreements, and dus_{99} is a dummy for the first months after the 1999 currency devaluation. Again, firm-specific shifts are included by using χ_{2k}'s and d_{2k}'s.

I use here a two-step, two-stage least squares procedure – as suggested by Slade (2001)[24] – for equations (12), (13) and (15). Data was available in a monthly basis for the period of Jan-97 to Oct-01, for both the directional markets SDU-CGH and CGH-SDU[25]; the sample is formed by a panel of all airlines present on the route (VRG, VSP, TBA, TAM and RSL) and code-share agreements are counted as only one player. Total variable cost function is estimated with OLS by using a panel of the nineteenth most important airlines in the country (4 trunk and 15 regional), in a quarterly basis (Q1-97 to Q3-01). All information was kindly given by Brazil's Department of Civil Aviation.

Exogenous demand (gdp and irate) and cost (K, F, USD, $\bar{d}_i$) variables are used as instruments, except for labour's prices L, that could be endogenous in such a market with highly skilled workforce. Thus, other input price variables (fuel and effective exchange rate) were regarded as non-correlated with either demand or first-order conditions shocks, and then were used for the estimation. Coach and telecommunication prices of other regions in Brazil were also used as instruments[26].

One quite relevant variable, flight frequency, could be regarded as exogenous for at least two reasons. Firstly, permission by the national commission for route assignment (CLA) was still needed for any changes; secondly, CGH airport is a highly congested airport with fixed slots and thus it is not only difficult to quickly adjust flight frequencies to shocks but it is also a

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[24] Actually she uses a two-step, generalised method of moments (GMM) procedure; this sort of technique can be described in the following way: "In the first step, the parameters of the demand equation are estimated (...). In the second step, the estimated demand parameters and the postulated market-conduct and/or marginal-cost function is substituted into the first-order condition, and the remaining parameters are estimated" (Slade, 2001). The author suggests that this kind of procedure – that is, two-step – has the advantage of not allowing that a "misspecification of first-order condition to contaminate the demand estimates, in which one typically has more confidence" (Slade, 2001).

[25] Berry, Carnall and Spiller (1996) also consider directional markets for their estimation.

[26] An average of Brasilia and Belo Horizonte coach and telecom prices was developed. It is important to note that gdp, irate, coach and telecom were included as instruments considering both current and lagged values.

very hard strategic decision for any airline because it may be irreversible. However, it is nevertheless feasible for any airline to respond to demand shocks by adjusting its flight capacity: either by changing the aircraft used or by using the available slot for offering service to a different city. On account of that, flight frequency on the route was *not* used as instruments in the analysis.

Table 3 presents the results of model's estimation.

Table 3 – Estimation Results[27]

$\ln \sigma_i$		$\ln q^*$		$\ln TCi$		LI^{η}_i	
constant	-2.677	constant	5.277	constant	-1.114	constant	0.307
	(0.13)		*(0.82)*		*(1.01)*		*(0.03)*
$\ln r_i$	-0.770	$\ln p$	-0.600	$\ln K_i$	0.051	hhi	0.398
	(0.05)		*(0.04)*		*(0.02)*		*(0.10)*
$v_i \ln r_i$	0.882	$\ln gdp_{t-1}$	1.252	$\ln Q_i$	0.643	q*	-0.024
	(0.20)		*(0.13)*		*(0.01)*		*(0.00)*
$\psi_i \ln r_i$	0.141	$\ln irate_{t-1}$	-0.207	$\ln L_i$	0.476	s_i	-0.397
	(0.07)		*(0.02)*		*(0.05)*		*(0.04)*
$\ln \sigma_0$	-0.515	$\ln coach_{t-1}$	0.471	$\ln F$	0.268	dagr	0.099
	(0.08)		*(0.12)*		*(0.12)*		*(0.01)*
d_{11}	1.042	$\ln tel_{t-3}$	0.244	ln USD	0.459	dus_{99}	-0.101
	(0.17)		*(0.03)*		*(0.20)*		*(0.01)*
d_{12}	0.804	dlowcst	0.051			d_{21}	-0.473
	(0.04)		*(0.01)*				*(0.01)*
d_{13}	-0.212	dfire	-0.186			d_{22}	-0.444
	(0.05)		*(0.01)*				*(0.01)*
d_{14}	-0.398					d_{23}	-0.345
	(0.06)						*(0.02)*
						d_{24}	-0.397
							(0.03)
Observ.	378	Observ.	378	Observ.	321	Observ.	378
R2	0.884	R2	0.807	R2	0.957	R2	0.936
F test	361.8	F test	226.8	F test	1442.4	F test	616.2
Std.Dev.	0.289	Std.Dev.	0.083	Std.Dev.	0.457	Std.Dev.	0.062

By using the estimates of Table 3, it is possible to infer about the conduct performed in the market. Figure 3 presents the path of estimated conduct, considering the average of the whole air shuttle market CGH-SDU:

[27] Standard errors in brackets.

