Three Essays on Competition in Airline Markets With Recent Liberalisation

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to my wife, Rachel

Summary

This thesis aims at investigating the behaviour of airlines in recently liberalised markets, by making use of the Brazilian air transportation as a case study. In order to accomplish this objective, the following *three essays* were developed: a study of low cost carrier entry behaviour, an analysis of the pricing behaviour of the major incumbents in the industry, and, finally, an assessment of airline conduct in the most important market in the country. All essays contain empirical investigation performed by making use of data supplied by Brazil's Department of Civil Aviation, DAC.

In the first essay, the entry of Gol Airlines on several Brazilian domestic routes, in 2001 and 2002, is analysed in order to draw inference on the competition between a discounter in rapid expansion and the full-service carriers. A route-choice model is estimated by making use of a flexible post-entry equilibrium profits equation and accounting for endogeneity of the main variables.

The second essay aims at empirically investigating the pricing behaviour of the legacy carriers in Brazil, with special focus on reactions to the entry of Gol, in 2001. A study of localised competitive advantage regarding the determinants of pricing power is performed along with the analysis of the pattern of price reactions by the incumbents. A single econometric framework is designed and estimated with panel data controlling for city-specific effects.

And finally, the third essay aims at assessing the impacts of economic liberalisation on the route Rio de Janeiro – São Paulo. By making use of both a two-stages budgeting representation of the demand system, and a competition model with product heterogeneity among rivals, and based on the framework of the New Empirical Industrial Organisation, it was possible to examine the existence of a structural change on airlines' conduct parameters due to the regulatory reform.

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Declaration

I declare that the material contained in this thesis results from my own work and it has never been presented for submission for a degree at another university.

Chapter 2 was presented at the ESRC Econometric Study Group Conference, Bristol, July 15-17, 2004. Also a related (more theoretical) version of it was presented at the Second World Congress of the Game Theory Society, Marseille, July, 2004.

A version of Chapter 3 was published at the conference proceedings of the World Conference of the Air Transport Research Society, ATRS 2004, July, Istanbul.

And finally, preliminary versions of Chapter 4 were presented at the Annual Conference of the Brazilian Association for Transportation Research, ANPET, November 2001; at the Annual Conference of the Brazilian Association for Economics, ANPEC, December 2002; and at the Royal Economic Society Annual Conference, RES 2003, Coventry.

The papers have also been presented in seminars at the Institute for Transport Studies of the University of Leeds and at the Department of Economics of the University of Warwick.

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List of Abbreviations and Codes

CODE	DESCRIPTION
AFP	*Airtran/Frontier Airlines Paradigm*
ATPCO	*Airline Tariff Publishing Company*
BSB	*IATA code for the Brasília Airport*
CGH	*IATA code for the Congonhas Airport - São Paulo*
CLA	*Former Commission for Route and Flight Frequencies Requests Deliberation*
COMCLAR	*Commission for Route and Flight Frequencies Requests Deliberation*
DAC	*Department of Civil Aviation, the Brazilian airline regulator*
EXRS	*Exchange Rate Shock*
FSC	*Full-Service Carrier*
GIG	*IATA code for the Antônio Carlos Jobim/Galeão Airport - Rio de Janeiro*
GOL	*Gol Airlines*
GRU	*IATA code for the Guarulhos Airport - São Paulo*
HOTRAN	*DAC's Report on Domestic Flights*
JBP	*JetBlue Airways Paradigm*
LCC	*Low Cost Carrier*
PLU	*IATA code for the Pampulha Airport - Belo Horizonte*
SAP	*Special Airport-Pairs (DAC's terminology)*
SDU	*IATA code for the Santos Dumont Airport - Rio de Janeiro*
SWP	*Southwest Airlines Paradigm*
TAM	*Tam Airlines*
TBA	*Transbrasil Airlines*
USDOT	*Department of Transportation - United States*
VRG	*Varig Airlines*
VSP	*Vasp Airlines*

1. Introduction

1.1 The Brazilian Airline Industry: Characteristics

The airline industry is one of the sectors of the economy of Brazil that are usually regarded as "strategic" by both market analysts and the government; among the reasons is the constant need of enhancing the integration between its most important regions – undoubtedly a major issue for a country with the 5^{th} largest area in the world, with approximately 8.5 million squares kilometres.

In terms of economic justifications, one has that air transport represents approximately 3% of the country's gross domestic product, meaning a total (direct and indirect) impact of approximately 18 billion dollars on the economy (Marchetti et al., 2001a).

Brazil is notably the most important airline market in Latin America. According to Pasin and Lacerda (2003), out of the 75 million passengers in the whole region in 2000 (domestic and international traffic), the major stake, 35%, were carried by Brazilian airlines (mainly Varig and Tam); in fact, among the major Latin America airlines, and still considering figures of 2000, one had Varig with the largest global market share (14,9%), followed by Aeromexico (13%), Tam (11,9%) and Mexicana (11,7%).

Table 1.1 permits having an idea of the relative importance of each of the segments (domestic and international) and associated sub-markets (passengers in scheduled flights, passengers in chartered flights, mail, freight and others) in the Brazilian airline industry, by means of a disaggregation of the revenues generated in 2002:

Table 1. 1 – Air Transport Revenues by Segment (2002)

Sub-Market	International	Domestic	Total	%
Scheduled - Pax	*4,734*	*8,671*	***13,405***	85%
Charter - Pax	*18*	*241*	***259***	2%
Mail	*50*	*176*	***226***	1%
Freight	*1,148*	*709*	***1,857***	12%
Others	*0*	*21*	***21***	0%
Total	**5,950**	**9,818**	**15,768**	**100%**

Notes: Source – Statistical Yearbook of DAC (vol. II); ii. in million R$, values deflated to 2004 by using IBGE's IPCA.

Firstly, it is important to emphasise the relevance of both domestic *and* international segments of the air transport industry in Brazil. In fact, one can see that there is a split of approximately 40%-60% of total revenues between the international and domestic segments (approximately 6 million reais in the former and 10 million reais in the latter).

The international segment is mainly related to traffic either within Latin America, or to Europe/United States. According to Pasin and Lacerda (2003), the traffic to/from the United States, Europe and Argentina, accounted for, respectively, 26%, 34% and 18% of the total number of passengers in the international segment of the Brazilian air transport sector. The major policy issue in this segment, however, is related to the increasingly loss of participation of the national airlines on the international routes, which usually causes concerns about the current account of the Balance of Payments (Services Balance). For example, Pasin and Lacerda (2003) mention that the share of national airlines on the route Brazil-United States decreased from 60%, in 1991, to 35% in 2001.

As Table 1.1 also permits observing, the domestic segment of air transport in Brazil is formed mainly by scheduled passenger traffic, which represents approximately fifty five percent of the total revenues in the whole sector (R$ 4.7 million). The domestic segment is also representative of a fast-growing industry. According to the Statistical Yearbook of the Department of Civil Aviation (vol. I), there were 26.8 billion passenger-kilometres flown in 2002 against 17.8 billion in 1997, representing growth of approximately seven percent per year; this is certainly a much higher rate than the country's overall economy.

Table 1.2 below presents the evolution of the main figures of the sector:

Table 1. 2 – Evolution of Passenger times Kilometres (Domestic Segment)

Year	1997	1998	1999	2000	2001	2002
Pax.Km (million)	17,824	22,539	22,204	24,284	26,296	26,784
Pax.Km Growth (%)	7.5%	26.5%	-1.5%	9.4%	8.3%	1.9%
Revenues (Million R$)	6,525	6,701	7,734	8,684	9,265	9,818
Costs (Million R$)	5,832	6,539	7,944	8,176	9,936	10,632
Profits/Losses	693	162	-211	508	-671	-814
Profits/Losses (%)	10.6%	2.4%	-2.7%	5.8%	-7.2%	-8.3%
Load Factors (%)	57%	59%	55%	59%	58%	57%

Notes: i. Source – Statistical Yearbook of DAC (vol. II);
ii. values in R$ deflated to 2004 by using IBGE's IPCA.

One can also infer from Table 1.2 that, despite the rapid growth of the industry and the relative stability of the load factors figures, it was observed a large degree of instability in the profitability of the sector, with a range from –8.3% to +10.6% in only six years. This may be regarded as consistent with the international evidence of air transportation, in which major airlines across the world had significant losses recently[1]; indeed, as with most airline industries around the world, the Brazilian air transport is rather dependent on both domestic and international economic conditions on account of derived demand characteristics[2].

It is important to emphasise, however, the effects of a relevant country-specific feature of the period: Brazil faced a strong volatility of currency exchange rates (specially the US dollar). This usually affects not only demand for international travel, but also aircraft lease, maintenance, and fuel costs, causing recurrent financial distress. In fact, three relevant shocks in costs due to currency devaluation were observed after the federal government changed the country's monetary regime allowing fluctuation, in early 1999. The three exchange rate shocks (EXRS) were observed from, respectively, January 1999 (EXRS99), January 2001

[1] For example, since September 11 US Airways has already filled for bankruptcy protection twice in the US market.

[2] As transport (movement from one geographical point to another) is usually a consequence of an economic, political or social activity, it is then considered a "derived demand", that is, it is unnecessary but for the activities pursued at the ends of trips.

(EXRS01), and during the presidential election in 2002 (EXRS02). These events represented major sources of the bad performance of profits observed in Table 1.2.

There are four major airlines currently operating scheduled flights in the domestic segment of Brazil: Varig, Vasp, Tam and Gol. Table 1.3 provides some details on their market shares in both the domestic and international segments:

Table 1. 3 – Disaggregation of Passenger Times Kilometres by Airline - 2002

Market	Varig	Vasp	Tam	Gol	Others
Domestic Segment					
Pax.Km (billion)	10,481	3,386	9,344	3,224	350
Market Share	*39%*	*13%*	*35%*	*12%*	*1%*
International Segment					
Pax.Km (billion)	18.983		2.732		14
Market Share	*87%*		*13%*		*0%*

Notes: Source – Statistical Yearbook of DAC (vol. II).

On can see that Varig and Tam have dominant positions in both markets. Varig was the first airline in Brazil, with operations started in 1927; traditionally this airline had a major stake of the international traffic ("flag carrier" status), which clearly conferred her with a higher diversification of routes than the rivals; this means that she is more susceptible to variations in the exchange rates, for example, but also that she is in a position of, for example, awarding travellers with more frequent flier advantages. Also important to emphasize that Varig is a member of Star Alliance, a still select group of international airlines.

In fact, it was only recently that Tam, which is based in São Paulo and was founded in 1976, has occupied a position of dominance in the Brazilian market: this airline managed to increase her domestic market share from 14% (1996), when she was a regional airline, to 35% (2002), consolidating positions specially in very dense and business-related markets.

The other major airlines in operation in Brazil are Vasp and Gol. Vasp was founded in 1933 and was state-owned for most of the period until the early nineties, when the airline was privatised. Gol Airlines was not only the first scheduled LCC of Brazil, but also within all

Latin America, with operations started in January 2001[3]. Owned by Grupo Áurea, a conglomerate that has 38 companies and a major operator of urban and long-distance coach services across Brazil, the airline's innovative positioning in the market produced the most effective threat to the so-called "Big Four" legacy majors, Varig, Vasp, Tam and the defunct Transbrasil, since the establishment of liberalisation in 1992 (see details of the regulatory reform in next section). With a successful path of growth and penetration in the domestic market, after only two years of operations Gol was already Brazil's only profitable airline with operational profit of R$ 38 million (6%).

According to the Department of Civil Aviation (Yearbook, vol. II), the following airlines also operated in the scheduled domestic segment in 2002 (the "others" column of Table 1.3): Abaeté, Meta, Nordeste, Pantanal, Passaredo, Penta, Puma, Rico, Rio-Sul, Taf, Tavaj, Total, and Trip. All these 13 airlines have smaller regional operations within the country. According to Franco et al. (2002), the liberalisation measures adopted since 1992 promoted a significant increase in the demand for air transportation at the regional level. Indeed, from 1992 to 1998, there was a large boost in the number of regional airlines, but most of this growth was associated with subsidiaries of Tam and Varig; actually, there was a wave of acquisions by large national airlines (Rio-Sul by Varig, Nordeste by Rio-Sul, the defunct Brasil Central and Helisul by TAM).

Table 1.4 reports the evolution of yields (revenue per pax.km) for the domestic segment of passenger air travel:

[3] Gol Airlines and U Air (Uruguay) are the only scheduled LCC's based in Latin America nowadays. Some North-American LCC's provide service to Mexico and the Caribbean, such as JetsGo, Frontier and JetBlue, but do not have operational basis at the region (source: website lowcostairlines.org).

Table 1. 4 – Yields Evolution – Scheduled Domestic Segment - Pax

Year	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**
Revenues (Million R$)	5,331	5.455	6.472	7.395	7.949	8.671
Pax.Km (million)	17,824	22,539	22.204	24.284	26.296	26.784
Yield (Pax.Km)	0.299	0.242	0.291	0.305	0.302	0.324

Notes: i. Source – Statistical Yearbook of DAC (vol. II);
ii. values deflated to 2004 by using IBGE's IPCA.

In terms of demand, one has that the price elasticity in the domestic segment is usually acknowledged as being fairly low. According to Franco et al (2002), the Secretariat for Economic Monitoring – SEAE, of the Ministry of Finance, estimated the price-elasticity of demand as being approximately -0,44; also, estimated income-elasticities were found to be around one. These results were to some extent confirmed by a study carried out by the Airlines Association – SNEA, which arrived at the conclusion that 71% of the passengers in Brazil in 1996 was travelling with business-related purpose, while the average in other countries is usually regarded to be around 55%. Also, according to a survey performed by the newspaper Gazeta Mercantil, the three most relevant factors taken into account by businessmen when choosing the airlines were (in this order of relevance): firstly, the existence of direct flights; secondly, the time of departure; thirdly, the number of frequencies; and finally, fares. All these studies are reported by Franco et al. (2002).

With respect to the supply side, firstly, one can have a detailed view of the structure of costs in Table 1.5:

Table 1. 5 – Structure of Costs – 4 Major Airlines (2002)

ITEM	%
Flight Crew Salaries and Expenses	*8%*
Aircraft Fuel and Oil	*23%*
Flight Equipment Insurance	*1%*
Flight Equipment Rental	*13%*
Flight Equipment Depreciation and Amortization	*3%*
Maintenance and Overhaul	*12%*
Total Direct Costs	**60%**
Landing and Associated Airport Charges	*2%*
En route Facilities Charges	*3%*
Station Expenses	*5%*
Passenger Services	*4%*
Ticketing, Sales and Promotion	*18%*
General and Administrative	*7%*
Other Operating Expenses	*2%*
Total Indirect Costs/Expenses	**40%**
Total Operating Costs/Expenses	**100%**

Notes: Source – Statistical Yearbook of DAC (vol. II); ii. airlines: Varig, Vasp, Tam, Gol; iii. reflects ICAO's Costs Structure standards as reported by Betancor and Nombela (2001).

Table 1.5 disaggregates costs into Direct and Indirect Operating Costs/Expenses, by making use of the figures of the 4 major carriers. One can infer from Table 1.5 that the items with higher participation in costs are fuel and oil (23%), sales and promotion (18%), flight equipment rental (13%) and maintenance and overhaul (12%). Overall, total direct costs represent the majority of operating costs (60%).

Table 1.6 presents details on the fleet composition of the scheduled airlines in the market:

Table 1. 6 – Fleet Composition by Airline – Average, 2002

Manufacturer	Aircraft	Seats	Varig	Vasp	Tam	Gol	Others	Total	%
Airbus	**A-319**	120/122			8			*8*	2%
Airbus	**A-320**	108/150			26			*26*	8%
Airbus	**A-330**	211/225			8			*8*	2%
ATR	**AT42**	45/49					15	*15*	4%
Boeing	**B-737-200**	107/143	12	20			2	*34*	10%
Boeing	**B-737-300**	118/132	39	4				*43*	12%
Boeing	**B-737-500**	117	19					*19*	5%
Boeing	**B-737-700**	120/144	8			13		*21*	6%
Boeing	**B-767-200**	174/225	6					*6*	2%
Boeing	**B-767-300**	191/224	6				1	*7*	2%
Cessna	**C-208**	9					13	*13*	4%
Embraer	**E-110**	12/18					11	*11*	3%
Embraer	**E-120**	28/50	8				14	*22*	6%
Embraer	**E-145**	50	15					*15*	4%
Fokker	**F-100**	108			49			*49*	14%
Md-Douglas	**MD-11**	239/285	15					*15*	4%
Others	**Others**		21	8		2	6	*37*	11%
Total	**Total**		**148**	**32**	**91**	**16**	**59**	**346**	

Notes: Source – Statistical Yearbook of DAC (vol. II).

As one can see, the aircraft manufacturer Boeing has the largest share of the market, with around 40% of the number of aircraft in operations, followed by Embraer (14%) and Airbus (12%). It is important to emphasise that the industry is characterised by aircraft with more than 100 seats (more than two-thirds), and not by smaller, regional aircraft; this is probably an indication that there might be economies of route density to be exploited by larger aircraft in the market.

1.2 The Evolution of Regulation in the Brazilian Airline Industry

Until recently, one of the most relevant characteristics of the Brazilian air transport industry was the gradual and continuous process of economic liberalisation that had been initiated in the early nineties by the Department of Civil Aviation, DAC, within a broader governmental program for deregulation of country's economy. Table 1.7 presents the evolution of the regulation structure of the air transport industry, considering six main stages in the last thirty years.

The most representative stage of the regulatory period was from 1973 to 1986, where regulation was performed along with mechanisms of development policy (**1. Regulation with Industrial 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 inflation stabilisation targeting (**2. Regulation with Active Stabilisation Controls**). This policy was remarkable in terms of interfering in the pricing of all infrastructure industries in the country and led to artificially low real fares, which airlines still claim have caused them great losses.

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 (**3. Liberalisation with Inactive Stabilisation Policy Controls**), regionals' monopolies were abolished, with exception to the airport-pairs linking city centres of four major cities – São Paulo (CGH), Rio de Janeiro (SDU), Belo Horizonte (PLU) and Brasília (BSB) –, called "special" airport-pairs, SAP. Furthermore, the policy of "four nationals & five regionals" was abolished, and newcomer's entry was stimulated by the regulator, which has led to a tide of new small airlines into the market.

Also, there were now reference prices and bounds from -50% to +32% of the main value in substitution of price fixing, and competition in prices was seen as "healthy" for the industry, and was encouraged; fare bounds were conceived only as temporary instruments for enhancing price rivalry. This can be regarded as a period of inactive stabilisation policy control, as there was no need for the macroeconomic authorities to interfere in the market, no pressure for price increase, and lower instability in the costs side, as exchange rates were stable during most of the period.

In the late nineties the aviation authorities decided to remove two relevant regulatory devices still remaining: the fare bounds and the exclusivity of rights for operating SAP's by regionals. This generated the Second Round of Liberalisation (enacted in Dec/97-Jan/98), which triggered much strategic interaction by airlines, with intense price and frequency competition.

Another relevant characteristic of the period was the strong instability of exchange rates.

especially the high devaluation of January 1999, which represented a major increase in all airlines' operational costs. As the pressures for price increase throughout the economy were strong, macroeconomic authorities (Ministério da Fazenda, MF) started interfering in the industry again (**4. Liberalisation with Stabilisation Policy Constraint**). This has represented a relevant constraint to the airlines' strategies, as they could not increase prices as desired, but instead had to wait for previous authorisations from both the DAC and the MF. Besides that, antitrust authorities were now closely monitoring the market.

In 2001, most of the remaining economic regulation was removed, as well as the macroeconomic interference. All airlines could then set their prices freely – a "quasi-deregulation" period, as entry, price and frequencies were also almost entirely liberalised (**5. Quasi-Deregulation**).

Finally, in 2003, Brazilian aviation authorities, following directives of the new federal government, started implementing some procedures of re-regulation, aiming at controlling an alleged excess capacity and over-competition in the market (**6. Re-regulation**). New aircraft imports were banned, price competition controls were put in practice once again, and strategic movements increasing market concentration, such as the code-share agreement between the two major airlines, Varig and Tam, were neither disallowed nor discouraged.

Table 1. 7 - Evolution of Regulation in the Brazilian Airline Industry

Stage		**1. Regulation with Industrial Policy**	**2. Regulation with Active Stabilisation Policy Controls**	**3. Liberalisation with Inactive Stabilisation Policy Controls**	**4. Liberalisation with Stabilisation Policy Constraint**	**5. Quasi-Deregulation**	**6. Re-Regulation**
Period		1973-1986	1986-1992	1992-1997	1998-2001	2001-2002	2003-
Economic Policy in the Sector	***Regulation***	Present	Present	Partially Removed: First Round of Liberalisation	Partially Removed: Second Round of Liberalisation	Removed	Partially Restored
	Macroeconomic Interference	Active	Very Active	Possible, but not Active	Active	Absent	Absent
Fares	***Reference Price***	Imposed by DAC	Imposed by DAC	Not imposed by DAC	Not imposed by DAC	Absent	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	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	ex-post in the first year and ex-ante from 2004 on
	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	Unbounded

Table 1.7 (Cont.) - Evolution of Regulation in the Brazilian Airline Industry

Stage		1. Regulation with Industrial Policy	2. Regulation with Active Stabilisation Policy Controls	3. Liberalisation with Inactive Stabilisation Policy Controls	4. Liberalisation with Stabilisation Policy Constraint	5. Quasi-Deregulation	6. Re-Regulation
Period		1973-1986	1986-1992	1992-1997	1998-2001	2001-2002	2003-
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	Allowed, but stimulus to increase in concentration
	Regional Monopolies	Present	Present	Absent, with the exception of SAP routes	Absent	Absent	Absent
Competition	***Authority's attitude***	Avoid	Avoid	Stimulate	Stimulate but with antitrust controls	Stimulate but with antitrust controls	Avoid overcompetition and excess capacity and antitrust controls
	Among Nationals and Regionals	Absent	Absent	Allowed, with the exception of SAP routes	Allowed	No Distinction	No Distinction
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	Ex-ante authorisation; economic controls restored
	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.	State-owned enterprise: Infraero: codeshare TAM-VRG claimed to inhibit equal access to facilities.

1.3 An Overview of this Study

The main target of the present thesis is to permit some understanding of the competition among airlines in recently liberalised markets, by means of empirical modelling. Here I make use of two major events in the sector, in order to pinpoint the behaviour of carriers in the domestic segment of air transportation in Brazil: the process of economic liberalisation of the late nineties, and the entry of the low cost carrier (LCC) Gol Airlines. Three essays were therefore developed by considering those events, and are presented in, respectively, Chapter 2, 3 and 4.

Chapter 2 provides a study of the entry of Gol Airlines in several Brazilian domestic routes, in 2001 and 2002, in order to draw inference on the competition between a LCC in rapid expansion and the full-service carriers (FSC) – an issue that has recently become one of the most relevant of the airline industry.

A route-choice model is estimated by making use of a flexible post-entry equilibrium profits equation and accounting for endogeneity of the main variables. Results indicated the relevance of market size and rival's route presence as underlying determinants of profitability. Furthermore, the consistency of Gol's decision making with the pattern of entry classically established by Southwest Airlines for the LCC segment – short-haul and high-density markets – is investigated.

Evidence is found that although Gol initiated operations by reproducing standards of Southwest, she quickly diversified her portfolio of routes and became more in accordance with JetBlue Airways's entry pattern, focusing mainly on longer-haul markets, although with some relevant country-specific idiosyncrasies.

As Gol entered the markets within the country, the legacy FSC's started responding with cuts in prices. **Chapter 3** aims at empirically investigating the pricing behaviour of the incumbents and the response to the entry of LCC Gol Airlines in the Brazilian domestic market. A study of localised competitive advantage regarding the determinants of pricing power is performed along with the analysis of the pattern of price reactions by the legacy carriers. A single econometric framework is designed and estimated with panel data controlling for city-specific effects.

Results indicate that market structure at both the route and airport levels are relevant at explaining pricing behaviour; and that the degree of the newcomer's product differentiation is a relevant feature in determining the intensity of reactions. By comparing these results with the findings of Evans and Kessides (1993), which rejected market share effects at the route level, it was possible to arrive at the conclusion that here the analysis better suits airline markets at a very recent and/or immature stage of economic liberalisation, as is the case of Brazil.

Finally, **Chapter 4** aims at assessing the impacts of economic liberalisation on the route Rio de Janeiro – São Paulo. The measures of liberalisation had relevant impacts on competition on this route, the country's densest flow linking its most known cities; actually this started years before Gol's entry, at the beginning of the Second Round of Liberalisation.

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 "special airport-pairs" (SAP's). 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 where 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.

By making use of both a two-stages budgeting representation of the demand system, and a competition model with product heterogeneity among rivals, and based on the framework of the New Empirical Industrial Organisation, it was possible to infer whether a structural change on airlines' conduct parameters due to liberalisation was observed. This exercise ultimately served as a test of the efficacy of the policy employed by the regulators since 1998. The main conclusions were that regulatory reform effectively stimulated firms to significantly increase the degree of competition in the market, and that marginal-cost or even below-marginal-cost pricing was not rejected for some airlines.

1.4 Literature Review

This thesis contains research associated with three major areas of the *air transport economics literature*, namely, entry, pricing, and market power in airline markets. Below is a brief review of this related literature, which constitute the basis for Chapters 2, 3 and 4.

1.4.1 Entry and Price Reactions to Entry in Airline Markets

Some of the most relevant studies on airline entry behaviour are Morrison and Winston (1990) and (1995), Sinclair (1995), Berry (1992) and Bogulaski, Ito and Lee (2004). Berry (1992) considers an empirical methodology that makes use of the route entry decisions of airlines as indicators of underlying profitability, and implements a discrete game model of firm entry which is in line with Bresnahan and Reiss (1987) and (1991). He develops an equilibrium entry model in which "*at the beginning of the period, each firm takes its overall network structure as given and decides whether to operate in a given city pair*" (Berry, 1992). The assumed model is therefore a two-stage game in which entry is followed by competition between the newcomer and the incumbents; also, instead of assuming a particular model of competition in the second stage, the author considers a general profit equation as an approximation to the actual game.

By making use of a simulation estimator, Berry (1992) was in a position of considering firm-specific characteristics along with the traditional market-level variables such as market size and the number of firms. By considering data for the US market in 1980, his results were overall consistent with the wisdom that airport presence is relevant in determining airline profitability.

In a recent study, Bogulaski, Ito and Lee (2004) make use of probit estimation to investigate the patterns of city-pair entry of the pioneer low cost carrier Southwest Airlines by making use of data from 1990-2000. Results indicated that "*roughly 10% of the large network carriers' revenues will be exposed to new Southwest non-stop competition within the next five years, roughly the same proportion that became exposed throughout the entire 1990s*". Also, evidence was found that the entry strategies of the carrier have changed signicantly throughout the last decade, by considering "*a number of relatively thin, long-haul markets* *that it had previously avoided*". They also identified those markets that are the most likely for future non-stop entry and suggested which network carriers are most vulnerable to future Southwest expansion.

With respect to airline pricing behaviour, Evans and Kessides (1993) report several studies investigating post-US liberalisation conditions, which can be classified into two different sets:

i. **Inter-routes analysis**, in which data is disaggregated at the route level, and usually a cross-section of routes is considered; market-level variables such as flight distance, number of airlines, concentration, route presence of LCC's, presence of LCC on adjacent routes, etc. are used in order to estimate an average price equation. Examples in the literature being Bailey and Panzar (1981) and Hurdel et al. (1989), Dresner, Lin and Windle (1996) and Morrison (2001), among others.

ii. **Intra-routes analysis**, in which data is disaggregated at the airline level; carrier-specific characteristics such as route market share, airport market share and network size out of an airport, percentage of seats in direct or round-trip flights, etc., are used to control for effects of heterogeneity among firms in the market. Examples being Borenstein (1989), Berry (1990) and Evans and Kessides (1993).

Commonly, studies in both phases targeted testing the contestability theory and arrived at the conclusion that local market structure matters in the airline industry, and then variables like concentration levels have significant effect on prices - for example, fewer effective players facilitates collusion, increases incumbents' ability to create additional entry barriers or make them more effective, etc. What is more, second-generation studies provided evidence for the significance of market share measures as determinants of within-route competitive advantage, and therefore called attention to the consequences of dominance: "*consumers are willing to pay a premium for the services of the dominant airline* [at an airport]" (Berry, 1990). In fact, the studies usually found relevance for both sorts of measures, market share and concentration, and thus conciliating different IO traditions[4].

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[4] Slade (2004b) provides a detailed discussion of the "market share" and "market structure" models within the

In contrast to the consensus of the relevance of considering firm-specific disaggregation in pricing analysis, debate was established on at which level structure affects performance in this industry: either if at the route or at the airport level. Evans and Kessides (1993), for example, argue that, due to linear route system replacement by hub-and-spoke strategies, the increasing control of airport facilities by fewer airlines, the advent of frequent-flyer programmes and the usage of travel agent commission overrides, "*the bulk of any deviation from competitiveness in the airline industry is (now) associated with airport characteristics rather than with the structure of routes*"[5]. By making use of route-specific fixed-effects, they found only airport market share effects as statistically significant for the US domestic market, contrary to the results of Borenstein (1989).

Airport and route dominance, defined as presence in the market, usually in terms of market share either of passengers or of seats available, can be described in the following way: first, in terms of airport dominance, one has the incumbent's bureaucratic control over airport operations (slots, facilities, etc), as they usually represent the major source of financing for many airports in the US; this may permit them to efficiently block the entry or expansion by rivals. Berry (1990) also mentions that airlines with a large presence in a given city also have advantages from frequent flyer plans and non-linear travel agent commission schedules. All these features are likely to facilitate collusion between incumbents, and market-sharing agreements and alliances are commonly observed.

And second, with respect to route dominance, one can consider competitive advantage of large route presence stemming from lower distance between flights (lower "schedule delay", which appeals to business travellers) and therefore can be considered a proxy for higher service quality levels. The dominance effect can be regarded as one of the main reasons for Southwest's avoidance of head-on competition with incumbents in the United States.

More recently, there have been some few studies on the specific subject of **pricing behaviour in response to LCC entry**: firstly, Dresner, Lin and Windle (1996), which found significant spillover impacts of LCC entry onto other competitive routes, as on other routes at the same

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Industrial Organisation.

[5] Levine (1987) is one of the most influential papers on this issue.

airport and on routes at airports in close proximity to where entry occurred: this analysis was performed by inspecting, among others, the entry of Southwest Airlines into the Baltimore-Washington International Airport, in 1993.

Secondly, Windle and Dresner (1999) investigated the impacts of entry by ValuJet into Delta Airline's hub, Atlanta, and refuted the US DOT's claim that the latter increased fares on non-competitive routes to compensate for lost revenues on the competitive routes. And finally, Morrison (2001) examined the total extent of Southwest's influence on competition, by investigating its impacts with actual, adjacent and potential route presence, on other carriers' fares in 1998, obtaining a result of 20 per cent of US airline industry's domestic schedule passenger revenue for that year.

1.4.2 Airline Conduct

Brander and Zhang (1990) make use of the New Empirical Industrial Organisation, NEIO, approach to estimate conduct parameters for a set of duopoly airline routes in the US. By assuming product homogeneity and by making use of an approximation to the route level marginal costs, they estimate the mean conduct parameter for American Airlines and US Airlines in order to infer about whether Bertrand, Cournot, or cartel models are supported by the data. Conduct parameters are estimated and results provide evidence that data is much more consistent with the Cournot model. This seems to be a reasonable outcome for their model of competition in quantities with product homogeneity between firms; this setting is likely not to be a proper representation of competition, however, for airline markets characterised by product differentiation, as with the rivalry between full-service and low cost carriers.

A dynamic analysis is found in Brander and Zhang (1993). By focusing on competition between United Airlines and American Airlines as in their paper of 1990, they were in a position of estimating quarterly conduct parameters and test constant behaviour Bertrand, Cournot, cartel, and two regime-switching models in line with Green-Porter (1984). The constant behaviour models are all rejected and evidence is provided that the regime-switching models describe the data, with a Cournot-based version having the best results.

Berry, Carnall and Spiller (1996) estimate a model of airline competition for the US market, by assuming (non-spatial or "Chamberlinian") product differentiation and economies of density; they also make use of a nested logit framework and a flexible specification of marginal costs. Consistent with Borenstein (1989), they reach the conclusion that "*a hubbing airline's ability to raise prices is focused on tickets that appeal to price-inelastic business travelers, who favor the origin-hub airline, even while paying an average premium of 20%. These high prices do not, however, provide a 'monopoly umbrella' to other non-hub airlines*". They also find evidence of economies of density on longer routes, but not on shorter routes of the US market.

Röller and Sickles (2000) develop a two-stage model for airline competition in two variables, namely, capacity and prices: In the first stage firms make capacity decisions followed by a product-differentiated, price-setting game in the second stage. They estimate the structural model of demand, costs, and conduct for the European airline industry by making use of data for the period 1976–90. By performing some specification tests, they find evidence in favour of a "fat-cat" strategy: "*European airlines over-invest in capacities [airplanes, for example] in order to be less aggressive*". Final results illustrated that firms' market power in the product market is significantly overestimated whenever capacity competition is not accounted for.

And finally, Fischer and Kamerschen (2003) make use of a reduced form model to identify price-cost margins in selected airport-pair markets originating from Atlanta, US. With the assumptions of product homogeneity, simultaneous moves, conjectural variations, and competition in quantities (as Brander and Zhang, 1990), the authors find that conduct revealed by data is consistent with the Cournot behaviour; they also provide estimates for the Lerner index and final results indicated that incumbent airlines exerted a considerable degree of market power in all airport-pairs considered.

2. Estimation of a Model of Low Cost Carrier Entry

2.1 Introduction

Competition between rapidly expanding low-cost carriers (LCC) and traditional network full-service carriers (FSC) has recently become one of the most significant issues regarding the airline industry. Although basically a phenomenon of fully or partially liberalised markets – and thus dating back to the US deregulation process of the 1970s –, it was only recently, however, that the LCC segment won recognition as a relevant and distinct business strategy as well as a profitable market niche. Following the successful paradigm of the pioneer Southwest Airlines, in the United States, airlines such as Ryanair and EasyJet, in Europe, flourished in the market, and soon the concept has spread worldwide. Moreover, this segment is expected to expand considerably within the next few years, and this has undoubtedly been forcing legacy carriers to respond progressively – a movement that is shaping the frontiers of competition in the industry.

The present paper addresses this matter by examining the entry of the low-cost carrier Gol Airlines, in the Brazilian domestic market, in 2001. By making use of this case study, one is able to make inferences on the strategy of a successful and fast-growing newcomer LCC in an airline industry with recent liberalisation. The ultimate objective here is therefore to inspect the route choice decisions in order to pinpoint entry patterns which could be associated with notable benchmarks of the LCC niche.

Gol Airlines was not only the first scheduled LCC of Brazil, but also within all Latin America, and represented the most effective threat to the so-called "Big Four" legacy majors, Varig, Vasp, Tam and Transbrasil, since the establishment of liberalisation in 1992. By offering basic air transport service, without frills and lower prices, and above all with lower costs and careful choice of routes, Gol started a successful path of growth and penetration in the domestic market: the consequence was that, after only two years of operations, the carrier was already Brazil's only profitable airline, and with a thirteen percent stake in the market.

The literature on LCC is rather scarce and the few existing studies are usually related with the investigation of the FSC's pricing behaviour in response to entry: firstly, Dresner, Lin and Windle (1996), which examined and found significant spillover impacts of LCC entry onto other competitive routes, as on other routes at the same airport and on routes at airports in close proximity to where entry occurred; this analysis was performed by inspecting, among others, the entry of Southwest Airlines into Baltimore-Washington International Airport, in 1993. Secondly, Windle and Dresner (1999) investigated the impacts of entry by ValuJet into Delta Airline's hub, Atlanta, and refuted the US DOT's claim that the latter increased fares on non-competitive routes to compensate for lost revenues on competitive routes. And finally, Morrison (2001) assessed the total extent of Southwest Airlines's influence on competition, by investigating its impacts with actual, adjacent and potential route presence, on other carriers' fares in 1998, obtaining a result of 20 per cent of US airline industry's domestic schedule passenger revenue for that year.