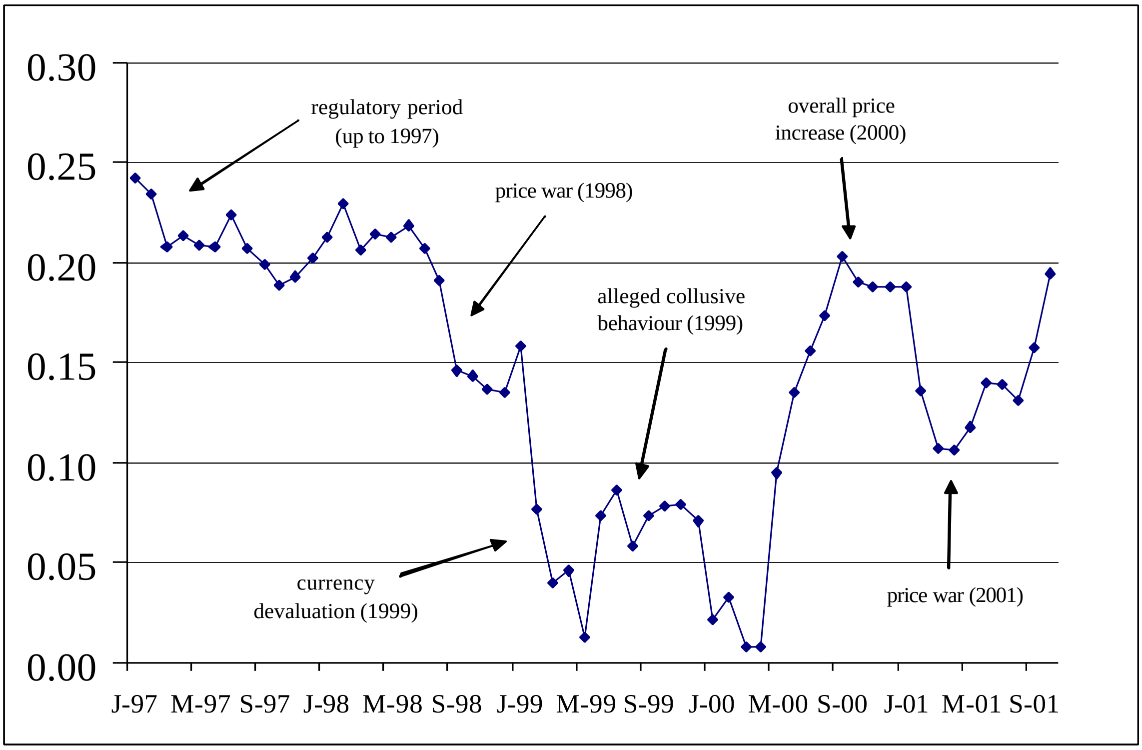

Figure 3 - Path of Estimated Overall Conduct

Figure 3 permits observing and making inference on how firms behaved after the liberalisation measures of the beginning of 1998. In fact, it can be seen that during the final months of the 'Ponte Aérea' period (from Jan-97 to the middle of 1998), the average conduct parameter was close to 0.20, a considerably competitive conduct for a cartel structure. This probably means that authorities were successful in regulating the quasi-monopoly by not allowing it to charge profit-maximising prices.

After the liberalisation, however, conduct decreased considerably by three major events: the 1998 and 2001 price wars, and the 1999 supply-shock caused by the currency devaluation in Brazil. By price wars I mean the a period triggered by a decrease in more than twenty per cent in overall fares (as suggested by Morrison and Whinston, 1996), and by the supply-shock I mean the periods where the index of effective exchange rates of Figure 1 was above 120. In the first case the conduct parameter was always between 0.10 and 0.15, and in the second case it was as low as zero, which virtually indicated marginal-cost pricing.

A final comment to make is on the co-ordinated price movement of 4 August 1999, where all airlines increased their prices by ten percent. This caused an investigation by the competition authorities based on country's legislation, under the allegation of collusive behaviour. As Figure 3 permits inferring, any pattern of collusion in the overall conduct of airlines can be clearly rejected.

CONCLUSIONS

The present paper developed a specific framework for modelling air shuttle competition in the Brazilian airline industry, by using non-address approach for vertical product differentiation. Conduct parameter estimation was also performed and results were used to infer about market behaviour in pre and post-liberalisation situations, as well as under costs shock conditions.

The main conclusion was towards a relevant increase in competition due to deregulation, specially if we consider the two events of price war observed in the market, where the estimated conduct parameter was approximately 40% lower than in the pre-liberalisation period. Besides that, one cannot reject marginal-cost pricing for the period subsequent to the costs shock.

Finally, with respect to the antitrust investigation performed by competition authorities after the overall price increase of August 1999, the analysis did not find any evidence of collusion. On the contrary, it could not reject the hypothesis of airline behaviour during the alleged collusive period being more competitive than pre-liberalisation.

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