In contrast, Ito and Lee (2003b) and Bogulaski, Ito and Lee (2003) are more focused on route entry decisions and entry patterns by LCC's. Whereas the former is aimed at studying the implications for further growth of the LCC's in the US market, by considering their propensity to enter high-density routes, the objective of the latter is to determine and quantify "*the market characteristics which have influenced Southwest's entry decisions*". Main conclusions are that LCC is no longer a niche segment restricted to particular geographic markets or leisure travellers and that the legacy airlines' degree of exposure to LCC competition is very likely to increase from "*roughly 30% today to just under 50% in the future*"; also that markets with high traffic density are becoming increasingly contestable, with relevant implications to market structure and competition. Other remarkable examples of empirical airline literature on entry are Berry (1992), Whinston and Collins (1992) and Joskow, Werden and Johnson (1994).

In order to study Gol Airline's entry decisions in the Brazilian market, an empirical model of route choice was designed in the same fashion of Bogulaski, Ito and Lee (2003). By considering a fairly flexible post-entry equilibrium profits equation, the model is estimated by making use of Newey (1987)'s methodology, and therefore Amemiya's Generalised Least Squares (AGLS) was employed; this approach is able to result in consistent and asymptotically efficient estimation of the parameters of a limited-dependent variable, such as the newcomer's entry decisions, for the case of the presence of some endogenous regressors.

Final results indicated the relevance of market size and rival's route presence as underlying determinants of profitability. Unobservables at the airport/city levels, such as sunk costs and economies of scope, are also found to be significant. Furthermore, the consistency of Gol's decision making with the pattern of entry classically established by Southwest Airlines for the LCC segment – short-haul and high-density markets – is investigated; evidence is found that although Gol initiated operations by reproducing standards of Southwest, she quickly diversified her portfolio of routes and became more in accordance with JetBlue Airways's entry pattern, focusing mainly on longer-haul markets, although with some relevant country-specific idiosyncrasies.

This paper has the following structure: Section 2.2 portrays the background of the entry of Gol Airlines in the Brazilian airline industry, with a description of the main paradigms related to LCC entry patterns along with some facts about the deregulation process in Brazil and the newcomer. Section 2.3 presents the empirical model and the econometric issues. Section 2.4 reports the results and includes an analysis of Gol's entry patterns consistency, which is followed by final conclusions.

2.2 Background: LCC Niche and Entry of Gol Airlines in Brazil

2.2.1 The LCC Market Niche and its Paradigms

The entry of low-cost carriers (LCC) providing basic air transport service with no frills and lower fares in a regular basis, has considerably transformed competition in the airline industry. Notwithstanding a phenomenon of partially or fully liberalised airline markets and thus dating back to the US deregulation process of the seventies, it was only recently, however, that this "*low-cost revolution*" (Doganis, 2001) has resulted in the formation of a well recognised and distinct business strategy and a sustainable market niche.

The LCC niche is usually associated with the *Southwest Airlines Paradigm* (hereafter **SWP**), mainly because that airline pioneered this sort of operations with standards that are deliberately reproduced around the world[6]. The most widely known characteristics of this paradigm are (Silva and Espírito Santo Jr., 2003): fleet standardisation; simplification or elimination of in-flight service; use of less congestioned secondary airports; direct sales to consumers; ticketless or electronic tickets; dense, short-haul, point-to-point flights with no interlining or transfers, which means a simple network structure, with absent or weak feed to long-range flights; single-class cabin lay-out; simple or no frequent-flyer programme; high level of fleet utilisation; and highly motivated employees[7]. Moreover, LCC's are typically associated with a very aggressive pricing strategy, typically with the use of simplified fare structure with few or no restrictions, and low one-way fares[8].

The cost advantage permitted by the SWP is not merely an issue of paying lower salaries or operating at cheaper airports, and, contrary to common sense, not even due only to the lack of frills; instead it is rather a function of fundamental differences in the business model associated with it, emerging mainly from a very careful choice of markets, targeting at dense, short-haul routes in order to exploit economies due to higher seating density and higher aircraft utilisation, especially with non-stop service. According Boguslaski, Ito and Lee (2003), Southwest has resulted in unit costs that are 28 to 51 per cent lower than the US major airlines, considering 2001 US DOT unit cost figures.

Since the early nineties, and in particular very recently, a plethora of *de novo*, LCC entry, has been observed around the world. Inspired by the more than three decades of success of Southwest Airlines, and stimulated by liberalisation measures of their own markets, airlines such as Ryanair and EasyJet in Europe, Air Asia and Virgin Blue in the South Pacific, 1Time and Kulula in Africa, and Gol and U Air in South America, flourished in the market, meaning

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6 As the Chief Executive of Ryanair (UK) once said: "*We went to look at Southwest. It was like the road to Damascus. This was the way to make Ryanair work*" (Doganis, 2001).

7 This description refers to what can be considered "classic" Southwest paradigm. One has to bear in mind, as we will see below, that Southwest's actual patterns of operations has had some changes recently: "its strategy evolved during the latter half of the decade to include a much more heterogeneous mix of markets, including a number of markets which were both long-haul and surprisingly thin" (Boguslaski, Ito and Lee, 2003).

8 Tretheway (2004) points out that the introduction of low one way fares ultimately served to undermine the ability of the FSC's to price discriminate, and not only resulted in a considerable increase in competition but also in an exposure of the problems associated with the FSC business model.

that the concept has rapidly achieved global recognition[9].

In parallel to the worldwide spread of the low-cost operations based on the SWP, alternative standards for the segment have been successfully implemented in the United States: firstly, the *AirTran-Frontier Paradigm* (**AFP**), with a clear focus on the low-fare business market by making use of multi-service operations, usually with mini-hubs to provide convenient connections and more possibilities in terms of origin-and-destination markets, and with a more complex fare structure and even business class[10]; secondly, the *JetBlue Airways Paradigm* (**JBP**), which is associated with the focus on long-haul routes (usually more than 1,500 kilometres), resulting in the highest average stage length of the LCC segments[11].

And finally, one has the Ryanair Paradigm (**RYP**). Ryanair, the most successful LCC in the world in terms of profitability, is extremely focused in selecting only destinations with underutilized secondary and tertiary airports. Contrary to all other major LCC's like EasyJet or even Southwest Airlines, Ryanair has always resisted entering either primary or congested airports; this permitted her to always be in a position to negotiate airport fees (cost control) and to focus almost completely on the leisure travellers segment, which makes this paradigm completely distinct from, for example, the AFP.

It is important to emphasise two caveats on the above-mentioned paradigms, however. First of all, whilst newer standards of operation have clearly emerged in the segment, the essence of the SWP remains dominant for most of LCC's, namely the absence or weak presence of frills and the lower costs, typically resulting in low prices; from this point of view, the SWP is still the major benchmark for LCC's. In addition to that, it is clear that, due to the ever-changing state of the competition in deregulated airline markets, it is rather unlikely to observe the three

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[9] According to the website lowcostairlines.org, there were ninety low cost carriers all over the world in March 2004 (56 in Europe, 14 in the USA, 6 in Canada, 9 in Asia and South Pacific, 2 in Africa and 3 in South America).

[10] AirTran Airways operates in the eastern United States with Atlanta as its hub, being the second-largest carrier at Hartsfield International Airport, and providing service to 45 cities within the country. Frontier Airlines operates routes linking its Denver hub to 38 cities in 22 states and Mexico.

[11] With operations started in 2000, JetBlue Airways soon was marked by her overnight, "red-eye", flights, usually in non-stop transcontinental routes in the US. The airline serves point-to-point routes between 22 destinations in 11 states and Puerto Rico. It is important to emphasise that both JBP and AFP are usually considered in a different category from Southwest when it comes to passenger amenities and in-flight entertainment (IFE).

above-mentioned paradigms in a very strict basis, but rather as a **mixture** of them. Indeed, the volatile frontier of competition along with the need of market expansion have forced LCC's to also enter atypical markets, with relevant examples being the recent entry of Southwest in the coast-to-coast markets of the United States (US Department of Transportation, 2001 and 2002). This trend has resulted in LCC's serving a variety of short/medium/long haul, business/tourism, direct/indirect routes, which has ultimately increased the exposure not only to FSC competition but also among LCC's.

Nevertheless, despite those caveats, my argument here is that the idea of paradigms is still useful for a better identification of actual LCC behaviour, especially because the industry all over the world is observing a wave of small entrants, most of them claiming to be LCC's. Actually it is not always straightforward to identify if a given airline is really operating as a LCC and this causes much confusion among industry analysts. Therefore, in order to better analyse and pinpoint patterns of entry behaviour by entrants that are trully consistent with LCC operations, some form of representation, such as the paradigms, is needed.

For example, one can study a newcomer's marginal propensity to enter a market with respect to flight haul in order to make inferences on her conformity with either SWP or JBP. The analysis of preference with respect to flight haul, in this specific case, is crucial to distinguish between both paradigms; in addition, a thorough investigation of the commercial and operational practices of the newcomer (with respect to strategic choices regarding frills, network, airports, labour, advertising, etc), can be very effective in permitting its correct classification.

Figure 2.1 presents a diagram with this sort of analysis:

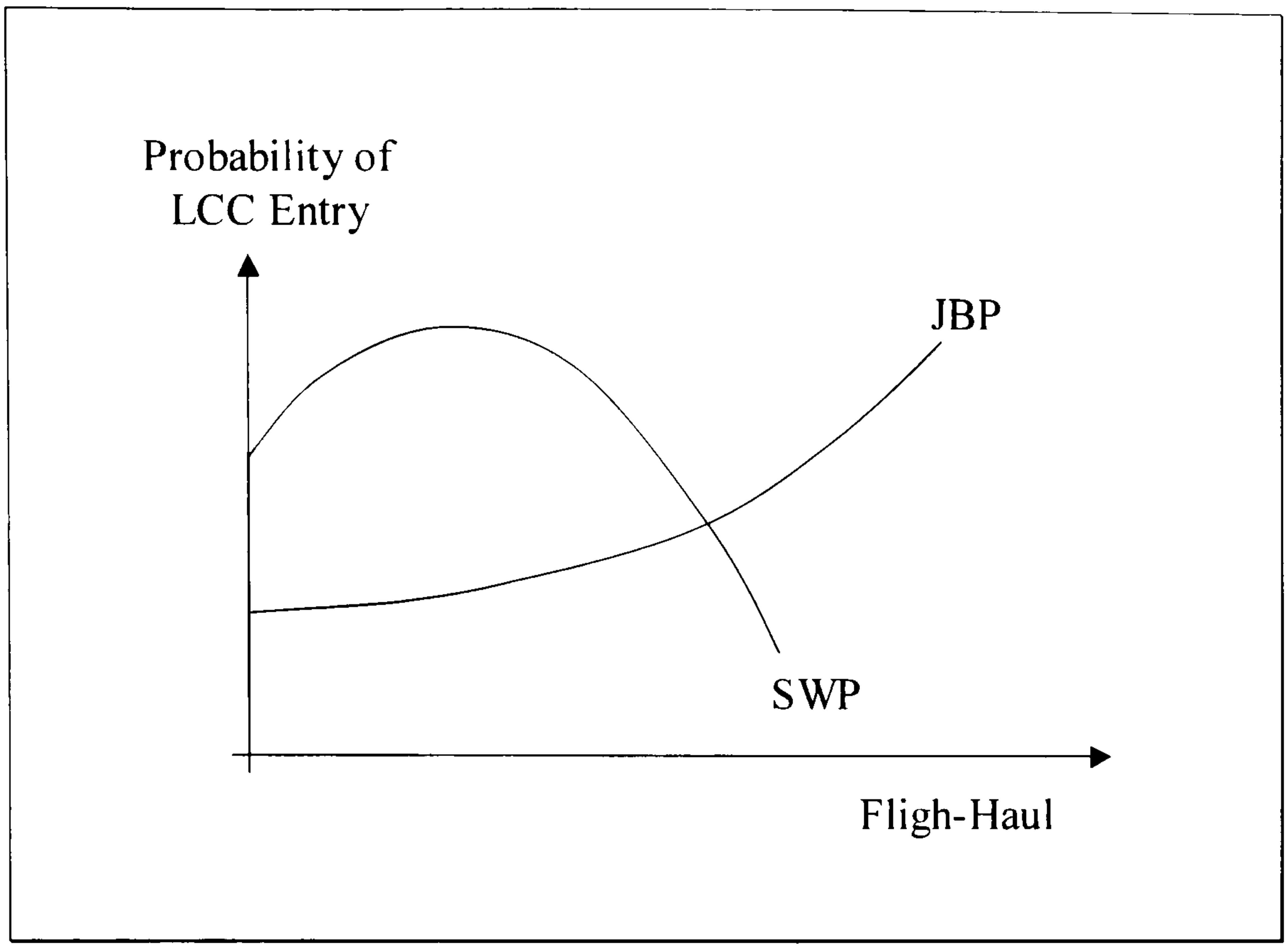

Figure 2. 1 - SWP versus JBP: Effects of Flight-Haul on LCC Entry Probability

As Figure 2.1 permits observing, the probability to enter of a SWP-like LCC is increasing in flight haul but with diminishing returns, in such a way that the highest probability is associated with relatively shorter-haul markets. On the other hand, a JBP-like LCC has typically an ever-increasing entry probability with respect to flight distance, with highest levels associated with long-haul domestic flights.

As one can see, by performing a simple inspection of the marginal effects of distance on the probability to enter a market by an alleged LCC's, it is possible to have a straightforward analysis of consistency with either SWP or JBP. Similarly, it would be possible to make inferences on the conformity of a given carrier with AFP by inspecting, for example, her degree of hubbing and propensity to enter business-related cities[12].

Next sections were designed to permit an examination of entry patterns of the Brazilian LCC Gol Airlines, and some inferences on her consistency with the above-mentioned paradigms. Before that, however, a brief report on the liberalisation measures undertaken in Brazil along with a description of country's solitary scheduled LCC are presented in 2.2.2.

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[12] In this case, however, an analysis of carrier's overall service attributes is probably more useful to infer the conformity with AFP than a focus on route entry decisions. None of them are accomplished in this paper,

2.2.2 Liberalisation and LCC Entry in Brazil

The removal of regulatory barriers in the Brazilian airline industry since the early nineties had a crucial role in the process that ultimately led to Gol Airline's entry and to an unprecedented increase in competition. Started at the beginning of the nineties within a broader governmental program for deregulation of country's economy, the measures of liberalisation were then performed gradually, in three main rounds, by the Department of Civil Aviation, DAC. See Section 1.2 for an overview of process of liberalisation in Brazil.

Gol Airlines was not only the first scheduled LCC of Brazil, but also within all Latin America, with operations started in January 2001[13]. Owned by Grupo Áurea, a conglomerate that owns 38 companies and a major operator of urban and long-distance coach services across Brazil, the airline was in a position of enhancing airport accessibility by setting counters at key airports for air/coach connections and transfers between multiple airports in the same city.

By offering a very simple fare structure, with prices that at the beginning were up to 45% below those of FSC competitors – which gradually became 25% as fares were matched – Gol started a successful path of growth and penetration in the domestic market. After only two years of operations, Gol was already Brazil's only profitable airline with operational profit of R$ 38 million (6%). Table 2.1 presents some characteristics of Gol, compared with the major legacy airlines within the country in 2002; Gol's figures of 2001 are also presented to permit having an idea of the airline's rapid growth. One can see that Gol's unit costs and yields were roughly a third lower than her opponents' and average stage length was approximately twenty percent lower; also, it is possible to visualise the pace of expansion of the LCC, which, from the start-up year, 2001, to 2002, increased air passenger traffic (number of passengers times kilometres flown) by 148% and passenger market share (number of passengers) by 78%:

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however.

[13] Gol Airlines and U Air (Uruguay) are the only scheduled LCC's based in Latin America nowadays. Some North-American LCC's provide service to Mexico and the Caribbean, such as JetsGo, Frontier and JetBlue, but do not have operational basis at the region (source: website lowcostairlines.org).

Table 2. 1 – Comparison of Gol and Incumbent FSC's (2002)[14]

Figures	*Unit of Measurement*	*FSC*			*LCC*		
		TAM 2002	*VRG 2002*	*VSP 2002*	*GOL 2002*	*GOL 2001*	*Growth 2001-02*
Air Passenger Traffic	*pax * km (million)*	9,323	7,158	3,384	3,136	1,265	*148%*
Traffic per Employee	*pax * km (thousand)*	1,224	611	698	1,514	1,081	*40%*
Market Share Pax	*fraction*	0.36	0.20	0.11	0.13	0.07	*78%*
Load Factor	*fraction*	0.53	0.61	0.55	0.63	0.62	*2%*
Unit cost	*seats * km (R$)*	0.174	0.182	0.169	0.126	0.108	*16%*
Yield	*pax * km (R$)*	0.290	0.294	0.266	0.210	0.184	*14%*
Operational Profit/Loss	*fraction*	-0.12	-0.02	-0.16	0.06	0.02	*153%*
Average Stage Length	*km (pax)*	868	1,179	1,016	792	772	*3%*

Notes: i. R$ means Brazilian currency (Real, current values);
ii. pax means number of passengers travelled.

Some additional characteristics of the newcomer are: absence of complete food service (only snacks and cereal bars); standardised fleet (Boeing 737-700s and 800s, the largest operator of Next-Generation 737 aircraft in Latin America); availability of full e-ticketing service and heavy distribution via internet (65% of sales, according to Silva and Espírito Santo Jr., 2003); reservation system software acquired from JetBlue ("Open Skies"); around half of the original staff coming from outside the industry and half recruited from other airlines – especially flight crew and technical staff –, although not more than 15% from any particular carrier[15].

In March 2003, the prominent tale of triumph and incessant growth permitted Gol to successfully trade 20% of her equity shares to the US insurance company American International Group, AIG. The twenty-six million transaction aimed at enhancing the airline's perspectives of further expansion, especially with respect to the acquisition of extra leased

[14] Source: DAC's Statistical Yearbook, vols. I and II.

[15] According to Lima (2002), hiring personnel from other carriers was made easier due to the downsizing process taken place at Vasp and specially at the bankrupt Transbrasil (Lima, 2002). According to Silva and Espírito Santo Jr. (2003), Gol had the following internal slogan: "*the youngest and most experienced airline in Brazil*".

aircraft. Early plans of additional growth were not put in practice, however, due to the recent policy of Brazilian aviation authorities (DAC) which, as discussed before, started to deny access to imports of new aircraft, on account of an alleged overcapacity in the market (see 1.2).

At the beginning, Gol's marketing efforts were clearly orientated to become "the people's airline", concentrating more on potential travellers with lower income than on current travelling-public (Zalamea, 2001, mentions "*small business officials, blue collar workers, students, farmers and others who have never flown before*" as targeted segments of consumers). For example, Tarcisio Gargioni, Gol's Vice President for Marketing and Services, once revealed: "*Our business plan identified that in 2000, out of the 170 million Brazilian population only 6 million flew commercial aviation. Out of the remaining 164 million, some 25 million could also become potential fliers provided fares were reduced 30%*" (Lima, 2002).

Nevertheless, demand stimulation from non-travelling-lower-income consumers was eventually not enough to guarantee the expansion of the airline and in fact Gol's rapid growth was achieved primarily at the expense of the legacy carriers, being particularly enhanced by Transbrasil Airlines's exit in 2001: "*We did a market survey in September [2001] and found only 4% of our passengers had never flown before*" (Gargioni, as in Lima, 2002). Undoubtedly, Brazil's economic instability, lower *per capita* income and high wealth concentration can be regarded as the major sources of Gol's lack of success in attracting non-travelling public. Also, the country's high interest rates are usually associated with higher risk of enterprise, which probably forced Gol not to venture providing service to new domestic destinations where new demand could be created, but to focus only on already existing routes. Another relevant restriction is the lack of infrastructure for typical LCC operations in other cities than the major conurbations in Brazil (suitable secondary airports, for example).

This does not mean, however, that Gol's entry was totally ineffective in stimulating new demand on existing routes; on the contrary, if one considers the top-500 densest routes in Brazil, and by comparing traffic density of 2002 with 2000 (previous to entry), it is possible to arrive at the conclusion that routes entered by Gol observed a 13.1% average increase in traffic density (pax), against a 7.0% increase on all 500 routes; actually, non-entered routes had a 11.5 decrease in traffic density within the same period[16].

A major issue is whether the above-mentioned difficulties in new demand generation have ultimately forced the airline to substantially alter her initial route entry strategy in order not to affect expansion. Indeed, this may be particularly true with respect to the effect on route choice of flight haul – as seen before, a crucial variable with respect to analysis of conformity with LCC paradigms. For example, it was observed that, since 2002, medium-to-long haul routes were increasingly added to Gol's network, as one can visualise from the maps of Figure 2.2:

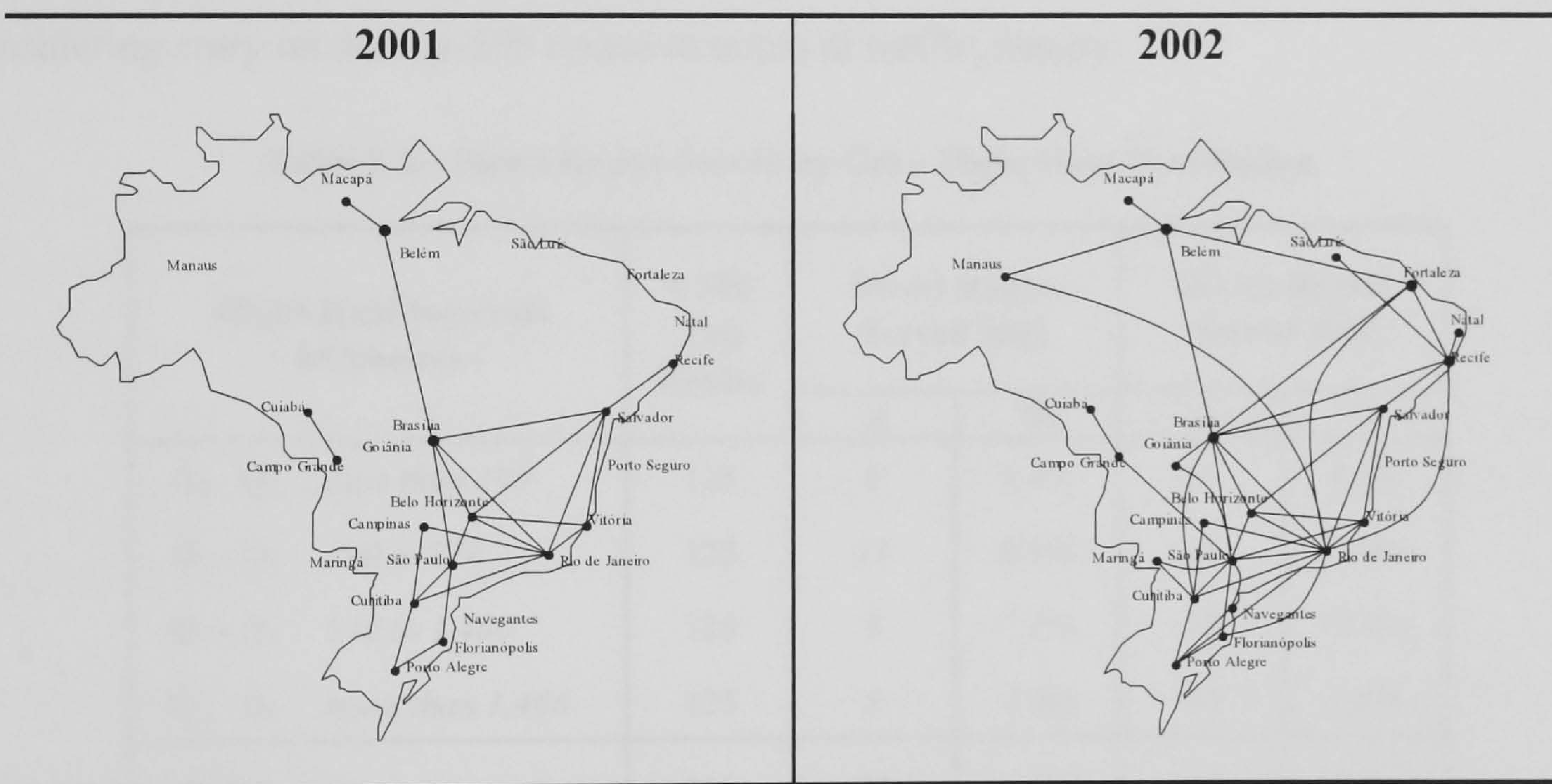

Figure 2. 2 – Evolution of Gol's Network within Brazil (Source: DAC's HOTRAN reports)

Actually, at the beginning of 2001, Gol was restrict to six 737-700s, providing service between São Paulo, Rio de Janeiro, Belo Horizonte, Florianópolis, Brasília, Porto Alegre and Salvador, and thus with the maximum haul below 1,500 kilometres. This straightforward link with SWP is not surprising since Gol positioned herself as an admitted follower of Southwest during the start-up of operations (Guimarães, 2002). This recipe permitted the newcomer to rapidly achieve higher-than-average levels of efficiency, with aircraft having 10 to 12 flights a day and very fast ground turn-around times, between fifteen and thirty minutes. In fact, by December 2001 there was only one city-pair in the entire network which could be classified as

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16 Own calculations based on figures of DAC's Statistical Yearbook (volume I). Results are consistent with findings of Dresner, Lin and Windle (1996), for the US market.

direct long-haul route: Brasília-Belém, with 1,610 km.

By the end of 2002, on the other hand, situation was clearly very different: the LCC had already 22 aircraft in operation, serving a much wider network with many routes with higher-than-average distance and certainly an additional target of feeding long-range flights[17]. For example, routes like Rio de Janeiro – Manaus (2,860 km), Rio de Janeiro – Recife (1,863 km) and Brasília – Fortaleza (1,690 km) were added to the network structure, indicating a higher propensity to enter long-haul direct routes and rapidly increasing the possibilities of traffic between extreme regions like the South and the North/Northeast.

Table 2.2 gives some details on the route profile of the airline with respect to flight haul, by considering entry on the top-500 routes in terms of traffic density:

Table 2. 2 - Direct Routes Served by Gol – Flight Haul Distribution

Flight-Haul Intervals - kilometres -		# 500 Top Routes	Direct Routes Served 2001		Direct Routes Served 2002	
			#	%	#	%
Q_0 - Q_1	*Less than 390*	125	*8*	*6.4%*	*11*	*8.8%*
Q_1 - Q_2	*390 to 716*	125	*11*	*8.8%*	*15*	*12.0%*
Q_2 - Q_3	*716 to 1,466*	125	*9*	*7.2%*	*18*	*14.4%*
Q_3 - Q_4	*more than 1,466*	125	*5*	*4.0%*	*10*	*8.0%*
Total		**500**	**33**	**6.6%**	**54**	**10.8%**

Notes: i. Q_1, Q_2, Q_3 and Q_4 mean the quartiles considering a sample with the 500 densest routes; ii. # means number of routes and % means percentage out of the top routes

As one can observe in Table 2.2, Gol increased by 21 the number of direct routes served from 2001 to 2002 (54-33). Out of these 21 new routes, two-thirds (14) were formed by medium-to-long-haul routes (that is, with flight haul above the median, 716 kilometres). Indeed, Gol doubled her presence on longer-haul routes in 2002 (28 routes above the median, against 14 in 2001); these effectively changed the participation of these sort of routes from a minority

[17] This started specially after the regulators authorised Gol's entry at Santos Dumont Airport (Rio de Janeiro), by the end of 2001, after the carrier had difficulties to expand operations at São Paulo's Congonhas Airport.

position in 2001 (14 out of 33) to a majority stake in 2002 (28 out of 54).

All these facts raise questions over the actual standard of operations undertaken by Gol in the Brazilian airline industry, specially with respect to which paradigm she might be consistent with. One might doubt whether Gol, although claiming herself as initially inspired by Southwest (Guimarães, 2002), could resist entering a wider range of markets in order to expand or even to exploit unobservable (to the analyst) economies of scope throughout Brazil, increasing the number of actual origin-and-destination markets. In fact, by a simple inspection on Gol's website, one can quickly arrive at the conclusion that flights with more than two stops and/or connections are much more frequently available than non-stop flights, which certainly represents a departure from the typical SWP.

The start of operations of "red-eye" flights in 2003 in order to attract more travellers from coach and to persist in expanding despite the restrictions of the "re-regulatory wave" serves as an additional argument to the claim that the LCC's standards are probably not consistent with the SWP, but could be potentially associated with a variant of the JBP (longer-haul routes target). In fact, it is known that, just before starting-up operations in Brazil, Gol's executives made visits to both Southwest Airlines and JetBlue Airways in order to design the airline's strategic planning.

By focusing on the issue of the analysis of Gol's entry patterns, it is possible to collect further evidence on the change of directions by the LCC from 2002 on and to make inferences about the determinants of entry decisions by a LCC in a recently liberalised airline market, a task for Section 2.3.

2.3 Empirical Modelling

In this section I present the empirical modelling for the analysis of route-entry decisions of Gol Airlines. Firstly, the LCC's route entry problem is analysed with a discrete-choice model; secondly, the process of sample delimitation, the variables and data sources, and the final empirical specification are described; and finally, the estimator is presented and the issue of endogeneity is examined, with the discussion of the instrumental variables employed.

2.3.1 Discrete-Choice Framework

The intention here is to develop a framework of discrete choice with random utility[18] for the analysis of the patterns of entry decisions of the newcomer Gol Airlines. It is straightforward that here we have Gol as the decision maker, and the set of decisions "to enter a route" and "not to enter a route" as the alternatives in this "route-choice problem".

Consider the **binary** variable representative of choice, $PRES_{kt}$, which accounts for the presence of Gol on the k-th route at time t. The probability of entry can then be regarded in the following way:

$$\Pr\left[PRES_{kt}=1\right]=\Pr\left[\delta\pi^{*}_{kt}-SC_{k}>0\right] \tag{1}$$

Where the multiplicative term $\delta\pi_{kt}^*$ is the present value of the stream of equilibrium profits of the newcomer (note that δ is the discount factor) in case of entry, and SC_k is the amount of sunk costs on the k-th route (considered once and for all). One can develop (1) in the following way:

$$\Pr\left[\delta\pi^{*}_{kt}-SC_{k}>0\right]=\Pr\left[\frac{\delta\pi^{*}_{kt}}{SC_{k}}>1\right]=\Pr\left[\ln\pi^{*}_{kt}+\ln\delta-\ln SC_{k}>0\right] \tag{2}$$

By introducing ε_{kt}, the disturbances associated with the choice mechanism within a random utility framework, in (2), we have the following random variable representative of equilibrium net present value profits at the route level (Π_{kt}^*):

$$\Pi^{*}_{kt}=\ln\pi^{*}_{kt}+\ln\delta-\ln SC_{k}+\varepsilon_{kt} \tag{3}$$

where ε_{kt} is assumed to be iid ~ N(0,1)[19].

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[18] In the random utility approach, "*the observed inconsistencies in choice behaviour are taken to be a result of observational deficiencies on the part of the analyst*" (Ben-Akiva and Lerman, 1984); therefore, contrary to the constant utility approach, which assume a probabilistic behaviour for the decision maker, by assuming random utility I assume that the individual (the firm) always select the alternative with the highest utility (profits). By doing this, here we have the standard interpretation of the error term as representing factors that are observable to the firm but not to the econometrician.

[19] This is a convenient assumption, as the literature on binary probit estimation within a simultaneous equations framework is vast (examples being Amemiya, 1978, Smith and Blundell, 1986, Rivers and Vuong, 1988 and

As in a typical discrete-choice model (ex. Amemiya, 1978), we have only $PRES_{kt}$ as an observable, whereas the other terms (δ, π_{kt}* and SC_k) are latent. Actually, only the sign of Π_{kt}* is observed:

$$PRES_{kt} = \tau\left(\Pi_{kt}^{*}\right) = \begin{cases} 1 & if \;\; \Pi_{kt}^{*} > 0 \\ 0 & if \;\; \Pi_{kt}^{*} \leq 0 \end{cases} \qquad (4)$$

Therefore we have $PRES_{kt}$ assigned with one in case of entry (expectation of positive route profitability) and zero in case of no entry (no expectation of route profitability).

2.3.2 Sample Delimitation, Variables and Empirical Specification

I now turn to the description of the sample and the empirical specification. The strategy here was to have a sample with a large and representative cross-section of routes, in terms of capturing a high percentage of total domestic traffic in Brazil. Fortunately, the Statistical Yearbook of the Department of Civil Aviation - volume II[20], provides annual figures of domestic origin and destination traffic; thus, data was collected for the 500 densest routes[21] in the country, structured in a panel with two years, 2001 and 2002, and with each observation being then a route-year.

Here I define "route" in the following way: the service of passenger air transportation between two given cities[22], either by direct (non-stop or with stops) or by indirect flights (any possible combination of non-stop flights and flights with stops and connections). Also, routes are considered as *non-directional markets*, which means that, for instance, the origin-and-destination market of travellers from Rio de Janeiro to Brasília is regarded as aggregated with

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Lee, 1991), in opposition to the binary logit with endogenous variables.

[20] All information contained in the yearbooks and reports used here is monthly supplied from all scheduled airlines to the Department of Civil Aviation according to specific legislation (Instrução de Aviação Civil - 1505). One of the drawbacks of the data is that one cannot distinghish direct from indirect traffic (ie, number of travellers with and without flight connections). This sort of data is currently unavailable in Brazil.

[21] In order to define the 500 densest, figures of the period 1998-2002, available in the Statistical Yearbooks of the Department of Civil Aviation, were considered.

[22] Evans and Kessides (1993) also use the city-pair definition of a route; in contrast, Morrison (2001) implements an analysis disaggregated at the airport-pair level, in order to capture the effect of "adjacent" route presence.

the market Brasília-Rio de Janeiro[23]. Therefore, the raw data available in the Statistical Yearbook (directional airport-pairs) was aggregated to represent non-directional city-pair markets.

Also, some additional procedures of sample delimitation were performed in order to reduce potential heterogeneity across routes, especially with respect to demand attributes such as price elasticities implicit in any specification of π_i*. More specifically, it is well-known that flight distance and trip purpose are relevant sources of heterogeneity across routes. In fact, one would expect higher price elasticities of demand on routes in which there is higher competition either between modes of transportation or between scheduled and charter airlines: in the Brazilian case, one would certainly have this sort of problem with very short-haul routes – in which, for example, coaches have lower relative disadvantage –, and with exceptionally highly tourism-related routes – in which there is higher availability of charter flights[24].

In order to deal with this problem, here all routes with unusually low flight haul and with high percentage of seats available during weekends (reasonable proxy for tourism-related routes) were discarded. Therefore I excluded routes: 1. with flight-haul that is lower than the 5^{th} percentile (160 kilometres, as measured for the top-500 densest routes sample)[25]; and 2. with a percentage of seats available during weekends that is higher than the 95^{th} percentile (also for the top-500 sample)[26]. This resulted in a final data sample with 448 routes. With this set, one

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[23] For example, Ito and Lee (2003b) and Richard (2003) also makes use the assumption of non-directional markets; on the other hand, Berry, Carnall and Spiller (1996), Evans and Kessides (1993) and Borenstein (1989) use directional markets.

[24] Indeed, the Brazilian airline industry is characterised by a high proportion of business-related traffic, with tourism-related routes being exceptions. According to a research performed by São Paulo's aviation authorities, DAESP, in 2002, approximately 60% of the passengers in domestic trips that travelled from or to that state's airports had business-related purposes of travel.

[25] This is consistent with the procedure of Bogulaski, Ito and Lee (2003) when studying the route choice of Southwest Airlines. They had a cut-off range of 100 and 3,000 miles. In the present case, however, there is no route with more than 3,000 miles in the initial data sample. The authors excluded markets with distance outside this intervals as they are not likely to be targets for Southwest Airlines entry (the minimum and maximum distance of Southwest's markets was, respectively, 152 and 2,438 miles). In the present case, the only market of Gol which was outside this range (Florianópolis-Navegantes, approximately 55 miles) has been discontinued (not available in Gol's website in February 2003).

[26] As mentioned before, this measure can be regarded as a proxy for identifying tourism-related routes. The average is 21% of total whole-week seats available and the 95^{th} percentile is 35%. Source: Department of Civil

could still be able to represent the traffic of an average of 27 million passengers per year, which represents approximately 966 out of 1000 domestic trips during that whole period.

With respect to the *algebraic specification* of (3), here I propose the use of a translogarithmic function. This specification has advantages and disadvantages. On the one hand, it can represent any equilibrium profit function of unknown form and does not restrict the substitution elasticities between the arguments (permits a full modelling of substitution and complementarity).

On the other hand, however, the translogarithmic is vulnerable to multicollinearity among its many terms, and thus is not suitable for very disaggregated models. As the number of second-order terms in the right-hand side increases quickly as the set of independent variables grows, there is usually a trade-off between the increased flexibility permitted by having higher order terms and the practical difficulties associated with a elevated number of parameters to be estimated; examples of flexible profit functions of this type in the empirical literature are Mullineaux (1978) and Slade (1986).

One alternative would be to constrain all the square and cross-product terms to zero, which would reduce (3) to a Cobb-Douglas equilibrium profits function. A comparison of the empirical performance of the two models is made in Section 2.4.

With respect to the *empirical specification* of (3), there is a large list of potential regressors, and many of them are indicated by the literature. As the major focus here was to analyse the conformity of Gol Airlines with either the SWP or the JBP – especially with respect of flight-haul and route density –, and, at the same time accounting for the effects of market structure at the route level (presence of the opponent FSC's), the chosen empirical specification was then:

$$\Pi_{kt}^{*} = \Pi\left[\pi_{kt}^{*}\left(den_{kt}.km_{k},sdr_{kt}\right),cpres_{kt-1},tbapres_{kt-1},DC_{l},\varepsilon_{kt}\right] \qquad (5)$$

Where den_{kt} is route density (number of passengers) of route k and time t, km_{kt} is flight distance of route k, and sdr_{kt} is the number of seats available per passenger on direct flights of

Aviation's HOTRAN reports (various).

FSC rivals of route k and time t; $cpres_{kt-1}$ and $tbapres_{kt-1}$ are dummy variables that control for the presence, both at time t-1, of Gol at the endpoint cities, and of the bankrupt Transbrasil on route k. Finally the DC's (l = 1, 2, ..., L) are city-specific dummies. The translog representation of (5) would then be:

$$\Pr\left[PRES_{kt}=1\right]=\Pr\left[\Pi_{kt}^{*}>0\right]=$$

$$\Pr\left[\begin{array}{l} \upsilon_0+\upsilon_1\ln den_{kt}+\upsilon_2\ln km_k+\upsilon_3\ln sdr_{kt}+\upsilon_4\ln den_{kt}^2+ \\ \upsilon_5\ln km_k^2+\upsilon_6\ln sdr_{kt}^2+\upsilon_7\ln den_{kt}\ln km_k+\upsilon_8\ln den_{kt}\ln sdr_{kt}+ \\ +\upsilon_9\ln km_k\ln sdr_{kt}+\sum_l u_l DC_l+v_1 cpres_{kt-1}+v_2 tbapres_{kt-1}+\varepsilon_{kt}>0 \end{array}\right] \quad (6)$$

where the υ's, u's and v's are parameters. Let us now present details of each of the variables present in (5) and (6):

$PRES_{kt}$, is a binary variable that accounts for route presence of Gol Airlines, being assigned with one if entry has occurred in any year lower or equal than t, and with zero otherwise. $PRES_{kt}$ then means the presence of the LCC on route k in year t.

As mentioned before, a "route" here means a unique city-pair market, being thus an aggregation of all travel between two given cities, irrespective of the airports of origin and destination, and of the travel's direction. Once route is defined, one has to precisely define "entry". Here I define entry as Gol's presence in any of the possible origin-to-destination (O-D) markets, within the period under consideration (2001-2002); for more details, see the discussion of $cpres_{kt-1}$ below. The information of the presence of Gol in the O-D markets was collected from Panrotas' Domestic and International Schedules and Fares Guide[27] and Airwise's website.

The definition of $PRES_{kt}$ including all O-D traffic is certainly in contrast with Bogulaski, Ito and Lee (2003), which consider only non-stop markets and thus disregard routings with flight connections and stops within a given route. That procedure is certainly more reasonable for their case of Southwest Airlines, which is usually associated with non-stop and short-haul

[27] This is database is similar to OAG's of flight schedules guide, the world's most comprehensive schedules database.

flights (the SWP, as discussed in 2.2.1). In the present case, however, one may be unconvinced whether Gol has typical SWP standards, but, on the contrary, would believe that she has some propensity to enter a more diversified range of markets, specially longer-haul routes with stops and connections (see 2.2.2). Therefore, it would not be a reasonable procedure to include only either non-stop or direct flights in the definition of "route", as it would not be representative of Gol's operations; also, it would be impossible to investigate the conformity of Gol with the SWP (see Figure 2.1). Therefore, the broader definitions of both route and entry were considered more appropriate for this study.

Another issue regarding the definition of entry is related to the minimum level of operations (MLO) within a year for Gol's presence to be accounted for. Previous literature usually had either absolute or relative definitions of MLO. For instance, whereas Oum, Zhang and Zhang (1993) and Berry (1992) used MLOs of, respectively, 100 and 90 passengers per quarter in the ten per cent sample collected by the US DOT[28], Evans and Kessides (1993) used a fractional definition, considering effective presence as more than 1% of total traffic on the route. The latter is certainly a more flexible filtering criterion which could be adapted for the Brazilian conditions; however, as here traffic disaggregated by airline is not observed, the proxy used was to adapt Evans and Kessides (1993)'s approach by using the minimum percentage of (observable) seats available at the endpoint cities[29], considering then "entry" when actual figures are higher than 1%.

den_{kt} is route density of traffic (in million passengers) and was collected from the Statistical Yearbook of the Department of Civil Aviation (volume II) for the years 2001-2002. Consisting of origin-and-destination traffic figures, this variable represents total (non-airline-specific) domestic number of trips, aggregating all direct and indirect, single-trip and round-trip, traffic (that is, revenue passengers).

km_k represents route distance, that is, the one-way distance between origin and destination airports. This information was provided by Department of Civil Aviation's Laboratory of Simulation and was calculated by using the polar coordinates method. One important issue

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[28] U.S. Department of Transportation (DOT) Origin and Destination Survey.

[29] Source: Department of Civil Aviation's HOTRANs (various).

about km_{kt} is related to distance calculation when the sample presents more than one airport in one or both endpoint cities of the given route. In both cases the latitude and longitude of the airports closest to the city centre was employed and considered representative of the distance between cities[30].

Another aspect of km_k is that it represents the *minimum* distance between two given airports, and therefore does not take into account neither actual airway distance nor the effect of flight connections and/or stops. In principle, one would object using this proxy for flight distance, specially for medium-to-long-haul routes, because their higher availability of seats in flights with stops certainly represents higher actual distance flown than can be assessed by km_k. Therefore, the lower the participation of non-stop flights on a given route the more one would underestimate the effect of actual flight distance on profits via a decrease in unit costs[31]. Also, more stops are known to actually increase costs – for instance, via additional landing/departure fees; moreover, on the demand side, stops usually increase passengers' flight disutility, generating competitive disadvantage and also reducing profitability - a product differentiation effect. In spite of these arguments, we can therefore interpret km_{kt} as capturing the broad effect of flight distance on the probability of entry by the LCC[32].

$\mathbf{sdr_{kt}}$ is the number of total seats available per passenger on direct flights of FSC's on route k and time t. A relative measure, that is seats *per* passenger, was considered a better indicator than the absolute figure of seats available, as it avoids strong collinearity with den_{kt}; it is also a proxy for the inverse of capacity utilisation on direct routes. Data for total number of flights disaggregated by airline and by each day of the week is available in Department of Civil Aviation's HOTRAN, "Horário de Transporte", a data system that generates reports containing operational information of all scheduled flights within the country (non-published data). This information was extracted from their system on every month for the period 2001-2002, and subsequently aggregated by year. Sdr_{kt} is then both a measure of product

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30 As mentioned before, there were only three cities in this situation found in the data sample: Rio de Janeiro, Sao Paulo and Belo Horizonte. In all cases the largest city airport (in terms of figures of number of passengers and movement of aircraft) is located closer to the city centre. Source: INFRAERO's website (February, 2004).

31 A phenomenon known as "cost taper" in the transport literature, see Brander and Zhang (1990).

32 Some collinearity with sdr_{kt} is expected *ex-ante*, however.

differentiation – that is, more seats available meaning more convenient flights and service levels generated by the FSC's –, and of the degree of how well or underserved a given route actually is.

$cpres_{kt-1}$ is a binary variable that controls for entry at any of the endpoint cities of a route in the previous year. It is assigned with one for each route in 2002 that had one of the endpoint cities entered by Gol in 2001, and zero otherwise. This variable is crucial in the present framework as it is designed to control for the effects of sunk costs at the city level, that is, once one given airport/city was entered, it is then expected to be easier for the newcomer to provide services on other routes out of it, as she had already incurred in most of the sunk costs, such as advertising in one city, the sales and operational structure at the airport and the city, etc. It also controls for the effects of routes already entered in the year before and thus making a distinction between "new" or "true" entry and "previous" entry; in this sense, this variable makes this study in line with Toivanen and Waterson (2001)[33].

$tbapres_{kt-1}$ is a binary variable representative of the presence of the bankrupt (and no-longer existing) Transbrasil Airlines on route k and time t-1. One the one hand, one would think of the exit of this airline as giving an opportunity to entry for Gol; this would be certainly the case in city-pairs in which airports are subject to slots restrictions, for example; on the other hand, however, one would think of the exit of Transbrasil as a clear signal for Gol that those routes were not profitable. The prior intuition here is that the latter effect is stronger than the former, specially if one considers that very few airports are slot-constrained in Brazil; in this case, the sign of this coefficient is expected to be negative.

DC_l, which are *city-specific dummies*: assigned with 1 if the city is one of the endpoint cities of the city-pair, and 0 if not. The city dummies provide an economical way to capture and control for a large number of truly significant (frequently exogenous) variables, which can be regarded as being actually city-specific, instead of route-specific; also, most of them are in fact unobservables by the researcher.

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[33] The authors criticise the common procedure found in the entry literature, of treating "entry" of existing firms, meaning the continuation of operations, in a similar way to entry of new firms; this would be equivalent to "*making the assumption that firms can in every period, without a change in costs, review their entry decision*".

Below is a list of some of the potential effects that may be controlled by the city dummies:

a. Characteristics of travellers from/to a city: consumers' purchasing behaviour and attributes, like the percentage of the travellers which frequently makes use of the internet when searching and buying; consumers' attributes: income, niche preferences, propensity to make either tourism-related or business-related trips, etc; city's gross domestic product and wealth in general, as a factor of business-trips generation: percentage of migrants established in one city (ex: large participation of migrants from Northeast in São Paulo, a fact that is potentially trip-generation enhancing); geographic idyosincrasies;

b. Characteristics of the airports of a city: sunk costs; airport accessibility and costs of the access to the airport (price of taxi, distance from the zones-of-trip-generation, etc), the size of the zone of influence of the city's airport(s) in terms of trip generation (nearby cities); operational costs and expenses related to a particular city (airport fees, cost of hiring personnel, cost of contracts in general, etc.); presence of airports with constrained capacity (slots) or with spare capacity; subsides and incentives given by authorities to operations in one given city; presence of airports owned by the public enterprise Infraero; vacant slots or frequencies left by the bankrupt Transbrasil; airport/airway infrastructure: size of the runway, air traffic control capacity;

c. Characteristics of network out of a city: size of the airlines' network (unobservable degree of product differentiation, economies of scope, etc. at the airport level); presence of hub or mini-hub in a city; frequent flyer effect: number of possible destinations out of a city;

d. Characteristics of the competition in a city: quality/availability of motorways out of a city; tolls; presence of charter; number of travel agents; commission fees to travel agents of a city; airport dominance by particular airlines; number of airlines operating out of a city and concentration levels; levels of advertising and forms of effective media in one city; number of flights and excess capacity out of a city.

They state: "*Given sunk costs, we believe that particular assumption to be unwarranted, and we do no utilize it*"

Most of these effects are expected to generate persistent heterogeneity in the error-term structure **across cities** (but not routes), which can be controlled via the city-specific dummies, DCs[34].

Another relevant feature of the dummy-specific cities is that one is able to identify only the effects of actually entered cities. This is a common problem of any discrete-choice model, in which "*one cannot use as a regressor a dummy variable if for any of the values it takes, there is no variation in the dependent variable*" (Toivanen and Waterson, 2001). This is precisely the case of non-entered cities, all of them with no variation in $PRES_{ikt}$[35]. However, by having dummies only for actually-entered airports, one is certainly inducing somewhat artificially designed correlation with the dependent variable, due to the obvious fact that only routes from and to actually chosen airports/cities will be entered. The extreme alternative, namely dropping all city dummies, would probably be inappropriate as it would induce omitted variables bias.

Thus, in order to balance between the gains of controlling for city-specific effects and to avoid the aforementioned sort of artificial correlation, I then focused on the *network decisions of any potential newcomer* in the Brazilian domestic market. In fact, given that "*there are no secondary airports near major Brazilian cities able to handle midsize jet operations (737s, A320/319, etc.)*" (Silva and Espírito Santo Jr., 2003), any major player considering entering the market would not be able to avoid having operations in the airports of some of the most important cities within the country. Indeed, this is a sort of networking decision that is expected *ex-ante*, irrespective of the type of operations and specific niche of the potential competitor. This evidence is *per se* a justification for the inclusion of dummies for the major cities present in the sample (**ten** in total), as they constitute the potential mini-hubs for any entering carrier; at the same time, one would not be causing unreasonable correlation with the dependent variable, as the dummies are designed independently of Gol's entry decision.

(Toivanen and Waterson, 2001, p.3).

[34] The cities included were: Brasília, Belo Horizonte, Curitiba, Manaus, Fortaleza, Porto Alegre, Recife, Rio de Janeiro, Salvador and Sao Paulo; this was the list of the top-ten cities in terms of total density of traffic from 1998 and 2002 (source: Statistical Yearbook of DAC, vol. I).

[35] The other extreme would be the case of the sample containing cities with all routes actually entered, and thus

Descriptive statistics for all variables used in the empirical model are presented in Table 2.3:

Table 2. 3 - Descriptive Statistics

Variable	Designation	Mean			Std. Dev. (Full Sample)
		$PRES_{ikt}=0$	$PRES_{ikt}=1$	Full Sample	
$pres_{ikt}$	Route Presence - Gol	-	-	0.198	0.398
den_{kt}	Route Number of PAX/Year	21,552.220	236,466.475	64,007.379	246,566.718
km_{kt}	Route Distance	966.817	1,383.838	1,049.197	776.293
sdr_{kt}	Route Direct Seats per PAX	2.827	2.626	2.787	7.362
$cpres_{kt-1}$	City Presence - Gol (One Lag)	0.309	0.599	0.366	0.482
$tbapres_{kt-1}$	Route Presence - Transbrasil (One Lag)	0.050	0.113	0.063	0.242
Belo Horizonte	Dummy of City	0.039	0.124	0.056	0.230
Brasília	Dummy of City	0.085	0.164	0.100	0.301
Curitiba	Dummy of City	0.046	0.141	0.065	0.246
Fortaleza	Dummy of City	0.054	0.073	0.058	0.234
Manaus	Dummy of City	0.083	0.045	0.076	0.265
Porto Alegre	Dummy of City	0.042	0.124	0.058	0.234
Recife	Dummy of City	0.039	0.147	0.060	0.238
Rio de Janeiro	Dummy of City	0.051	0.186	0.078	0.269
Salvador	Dummy of City	0.053	0.158	0.074	0.261
São Paulo	Dummy of City	0.135	0.186	0.145	0.352

It is pertinent to emphasise that both den_{kt} and sdr_{kt} have zero as minimum. This is on account of routes in which air transport operations were either interrupted or there were no direct flights in a given year. This generated the problem of dealing with the logarithm of zero in (6). One way to circumvent this problem is by having the data transformation indicated by Fox (1997): "*[to] add a positive constant (called "start") to each data value to make all the values positive*". Hence, a "start" of, respectively, 10 and 0.10 units, was then applied to all observations of both variables in order to permit accomplishing proper estimations.

generating the same problem – a case not present in the current data sample.

2.3.3 The Issue of Endogeneity, Instruments and Estimator

One relevant issue related to the estimation of (6) is the potential correlation of den_{kt} and sdr_{kt} with the error term ε_{ikt}. In fact, one would expect both variables to be jointly determined with Π_{kt}* and thus causing simultaneous equations bias to emerge. The correlation would be in the following fashion: if actual profits are higher than the predicted, that is, a positive ε_{kt}, which stimulates entry, then route density may be higher due to new demand generation permitted by the low-cost carrier (a fact reported by Whinston and Collins, 1992), and thus one would have positive correlation between den_{kt} and ε_{kt}. Similar effect is expected to happen with sdr_{kt}: a positive ε_{kt} would cause post-entry reactions in terms of increase in route presence via higher capacity and sdr_{kt} (also reported by Whinston and Collins, 1992). Of course, the opposite may happen in case of a "crowding-out" effect caused by Gol's entry, that is, FSC rivals reducing sdr_{kt} after Gol enters, via reduction in the number of flights, in the size of aircrafts or even exiting the market[36]. In both cases, with either positive or negative correlation with the error term, the standard probit estimation would either overestimate or underestimate the true effects on entry as one would not account for post-entry route density and presence adjustment in the estimation.

As endogeneity is potentially present, one needs to perform a test for exogeneity in the model; the variables under suspicion were den_{kt}, sdr_{kt} and their second-order terms sdr_{kt}^2, $sdr_{kt} * den_{kt}$, $sdr_{kt} * km_k$, den_{kt}^2, $den_{kt} * km_k$. The test employed was the one suggested by Smith-Blundell (1986), which is more suitable for discrete-choice models than, for example, the frequently used Hausman test. It is Chi-squared distributed with m degrees of freedom – m being the number of endogenous variables in the model –, and tests the null hypothesis that all explanatory variables are exogenous; a rejection therefore indicates that the standard probit should not be employed. For the present model, the Smith-Blundell statistic was 14.58 (P-

36 For example, Transbrasil exited the market some months after Gol's entry.

value of 0.04), permitting the rejection of the null[37].

Once exogeneity of den_{kt} and sdr_{kt} (and related terms) is rejected, one needs an instrumental variables estimator for binary variables. Moreover, GMM estimation would be required in case of rejection of the hypothesis of homoskedasticity of ε_{kt}. In order to test for this, a likelihood-ratio test of heteroskedasticity in the discrete-choice framework was performed after a maximum-likelihood heteroskedastic probit estimation. This test requires the specification of an indicator vector of suspected explanatory variables that could affect the unobservables, which, in this case, was set equal to $[sdr_{kt-1}, den_{kt-1}, km_k]$[38]. The null hypothesis of homoskedasticity was not rejected at 10% level of significance – the Chi-squared statistic with 3 degrees of freedom was 1.57 (P-value of 0.6671).

As homoskedasticity is not rejected, one possible discrete-choice estimator that control for endogeneity is the Amemiya (1978)'s Generalised Least Squares (AGLS); here I employed the AGLS implementation of Newey (1987). In the case of disturbances that are normally distributed, this estimator is consistent, and asymptotically equivalent to the efficient minimum chi-square estimator (Lee, 1991 and Newey, 1987); also it is shown to be more efficient than other popular two-stage estimators for simultaneous equations with binary response models (for example, the 2SIV estimator of Rivers and Vuong, 1984[39]).

The steps of AGLS estimation are the following: firstly, a set of regressions is estimated by OLS to obtain the reduced form parameters and the respective predictions and residuals are computed; this is followed by running a probit with the exogenous variables and the predicted endogenous variables as regressors; thirdly, a probit is regressed by making use of the exogenous variables, the instruments, and the predicted residuals from the reduced form model; and finally, a generalised least square estimator relating the previous estimated parameters is performed in order to obtain efficient estimates of the structural parameters.

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[37] The list of instrumental variables used for this test (and for estimations) is described below.

[38] According to Baum, Schaffer and Stillman (2003), when testing for heteroskedasticity in a simultaneous equation framework, the indicator vector must be exogenous and is typically formed by "*either instruments or functions of the instruments*".

[39] Blundell and Smith (1989) and Rivers and Vuong (1988) provide additional discussion on relative efficiency of the AGLS estimator in comparison to others found in the literature.

This estimator requires consistent standard errors correction to account for the first-stage estimation, which is performed here by making use of Newey (1987)'s approach[40].

The basic procedure for identification here was to employ lagged variables as instruments and test for their validity. The list of instrumental variables included den_{kt-1}, sdr_{kt-1}, stt_{kt-1} (total direct seats available), swe_{kt-1} (total direct seats available during weekends) and asz_{kt-1} (average size of aircraft); it also comprised respective second-order terms: $(\ln den_{kt-1})^2$, $(\ln sdr_{kt-1})^2$, $\ln den_{kt-1} * \ln km_k$, $\ln den_{kt-1} * \ln sdr_{kt-1}$, $\ln km_k * \ln sdr_{kt-1}$. The validity of instruments is supported by the following diagnostics described below; all figures are reported in Appendix 2.1.

Firstly, in terms of **relevance** of the instruments, by having a look at the matrix of correlations between endogenous and instrumental variables one can have an idea of the reasonably high correlation among them (Appendix 2.1, Tables 2.12). Also in terms of relevance of the instruments, by inspecting the partial R-squared and the F-test of joint significance of the excluded instruments in the first-stage regressions; the minimum R-squared was 0.55 and the minimum F-statistic was 105.20 (p-value of 0.00), which further indicated they are fairly correlated with the endogenous variables (Appendix 2.1, Tables 2.13).

Since the number of instruments exceeds the number of endogenous regressors I made use of over-identification restrictions tests to check for the **validity** of the instruments proposed (tests of orthogonality, as in Davidson and MacKinnon, 1993; see Baum, Schaffer and Stillman, 2003, for a survey); by regressing a linear probability model in two-stages least squares (LPM/2SLS) one could confirm the validity of instruments. The tests used were the Sargan N*R-squared test and the Basmann test, and both failed in rejecting the null hypothesis that the excluded variables are valid instruments (Appendix 2.1, Tables 2.13).

With the intention of emphasizing the relevance of controlling for endogeneity, I perform comparison between the standard (single stage) probit with the AGLS in the results presentation of Section 4; this is specially useful to have an idea of the magnitude (and sign) of the underlying simultaneous equations bias.

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[40] Stata's routine "ivprob" was used to perform all estimations and standard error corrections in Newey (1987)'s fashion (Harkness, 2001).

2.4 Estimation Results

The estimation results of the empirical modelling developed in Section 2.3 are reported in the first column of Table 2.4; these results are indicative of the AGLS instrumental variables estimator with full-specification, that is, with the inclusion of both first and second-order terms of equation (6):

Table 2. 4 - Estimation Results

Dependent Variable	PR [ENTRY = 1]			
	(1) AGLS	(2) AGLS⁻	(3) PROBIT	(4) RFM PROBIT
$\ln den_{kt}$	0.078 *	0.052 ‡	0.057	0.071 †
	(0.039)	(0.009)	(0.032)	(0.031)
$(\ln den_{kt})^2$	0.003		0.006 ‡	0.008 ‡
	(0.003)		(0.002)	(0.002)
$\ln km_k$	0.464 †	0.077 ‡	0.562 †	0.635 ‡
	(0.211)	(0.021)	(0.205)	(0.209)
$(\ln km_k)^2$	-0.033 †		-0.038 †	-0.042 †
	(0.015)		(0.015)	(0.015)
$\ln sdr_{kt}$	-0.183 *	0.013	-0.105 *	-0.097 *
	(0.072)	(0.010)	(0.054)	(0.052)
$(\ln sdr_{kt})^2$	0.012 *		0.006 †	0.007 †
	(0.006)		(0.003)	(0.003)
$\ln den_{kt} * \ln km_k$	-0.012 *		-0.007	-0.010 *
	(0.006)		(0.005)	(0.005)
$\ln den_{kt} * \ln sdr_{kt}$	0.014 *		0.005 *	0.005 †
	(0.006)		(0.003)	(0.002)
$\ln km_k * \ln sdr_{kt}$	0.015		0.011	0.009
	(0.009)		(0.007)	(0.007)
$cpres_{kt-1}$	0.049 ‡	0.109 ‡	0.061 ‡	0.063 ‡
	(0.023)	(0.034)	(0.021)	(0.020)
$tbapres_{kt-1}$	-0.035 †	-0.037	-0.042 †	-0.044 †
	(0.016)	(0.042)	(0.014)	(0.013)
Control for Endogeneity	YES	YES	NO	NO
Second-Order Terms	YES	NO	YES	YES
LR χ^2 Statistic	462.00 ‡	401.85 ‡	460.25 ‡	451.11 ‡
# Predicted = 0 / # Actual = 0	673/719	673/719	683/719	685/719
# Predicted = 1 / # Actual = 1	118/177	110/177	109/177	110/177
Lave-Efron Pseudo-R2	0.493	0.453	0.514	0.507
McKelvey-Zavoina Pseudo-R2	0.803	0.626	0.750	0.748
N. Observations	896	896	896	896

*Notes: i. marginal-effects reported; ii. standard errors in parentheses; iii. * means significant at 10%, † at 5% and ‡ at 1% level; iv. city-specific dummies not reported; v. column (4) reports estimated reduced form coefficients (one-period lagged instruments correspondent to the respective endogenous variables).*

Now consider the other estimates presented in Table 2.4. Firstly, we have column (2), AGLS⁻, which reports results when endogeneity is controlled in the same way of column (1) but relevant misspecification is present in terms of omitted second-order effects. Secondly, we have column (3), which reports results when one does not control for endogeneity (standard probit), but makes use of the same variables set of column (1). And finally, column (4) presents a reduced-form model (RFM PROBIT) where all endogenous variables are substituted by their one-period lagged counterparts, with standard probit also being estimated; reduced-form models of entry decisions are also employed by Berry (1992) and Toivanen and Waterson (2001).

The relative performance of estimators in columns (2), (3) and (4) of Table 2.4, with respect to column (1), can be better inspected if one analyses the *full effects* of the variables den_{kt}, km_k and sdr_{kt} on the probability of entry. In order to accomplish that, *arc elasticities* were extracted, that is, considering the effects of an arbitrary percentage change in each variable on the estimated probability; the elasticity was considered a better measure than the marginal effects as it is invariant to the unit of measure. Figures were calculated by making use of the formula $(Pr_1-Pr_0)/0.10$, where Pr_1 is the predicted probability with the explanatory variables at the sample mean, except for the one under analysis, which is increased by ten percent (represented by 0.10), and Pr_0 is the predicted probability holding all variables at the sample mean[41]. It is important to emphasise that, as here we have a translog specification, which engenders interactions between terms, the elasticity of any variable always depends on the values of the other variables in the model.

The resulting elasticities for each estimator are reported in Table 2.5:

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[41] In terms of the binary explanatory variables, $cpres_{kt-1}$ and $tbapres_{kt-1}$ were set equal to zero and the DC's were considered by extracting the average effect times two (as each route has two endpoint cities).

Table 2. 5 - Estimated Elasticities

Variable	(1) AGLS	(2) AGLS$^-$	(3) PROBIT	(4) RFM PROBIT	(2)-(1) %	(3)-(1) %	(4)-(1) %
den_{kt}	0.151	0.134	0.283	0.274	*-11%*	*88%*	*82%*
km_k	0.061	0.198	0.194	0.157	*227%*	*220%*	*159%*
sdr_{kt}	0.166	0.034	0.179	0.182	*-79%*	*7%*	*10%*

Notes: i. figures calculated at the sample mean; ii. calculated as a 10% increase in each variable at the mean; iii. "all" means the effect of a 10% change in all variables; iv. column (4) reports elasticities of the one-period lagged instruments correspondent to the respective endogenous variables;

Figures in Table 2.5 are interpreted in the following way: if, for instance, den_{kt} is increased by 10%, the probability of entry (at the sample mean) is increased by 1.5%. By examining the differences (in percentage) between estimated elasticities across estimators, in Table 2.5, one can see that all alternative estimators of column (2), (3) and (4) present significant deviation from the results of the fully-specified and more efficient AGLS of column (1); in fact, this is in line with joint-significance tests of the second-order terms, and also with the exogeneity tests reported in Section 2.3, all supportive of the AGLS estimator.

Also, by inspecting Table 2.5 one can infer that no single alternative estimator persistently outperforms the others and therefore failure to control for either endogeneity or second-order effects can severely damage the estimation results. Another comment is related to the bad performance of AGLS$^-$, which serves as an illustration that the gains permitted by the instrumental variables estimator cannot overcome major problems of model's misspecification.

Finally, let us analyse the impacts of the simultaneity bias, by comparing the elasticities implied by AGLS's and PROBIT's estimated coefficients. As expected, there seems to be a positive bias related to density (the difference between estimators is +88%), indicating that this variable is positively correlated with the error term, and, as discussed before, this being probably due to new demand generation caused by LCC entry[42]. What is more, the positive simultaneity bias caused by not controlling for endogeneity of sdr_{kt} (associated with the +7%

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[42] As mentioned in Section 1, routes entered by Gol had 13.1% increase in traffic density against a 7.0% increase on all 500 top-routes, when comparing figures of 2002 (posterior to entry) with 2000 (previous to entry).

difference between elasticities) provides some evidence that LCC entry causes FSC presence to adjust upwards – and therefore providing basis for the rejection of the hypothesis of "crowding-out", which is consistent with Winston and Collins (1992)'s results of an increase in 25% of incumbents' seats offered in response to low cost airline entry. The last coefficient, km_k, has large positive difference between estimators (+220%); although flight distance is not *per se* an endogenous variable, its full effect measured by the elasticity presented in Table 2.5 is formed by endogenous variables, namely, the second-order terms $\ln den_{kt} * \ln km_k$ and $\ln km_k * \ln sdr_{kt}$. On account of these interactions, one would expect that, *ceteris paribus*, the true sensitivity of an additional kilometre to be lower in case of higher demand generation and higher presence of competitors – which is caused by the simultaneity bias of, respectively, den_{kt} and sdr_{kt}[43].

I now turn to the analysis of the signs and magnitudes of the estimated elasticities (the AGLS column). From Table 2.5 one can see that the elasticities of the original, not log-transformed, variables den_{kt}, km_k, and sdr_{kt} were, respectively 0.151, 0.061 and 0.166, all measured at the sample mean. Apart from the results of den_{kt}, which can be naturally thought of having positive overall effects – that is, the more is a given route's density of traffic the more it is attractive for LCC entry –, special attention is required with respect to the analysis of the effects of km_k, and sdr_{kt}.

Firstly, we have an overall positive elasticity of sdr_{kt}, considering everything else held constant at the sample mean. The immediate conclusion implied by this result is that the higher is the presence of the FSC competitors in terms of seats available on direct flights (*per* route passenger) the higher is the propensity to enter of Gol; in other words, the more is the market underserved by direct FSC supply the less is the entry probability.

On the one hand, one could interpret this finding as an indication that Gol does not follow the typical LCC practice of avoiding market contact with the legacy carriers but, quite the opposite, prefers behaving like a follower, learning from the others' past entry decisions first, and then making her own route choices. The "learning" argument is in line with the results of

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[43] One has to be cautious with those arguments, however, as here we have only the difference between the estimated effects, and not the real simultaneity bias. The difference between the results of the estimator is indicative of the problems engendered by not controlling for the endogeneity of the regressors, however.

Toinaven and Waterson (2001): "*Structural form estimations show that the positive effect of rival presence on the probability of entry is due to firm learning: rival presence increases the estimate of the size of the market*". Also, this would be clearly suggestive that **route** presence is a good indicator of underlying profitability, in opposition to Evans and Kessides (1993), which found evidence only for **airport** presence effects in the US market.

On the other hand, however, one could have the "market niche" argument of the LCC's: by positioning herself close to well-served direct markets, Gol is able to detect market opportunities once not perceived by the FSC's; this is specially true if one observe that, contrary to both SWP and JBP, and as discussed before, Gol provides a wider range of origin-and-destination products with stops and flight connections, and therefore placing in the market as the low fare alternative for less time-sensitive passengers.

Table 2.6 below presents a disaggregation of the elasticity of sdr_{kt} with respect to own values of that variable, with both den_{kt} and km_k held constant; one can observe decreasing but always positive elasticity figures, which means that a point of probability maximisation is reached at higher levels of sdr_{kt}. This pattern confirms that Gol has lower preference for creating new markets or entering underserved routes, contrary to the SWP:

Table 2. 6 - Sdr_{kt} Disaggregated Elasticities (1)

sdr_{kt}	0.70	1.00	1.50	3.00	6.00	10.00
Elasticity	*0.82*	*0.66*	*0.45*	*0.14*	*0.02*	*0.00*

Notes: i. figures calculated holding km_k and den_{kt} at the sample mean; ii. calculated as a 10% increase in each variable at the mean; iii. values of sdr_{kt} are representative of the following percentiles: 0.35, 0.50, 0.65, 0.80, 0.90 and 0.95.

Table 2.7 presents another disaggregation of the elasticity of sdr_{kt}, with respect to kilometres and density, this time holding sdr_{kt} constant at the mean:

Table 2. 7 - Sdr_{ikt} Disaggregated Elasticities (2)

den_{kt} \ km_k	**350**	**500**	**750**	**1,150**	**1,850**	**2,250**	**2,600**
1,000	*2.32*	*2.31*	*2.26*	*2.21*	*2.20*	*2.22*	*2.24*
3,000	*2.55*	*2.36*	*2.15*	*1.98*	*1.89*	*1.88*	*1.90*
6,000	*2.40*	*2.11*	*1.83*	*1.62*	*1.51*	*1.50*	*1.51*
15,000	*1.85*	*1.50*	*1.20*	*0.99*	*0.89*	*0.88*	*0.90*
50,000	*0.80*	*0.53*	*0.35*	*0.25*	*0.21*	*0.22*	*0.23*
150,000	*0.12*	*0.06*	*0.03*	*0.02*	*0.01*	*0.02*	*0.02*
300,000	*0.01*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*

Notes: i. figures calculated holding sdr_{kt} at the sample mean; ii. calculated as a 10% increase in each variable at the mean; iii. values are representative of the following percentiles: 0.20, 0.35, 0.50, 0.65, 0.80, 0.90 and 0.95.

Undoubtedly, Table 2.7 is quite useful in permitting a detailed analysis of Gol's route choice preferences regarding opponents' presence. Actually, it is possible to observe two regimes: one, for the great majority of the routes, of ever positive elasticities – for routes with density below 150,000 pax/year–, and one with elasticities that are almost null – associated with very high density routes, above 150,000 pax/year. This probably means that opponent's presence is a good indicator of underlying profitability for low-to-medium sized markets (in terms of density of traffic) but it is irrelevant for high-sized ones. In other words: actual market size is much more observable for the newcomer the higher is traffic density, and for routes in which traffic is rather thin, opponents' presence becomes a better signal for entry.

To sum up on the effects of sdr_{kt}, one has, contrary to traditional Industrial Organisation literature, that rival's market presence does not inhibit entry but, on the contrary, is used as a warning sign for underlying profitability (mainly in markets with lower size). This is consistent with the results of Toivanen and Waterson (2001) which unveiled learning processes regarding entry[44]. There are three explanations for these results: first, as Brazil's very high interest rates are well-known for increasing the risk of enterprise, firms usually

[44] In the present case, one could think of Gol learning from the FSC's previous entry decisions, that is, from the number of direct seats available, in order to infer the amount of business traffic on a given route, which is usually associated more with direct flights.

prefer not taking additional risk of venturing to create new markets; second, the airline market all over the world has been highly volatile and uncertain in the past few years: and third, as regulators were stimulating entry and forcing entry barrier to vanish, it was relatively easy for Gol to enter the same markets of her opponents and, what is more, without much competitive disadvantage in terms of slots, access to airport facilities, etc.

The other result that needs to be carefully addressed is related to the marginal effects of km_k. A more detailed analysis of this variable is not only essential for a proper understanding of the model's most relevant outcomes but also for performing an analysis of Gol's consistency with either SWP or JBP, detailed in Section 2.1. The positive elasticity of flight haul, presented in Table 2.5, does not reveal much as it is a rather aggregate figure, measured at the sample mean; once again, one useful alternative is to extract the same measure for a broader set of combinations of density and flight-haul values:

Table 2. 8 - Disaggregated Elasticities of km_k

den_{kt} \ km_k	350	500	750	1,150	1,850	2,250	2,600
1,000	*15.59*	*10.05*	*6.16*	*3.62*	*1.83*	*1.28*	*0.92*
3,000	*9.22*	*5.90*	*3.54*	*1.99*	*0.90*	*0.56*	*0.33*
6,000	*6.28*	*3.95*	*2.30*	*1.24*	*0.49*	*0.26*	*0.10*
15,000	*3.39*	*2.02*	*1.09*	*0.53*	*0.16*	*0.04*	*-0.04*
50,000	*1.00*	*0.50*	*0.22*	*0.08*	*0.01*	*-0.02*	*-0.04*
150,000	*0.12*	*0.04*	*0.01*	*0.00*	*0.00*	*0.00*	*-0.01*
300,000	*0.01*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*

Notes: i. figures calculated holding sdr_{kt} at the sample mean; ii. calculated as a 10% increase in each variable at the mean; iii. values are representative of the following percentiles: 0.20, 0.35, 0.50, 0.65, 0.80, 0.90 and 0.95.

As one can see in Table 2.8, Gol's propensity to enter a route is marked by diminishing returns of both flight-haul and density. Again, one can observe two regimes: first, for routes with traffic density values up to approximately 50,000 pax/year, where distance has an ever increase effect on entry (in the direction of a point of maximisation), probably meaning that Gol is willing to substitute density by kilometres since she is able to force passengers to have stops or to flight connect; this seems to be in line with a modified version of the JBP. And second, for routes with very thick density (higher than 50,000 pax/year), flight haul has no influence on entry; this is the outcome of the same factors affecting the elasticities of sdr_{kt} on the same set of routes, as seen above – that is, for those routes, density is a clearer indicator of profitability than distance.

One would claim, however, that Gol changed operational standards from 2002 on, as discussed in 2.2, and probably started to enter a broader range of markets, especially with respect to long-haul routes and flight connections. This might be due to the opportunities presented by some events of 2001, such as the exit of Transbrasil Airlines, the barriers to expansion at São Paulo, the DAC's authorisation to operate Rio de Janeiro's city-centre airport, and the fiercer incumbents' reactions on short-haul routes (see Chapter 3).

If the above argument is correct, however, the aggregated 2001-2002 regressions of Table 2.4 would present a rather "average" entry behaviour, and disaggregation with respect to time would then be required. In order to perform that, variables $\ln km_k$, $(\ln km_k)^2$, $\ln den_{kt} * \ln km_k$ and $\ln km_k * \ln sdr_{kt}$ were multiplied by a dummy representative of the year 2002 (d02), in order to test for possible structural change from that year on; thus the following variables were generated: $\ln km_k * d02$, $(\ln km_k)^2 * d02$, $\ln den_{kt} * \ln km_k * d02$ and $\ln km_k * \ln sdr_{kt} * d02$. Table 2.9 reports the results for the same AGLS estimates but with those variables included:

Table 2. 9 - Estimation Results Disaggregated by Year

Dependent Variable	PR [ENTRY = 1] AGLS
$\ln den_{kt}$	0.067 (0.038)
$(\ln den_{kt})^2$	0.004 (0.004)
$\ln km_k$	0.525 ‡ (0.222)
$(\ln km_k)^2$	-0.039 ‡ (0.016)
$\ln sdr_{kt}$	-0.157 * (0.073)
$(\ln sdr_{kt})^2$	0.011 (0.005)
$\ln den_{kt} * \ln km_{kt}$	-0.011 * (0.006)
$\ln km_k * \ln sdr_{kt}$	0.012 (0.009)
$\ln den_{kt} * \ln sdr_{kt}$	0.013 (0.006)
$\ln km_k * d02$	-0.050 † (0.031)
$(\ln km_k)^2 * d02$	0.007 † (0.004)
$\ln den_{kt} * \ln km_k * d02$	0.001 (0.001)
$\ln km_k * \ln sdr_{kt} * d02$	0.000 (0.001)
$cpres_{kt-1}$	0.008 (0.034)
$tbapres_{kt-1}$	-0.033 † (0.016)
LR χ^2 Statistic	468.36 ‡
Predicted = 0 / Actual = 0	670/719
Predicted = 1 / Actual = 1	119/177
Lave-Efron Pseudo-R2	0.504
McKelvey-Zavoina Pseudo-R2	0.810
N. Observations	896

*Notes: i. marginal-effects reported; ii. standard errors in parentheses; iii. * means significant at 10%, † at 5% and ‡ at 1% level; iv. city-specific dummies not reported.*

By making use of the results of Table 2.9, it is possible to compare the elasticities of km_k across flight distance and route density *disaggregated by year*, in order to inspect how Gol's sensitivity to kilometres changed from 2001 to 2002. Tables 2.10 and 2.11 report the results:

Table 2. 10 - Disaggregated Elasticities of km_k – 2001

km_k / den_{kt}	350	500	750	1,150	1,850	2,250	2,600
1,000	*11.09*	*6.81*	*3.83*	*1.85*	*0.32*	*-0.21*	*-0.58*
3,000	*6.65*	*4.02*	*2.17*	*0.92*	*-0.09*	*-0.47*	*-0.75*
6,000	*4.52*	*2.67*	*1.37*	*0.51*	*-0.21*	*-0.51*	*-0.73*
15,000	*2.37*	*1.31*	*0.61*	*0.16*	*-0.24*	*-0.43*	*-0.58*
50,000	*0.61*	*0.28*	*0.10*	*0.00*	*-0.11*	*-0.18*	*-0.25*
150,000	*0.05*	*0.02*	*0.00*	*0.00*	*-0.01*	*-0.02*	*-0.04*
300,000	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*-0.01*

Table 2. 11 - Disaggregated Elasticities of km_k – 2002

km_k / den_{kt}	350	500	750	1,150	1,850	2,250	2,600
1,000	*23.02*	*14.55*	*8.83*	*5.26*	*2.87*	*2.17*	*1.73*
3,000	*13.98*	*8.84*	*5.31*	*3.08*	*1.59*	*1.16*	*0.89*
6,000	*9.76*	*6.10*	*3.58*	*2.01*	*0.98*	*0.69*	*0.50*
15,000	*5.54*	*3.32*	*1.82*	*0.94*	*0.41*	*0.26*	*0.17*
50,000	*1.90*	*0.96*	*0.42*	*0.17*	*0.05*	*0.03*	*0.01*
150,000	*0.29*	*0.10*	*0.03*	*0.01*	*0.00*	*0.00*	*0.00*
300,000	*0.03*	*0.01*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*

Notes: i. figures calculated holding sdr_{kt} at the sample mean; ii. calculated as a 10% increase in each variable at the mean; iii. values are representative of the following percentiles: 0.20, 0.35, 0.50, 0.65, 0.80, 0.90 and 0.95.

Firstly, with Table 2.10 one can assess Gol's entry strategy in her start-up year. In this case a parabolic curve is clearly observed, meaning that the highest probability of entry is located within 1,150 and 1,850 kilometres for most cases: this could be associated with the SWP[45]. On the other hand, in Table 2.11, the estimates for 2002 resulted in an ever-positive flight-haul elasticities for any route density lower than 150,000 pax/year, and this is certainly more in line with JBP. Therefore we have that a pattern of entry that was in accordance with the

[45] In comparison, the average stage length of Southwest Airlines in 2003 was approximately 1160 kilometres (source: Southwest Airlines Annual Reports).

SWP, observed in 2001. seems to be replaced by a propensity to enter a more diversified set of routes, and thus also considering high flight sectors in 2002 (JBP). In both cases, however, a set of almost null elasticities for thick-density routes was observed.

The aforesaid findings noticeably reject the notion that Gol follows a pure standard of operations like the SWP or the JBP, but, consistent with recent trend in the LCC segment, preferred to develop a more diversified portfolio of markets. Some evidence is found, however, that, for a great deal of medium-sized markets, Gol behaved more consistently with the SWP, but this was limited to her first year of operations; in contrast, there is unambiguous evidence that she accomplished a deviation towards a more JBP-like standard of operations, implemented since 2002.

Two caveats must be considered with respect to the abovementioned results on flight distance: firstly, as discussed before, country idiosyncrasies (for example, unobserved economies of scope) probably influenced Gol in the strategic decision of not to focus only on non-stop short flight markets, **but** to put into practice a modified version of JBP – that is, also considering long-haul markets but with many stops and connections. Also, it is important to emphasise that, from 2002 on, Gol's pace of expansion made her the third biggest domestic airline; it is no surprise, therefore, that her entry behaviour became more similar to the incumbent majors as she started to enter every single dense route across the country, irrespective of other market attributes, such as flight haul or rival's presence. Once the decision of rapid expansion was taken it actually made the the airline path-dependent, which can potentially undermine her LCC attributes and cost advantage.

2.5 Conclusions

This paper aimed at developing an empirical model for the analysis of entry decisions of Gol Airlines, the first low cost carrier in Latin America. By making use of Amemiya's Generalised Least Squares (AGLS) it was possible to estimate a route-choice model associated with a flexible post-entry equilibrium profits equation, and in which some of the regressors were treated as endogenous.

Results revealed market size and rival's route presence to be relevant indicators of underlying determinants of profitability. The consistency of Gol's decision making with the pattern of entry classically established by Southwest Airlines – with stronger preference for dense and short-haul routes – was investigated and was not rejected for the start-up year (2001). Unambiguous evidence was found, however, that Gol deviated from this paradigm towards a standard of operations more in accordance with the JetBlue Airways' paradigm (higher average stage length), in 2002, when compared to 2001. This tendency engendered diversification of portfolio of routes, instead of specialisation in one single business approach.

The main reason for that deviation is associated with country idiosyncrasies like unobserved economies of scope, which probably influenced Gol in the strategic decision of not to focus only on non-stop short flight sector markets, but to put into practice a modified version of JBP – that is, considering long-haul markets but with many stops and connections.

Appendix 2.1 – Additional Statistics

Table 2. 12 - Matrix of Correlations of Variables

Variable	$\ln den_{kt}$	$\ln sdr_{kt}$	$(\ln den_{kt})^2$	$(\ln sdr_{kt})^2$	$\ln den_{kt}$ $*\ln km_k$	$\ln den_{kt}$ $*\ln sdr_{kt}$	$\ln km_k$ $*\ln sdr_{kt}$
$\ln den_{kt}$	1.000						
$\ln sdr_{kt}$	0.422	1.000					
$(\ln den_{kt})^2$	0.374	-0.177	1.000				
$(\ln sdr_{kt})^2$	0.206	0.943	-0.287	1.000			
$\ln den_{kt}*\ln km_k$	0.992	0.420	0.375	0.208	1.000		
$\ln den_{kt}*\ln sdr_{kt}$	0.847	0.310	0.630	0.083	0.844	1.000	
$\ln km_k*\ln sdr_{kt}$	0.412	0.973	-0.168	0.933	0.427	0.321	1.000
$\ln km_k$	0.074	-0.003	-0.059	0.061	0.131	0.058	0.194
$(\ln km_k)^2$	0.067	-0.002	-0.064	0.066	0.124	0.052	0.194
$\ln den_{kt-1}$	0.795	0.282	0.497	0.104	0.787	0.763	0.270
$(\ln den_{kt-1})^2$	0.568	-0.018	0.862	-0.154	0.566	0.700	-0.019
$\ln sdr_{kt-1}$	0.246	0.734	-0.079	0.695	0.246	0.275	0.729
$(\ln sdr_{kt-1})^2$	0.083	0.658	-0.189	0.698	0.085	0.102	0.673
$\ln den_{kt-1}*\ln km_k$	0.788	0.277	0.497	0.103	0.795	0.762	0.285
$\ln den_{kt-1}*\ln sdr_{kt-1}$	0.762	0.347	0.602	0.156	0.762	0.865	0.340
$\ln km_k*\ln sdr_{kt-1}$	0.244	0.717	-0.079	0.694	0.259	0.280	0.763
$\ln seats_{kt-1}$	0.125	-0.425	0.383	-0.371	0.131	0.184	-0.379
$\ln swe_{kt-1}$	0.667	0.596	0.427	0.460	0.667	0.762	0.604
$\ln asz_{kt-1}$	0.289	0.017	0.315	0.073	0.309	0.396	0.118

Table 2. 13 - Hypothesis Tests – AGLS Model

Test	Description	H_0	Statistic	P-Value
Endogeneity	*Smith-Blundell Test (1986)*	*All explanatory variables are exogenous*	15.49	*0.03*
Heteroskedasticity	*Likelihood-ratio/Maximum-likelihood heteroskedastic Probit*	*Homoskedasticity*	1.23	*0.75*
Relevance of instruments (test of correlation with included endogenous variable)	*Partial R-squared of excluded instruments (min)*		0.55	
	F Test of excluded instruments - joint significance (min)	*Instruments are not relevant*	105.20	*0.00*
Validity of Instruments (overidentification/orthogonality test of all instruments)	*Sargan Test*	*Instruments are orthogonal to the error*	1.87	*0.60*
	Bassman Test	*Instruments are orthogonal to the error*	1.82	*0.61*

3. Localised Competitive Advantage and Price Reactions to Low-Cost Carrier Entry

3.1 Introduction

Competition between rapidly expanding low cost carriers (LCC) and traditional network full-service carriers (FSC) has recently become one of the most significant issues regarding the airline industry. Although basically a phenomenon of fully or partially liberalised markets - and thus dating back to the US deregulation process of the 1970s -, it was only recently, however, that the LCC segment won recognition as a relevant and distinct business strategy as well as profitable market niche. Following the successful paradigm of the pioneer Southwest Airlines, in the United States, airlines such as Ryanair and EasyJet, in Europe, flourished in the market, and soon the concept has spread worldwide. Moreover, this segment is expected to expand considerably within the next few years, and this has undoubtedly been forcing legacy carriers to respond progressively - a movement that is shaping the frontiers of competition in the industry.

This paper aims at empirically investigating the entry of the Brazilian LCC Gol Airlines, in the domestic market, in 2001, by focusing on the *price reactions* by the major FSC incumbents. Following Evans and Kessides (1993), here I make use of an empirical approach that makes possible to uncover the determinants of pricing power in the industry ("localised competitive advantage"), a feature regarded as a precondition for pinpointing the airlines' patterns of behaviour with respect to *de novo* entry and also for better understanding competition in a recently liberalised airline market.

Early contributions to the literature on entry focusing on airlines are Berry (1992), Whinston and Collins (1992) and Joskow, Werden and Johnson (1994). With respect to airline pricing behaviour, Evans and Kessides (1993) report several studies investigating post-US liberalisation conditions, which they classified into two different phases: the first-generation papers, with the methodology of inferring the effects of market structure variables on prices from cross-sectional variation over routes ("inter-routes" investigation), as in Bailey and Panzar (1981) and Hurdel et al. (1989); and the second-generation papers, aiming at accounting for firm heterogeneity within a route ("intra-route" investigation), as in Borenstein (1989) and Berry (1990).

Commonly, studies in both phases targeted testing the contestability theory and arrived at the conclusion that local market structure matters in the airline industry, and then variables like concentration levels have significant effect on prices. What is more, second-generation studies provided evidence for the significance of market share measures as determinants of within-route competitive advantage, and therefore called attention to the consequences of dominance: "*consumers are willing to pay a premium for the services of the dominant airline* [at an airport]" (Berry, 1990). In fact, those studies usually found relevance for both sorts of measures, market share and concentration, and thus conciliating different IO traditions[46].

In contrast to the consensus of the relevance of considering firm-specific disaggregation in pricing analysis, debate was established on at which level structure affects performance in this industry: either if at the route or at the airport level. Evans and Kessides (1993), for example, argue that, due to linear route system replacement by hub-and-spoke strategies, the increasingly control of airport facilities by fewer airlines, the advent of frequent-flyer programmes and the usage of travel agent commission overrides, "*the bulk of any deviation from competitiveness in the airline industry is (now) associated with airport characteristics rather than with the structure of routes*"[47]. By making use of route-specific fixed-effects, they found only airport market share effects as statistically significant for the US domestic market, contrary to the results of Borenstein (1989).

More recently, there have been some few studies on the specific subject of pricing behaviour in response to LCC entry: firstly, Dresner, Lin and Windle (1996), which found significant spillover impacts of LCC entry onto other competitive routes, as on other routes at the same airport and on routes at airports in close proximity to where entry occurred; this analysis was performed by inspecting, among others, the entry of Southwest Airlines into the Baltimore-Washington International Airport, in 1993. Secondly, Windle and Dresner (1999) investigated the impacts of entry by ValuJet into Delta Airline's hub, Atlanta, and refuted the US DOT's

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[46] Slade (2004b) provides a detailed discussion of the "market share" and "market structure" models within the Industrial Organisation.

[47] Levine (1987) is one of the most influential papers on this issue.

claim that the latter increased fares on non-competitive routes to compensate for lost revenues on the competitive routes. And finally, Morrison (2001) examined the total extent of Southwest's influence on competition, by investigating its impacts with actual, adjacent and potential route presence, on other carriers' fares in 1998, obtaining a result of 20 per cent of US airline industry's domestic schedule passenger revenue for that year.

This paper estimates a pricing equation to investigate the effects of LCC entry, in the same way of its predecessors. There are some crucial distinctions, however. Firstly, it promotes a previous analysis of the sources of the incumbents' **competitive advantage** – in terms of the determinants of pricing power –, which is certainly relevant for understanding the patterns of price reactions; as Evans and Kessides (1993), here it is possible to draw inference on the location of competition (whether at the airport or the route level, or both) and therefore producing more evidence to the Borenstein-Evans and Kessides's debate.

Secondly, as it is disaggregated at the firm-level, it explicitly deals with elements of **product differentiation** as significant determinants of entry and post-entry competition, and allows for heterogeneity due to both airlines' and routes' idiosyncrasies. And last but not least, by controlling for **city-specific fixed-effects**, it is in a position of accounting for the econometrician's unobservables that could affect incumbent's pricing behaviour between routes; this represents an extension of Evans and Kessides (1993)'s framework in order to permit identifying route-specific effects such as the impacts of LCC entry and constitutes the core of the paper. Actually the belief here is that the proposed methodology constitutes an improvement over previous literature precisely because it permits one to examine FSC's price reactions along with the three aforementioned issues using one single econometric framework.

The paper is divided into four parts: firstly, in Section 3.2, it presents the background of the deregulation measures of the airline industry in Brazil and the characteristics of the newcomer in the market; secondly, one stylised fact about LCC positioning is presented in Section 3.3; then the empirical framework is detailed in Section 3.4 (methodological approach, data description and model specification), and estimation results are displayed and discussed in Section 3.5; finally, the conclusions are presented.

3.2 Background of the Deregulation Process and Entry

The removal of regulatory barriers in the Brazilian airline industry since the early nineties had crucial role in the process that ultimately led to the entry of Gol, the first scheduled low cost carrier in Latin America and to an unprecedented increase in degree of competitiveness in the sector. See Section 1.2 for an overview of process of liberalisation of the industry in Brazil.

The LCC market niche is usually associated with the ***Southwest Airlines Paradigm*** (SWP), mainly because that airline pioneered this sort of operations, during the seventies, and because her standards are deliberately reproduced successfully around the world[48].

The most widely known characteristics of this paradigm, according to Silva and Espírito Santo Jr. (2003) are: fleet standardisation; simplification or elimination of in-flight service; use of less congestioned secondary airports; direct sales to consumers; ticketless or electronic tickets; dense, short-haul, point-to-point flights with no interlining or transfers, which means a simple network structure, with absent or weak feed to long-range flights; single-class cabin lay-out; simple or no frequent-flyer programme; high level of fleet utilisation; and highly motivated employees[49]. Moreover, LCC's are typically associated with a very aggressive pricing strategy, typically with the use of simplified fare structure with few or no restrictions, and low one-way fares[50].

The cost advantage obtained by Southwest Airlines emerged mainly from a very careful choice of markets, which usually makes it possible to focus on short-haul routes and on markets where it can have dominant market share, and to exploit economies due to higher seating density and higher aircraft utilisation. According Boguslaski, Ito and Lee (2003), Southwest has resulted in unit costs that are 28 to 51 per cent lower than the US major airlines, considering 2001 US DOT's unit cost figures.

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[48] As the Chief Executive of Ryanair once said: "*We went to look at Southwest. It was like the road to Damascus. This was the way to make Ryanair work*" (Doganis, 2001).

[49] This description refers to what can be considered "classic" Southwest paradigm. One has to bear in mind, as we will see below, that Southwest's actual patterns of operations has had some changes recently: "*its strategy evolved during the latter half of the decade to include a much more heterogeneous mix of markets, including a number of markets which were both long-haul and surprisingly thin*" (Boguslaski, Ito and Lee, 2003).

[50] Tretheway (2004) points out that the introduction of low one way fares ultimately served to undermine the ability of the FSC's to price discriminate, and not only resulted in a considerable increase in competition but also

Gol Airlines was not only the first scheduled LCC of Brazil, but also within all Latin America, with operations started in January 2001[51]. Owned by Grupo Áurea, a conglomerate that owns 38 companies and a major operator of urban and long-distance coach services across Brazil, the airline was in a position of enhancing airport accessibility by setting counters at key airports for plane/coach connections and free bus transfers in selected cities. For additional characteristics of Gol airlines, see Section 2.2.

It is important to emphasise, however, that the Brazilian airline industry is particularly difficult for the implementation of typical LCC operations, mainly because of lack of secondary airports with required infrastructure: "*There are no secondary airports near major Brazilian cities able to handle midsize jet operations (737s, A320/319, etc.)*", report Silva and Espírito Santo Jr. (2003). What is more, the policy orientation followed by DAC since the First Round of Liberalisation was clearly to facilitate newcomers' entry in order to reduce entry barriers as much as possible. On account of that, and considering that the major Transbrasil Airlines started exiting the market in mid 2001, it was relatively straightforward for Gol to enter the same airports of its opponents, in direct competition with incumbents in virtually all situations.

3.3 Reactions to Entry and An Stylised Fact About Low-Cost Carrier Positioning

There are a number of ways incumbents can respond to LCC entry. Matching prices is the most commonly used but usually has undesirable outcome if employed without other strategic moves, for example, product differentiation: "*Price competition with homogenous services triggers a vigorous price war and erodes the profits of operators. Therefore, taking entry as given, there exists a strong incentive for both the incumbent and the entrant to differentiate their product in order to recover some profits*" (De Villemeur, Ivaldi and Pouyet, 2003). Besides that, differences in efficiency between newcomer and incumbents may be crucial in determining the ultimate post-entry result. Even reasonably assuming both product

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in an exposure of the problems associated with the FSC business model.

[51] Gol Airlines and U Air (Uruguay) are the only scheduled LCC's based in Latin America nowadays. Some North-American LCC's provide service to Mexico and the Caribbean, such as JetsGo, Frontier and JetBlue, but do not have operational basis at the region (source: website lowcostairlines.org).

heterogeneity and efficiency gap between FSC's and LCC's, the sort of incumbents' reactions may still be determined by the degree of market segmentation and brand loyalty, network structure, ability to commit to pre-entry strategy, newcomer's expected capacity, etc.

Below is a list of possible incumbents' post-entry pricing decisions. Here I further assume there are two major demand segments, one with higher willingness to pay (business travellers) and the other with lower willingness to pay (leisure travellers), and that there is some degree of interdependency among them. Therefore, in case of LCC's entry, FSC's may:

a. Not to react in prices, keep existing fare structure

b. React in prices, keep existing fare structure

b.1 Reduce prices for leisure travellers and maintain prices for business travellers

b.2 Reduce prices for leisure travellers and increase prices for business travellers

b.3 Reduce prices for both segments

c. React in prices but migrate to a simplified fare structure or to single fare scheme

The cases a, b.1 and b.2 may be representative of markets with a very high participation of business travellers and in which the disutility associated with travelling with the LCC is high (higher degree of product differentiation). It may be more profitable for the incumbents, in these cases, to increase quality or to stimulate brand loyalty, either **before or after entry** (commitment, for example), and either **with or without price changes**. This may be performed, for example, via more flights - the "*cut fares and add flights*" response (see Whinston and Collins, 1992, for the entry of People Express in the eighties). Other actions may include more advantages to first-class or business-class flyers, better service, more and easier frequent-flyer upgrades, etc.

b.1 and b.2 can be also representative of a situation in which the LCC is capacity constrained and there is strong demand segmentation. In this case, the FSC's may prefer price competition for leisure travellers (using some of the lower fares available in their existing fare structure) in order to lead the LCC to full utilisation, specially during the peak time: this ultimately permits the FSC to restore the monopoly situation with respect to the business traveller segment (for example, last-minute purchases), increasing its average yields and profitability, specially if followed by increases in own capacity to also capture the new demand generated by the fare war.

When the FSC's possess a well consolidated hub-and-spoke structure, the decision between "price react" and "not to price react" is also conditioned by potential network effects. For example, De Villemeur, Ivaldi and Pouyet (2003) emphasise that in this case not only the incumbents may have a substantial cost advantage over the potential entrants, but also a strategic advantage depending on the existence of substitutabilities and complementarities in the network. In fact, entry on a given route (a "local market", part of a network) may have positive spillover effects on the connecting markets served by the incumbents: "*By staying on the market where entry occurred, the incumbent engages in a vigorous price competition (which also erodes the profit of operators on this market). Since connecting services are complements due to the hub-spoke feature of the network, the price competition increases the demand on the complementary markets*" (De Villemeur, Ivaldi and Pouyet, 2003).

Another strategic move of incumbents may be to reduce prices for both segments (b.3), as mentioned by Alderighi et al. (2004). The authors interpret this reaction as being a direct consequence of the appeal of the LCC for business travellers, which engenders interdependence of both segments. In such cases, "*pricing strategies on the business market and on the leisure market have to be coordinated*". One can observe that b.2 is also an example of coordinated pricing strategies; in b.3, however, the willingness-to-pay of business travellers is certainly lower.

And finally, the incumbent can migrate from existing complex fare structure based on yield management techiques, which is typical of FSC's, to a policy of simplified pricing and discontinuation of fare restrictions. The most extreme example of this strategy is Bmi, which in spring 2002 changed to a single fare scheme, removing all restrictions such as minimum stays, advance purchase, etc, to compete with newcomer LCC's (Donnelly, James and Binnion, 2004).

In terms of non-price reactions, one can cite **cost-cutting** (for example, in 2004, United Airlines became the first to delay payment into its pension plans in other to restructure costs), **enter bankruptcy** (a very common move by players in the US - the so-called "Chapter 11", the bankruptcy-court protection which allows airlines to restructuring its loans, leases and capital structure), or even **to become a LCC or create a new LCC subsidiary** in the market:

Delta's Song, Brittish Airways's Go-fly are classic examples of LCC subsidiaries.

A very important determinant of the patterns of reaction by incumbent is related to the LCC **positioning** in the market. In Chapter Two, I presented some paradigms for LCC operations and, as mentioned before, the classic benchmark is the SWP; these paradigms are representative of the way newcomers will place their service in the market and, above all, in which sort of markets they will enter. With the idea of paradigms one has also a notion of how LCC entry will affect existing FSC's and the sort of strategic movement that will emerge from this positioning.

Here I make use of the SWP in terms of LCC positioning, and draw attention to two features[52]:

1. the focus on short-haul operations; and

2. the preference for underserved routes (Doganis, 2001) or routes in which she could have a dominant position. Dominance here is defined precisely in the same way as Borenstein (1991), that is, by considering airline market position (or "presence") in terms of market share measures either at the route or at the airport level[53].

As seen in Chapter 2, in 2001 Gol had a higher propensity to follow a pattern of entry in line with the SWP, but increased in diversification from 2002 on. Therefore, one knows *ex-ante* that for the period covered in this chapter (2001) the airline was more likely to be observed on shorter-haul (typical SWP) and well-served/dense routes (atypical), and that a broadening of the portfolio of markets of the LCC was in course.

Another relevant issue is that there is no clear cut-off that divides either "short-haul" from "medium-to-long-haul" markets or "underserved" to "well-served" markets. However, continuous variables such as route flight distance and incumbents' market share are expected to influence the degree of perceived product differentiation between airlines as they determine

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[52] As Windle and Dresner (1999) state: "*Southwest Airlines focuses on short haul routes into underutilized or secondary airports, and as a result often does not directly compete with established carriers*".

[53] Borenstein (1991) measures dominance using different proxies and getting consistent results. He uses shares of passengers, shares of aircraft departures, shares of seat-departures, and share of seat-mile-departures. The latter is developed so as to "*weight by plane size and the average size of purchase (distance) made by each firm's customers*", and is the unit of measurement of dominance used in the empirical model here (see Section 4).

the attributes of each market.

Given the above description, one can consider the problem of Gol's entry in the Brazilian airline industry as the following: suppose an entry situation where the newcomer has a differentiated product from the incumbents. Besides that, consider that the characteristics of markets (routes) entered condition the degree of product differentiation between LCC and FSC competitors. And finally, consider, as indicated above, that main variable route characteristics are flight distance and incumbents' presence (route dominance). This can be summarised by the stylised fact below:

> **STYLISED FACT:** *The degree of product differentiation between the full service airlines (FSC) and the low cost carrier (LCC) is lower in short-distance routes and in less dominated routes. In these kinds of markets, the newcomer operates a "typical" market niche, that is, as in the traditional Southwest Airlines way (LCC_1). On the other hand, if the newcomer chooses to enter either rather dominated or longer distance routes, then the perceived degree of product differentiation is higher (LCC_2).*

The intuition behind the stylised fact above is that there is lower competitive advantage to low cost operations in LCC_2 markets, on account of two factors. Firstly, higher disutility of longer flight haul (because of LCC's lack of in-flight meals and lower leg space, for instance); actually, one evidence for that is the fact that airlines usually have a broader variety of in-flight frills in, for example, intercontinental flights from US and Europe, than for flights within either regions. Quality competition may then be much more apparent in longer-haul markets, whereas price competition is usually tougher in short-haul markets.

And secondly, due to higher FSC presence, market entry is less effective due to lower levels of recognition by consumers (the "dominant-firm advantage" effect[54], discussed in

[54] Berry (1990), for example, when describing airport dominance in the US market, states that "*incumbent airlines are the major source of financing for many airports and therefore gain a large degree of bureaucratic control over airport operations. This control may enable them to block the entry or expansion by rivals. Airlines with a large presence in a given city also gain advantages from frequent flyer plans and nonlinear travel agent commission schedules*". In terms of route dominance, as mentioned before, one can consider competitive advantage of large route presence coming from lower distance between flights (which appeals to business travellers) and therefore can be considered a proxy for higher service quality levels. The dominance effect can be regarded as one of the main reasons for Southwest's avoidance of head-on competition with incumbents in the United States.

Borenstein, 1991), in non-dominated routes. Also, in this situation the newcomer LCC is usually in disadvantage with respect to the number of flight frequencies, having as a consequence a relatively higher average period gap between flights (higher "schedule delay").

Figure 3.1 illustrates the abovementioned ideas in a scheme of horizontal product differentiation:

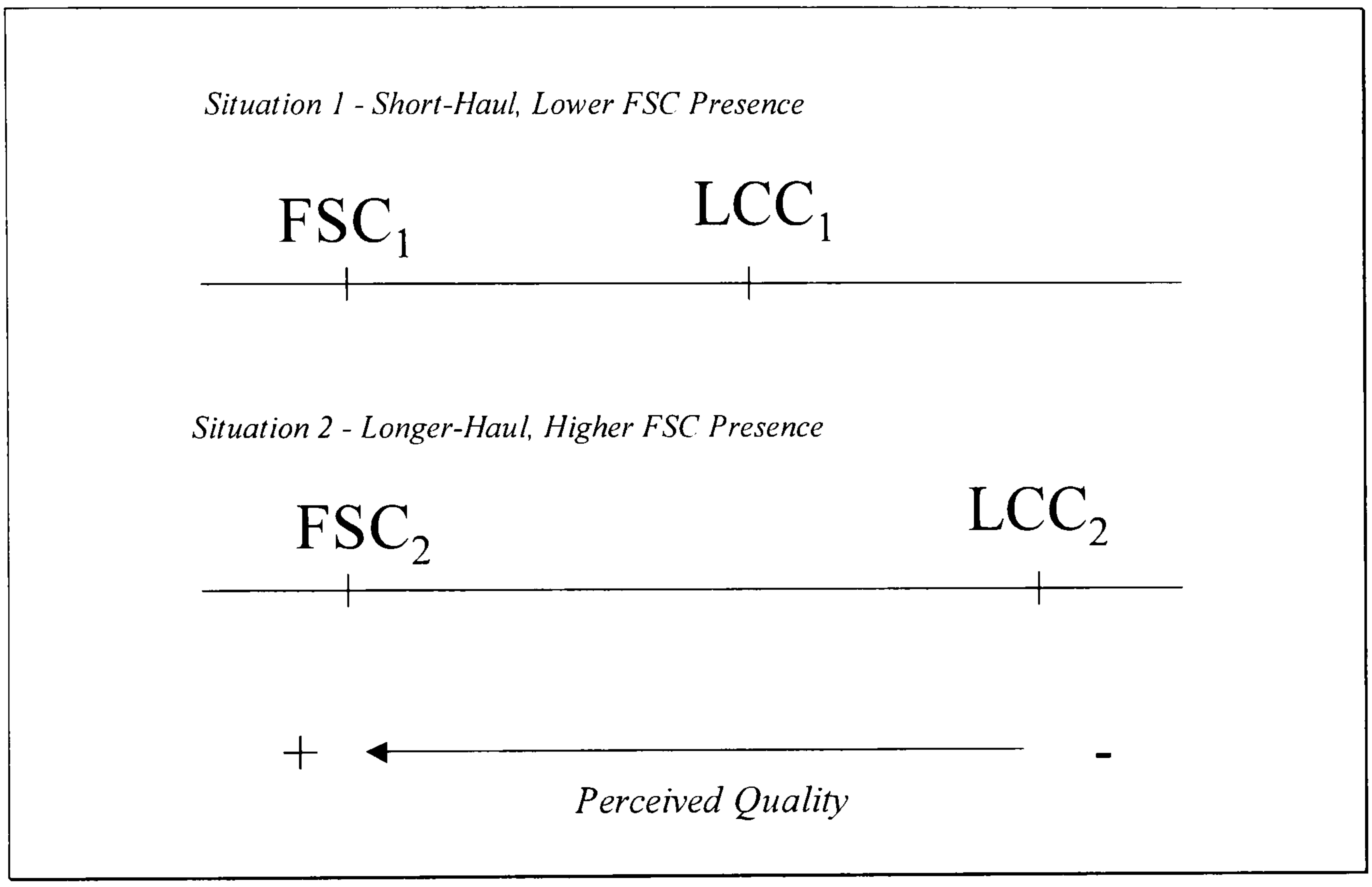

Figure 3. 1 - Low-Cost Carrier Market Positioning

In summary, as a LCC, Gol is expected to enter markets with short-distance and not dominated by incumbents, as with the Southwest paradigm. In this sort of markets, it can be argued that either the disutility of travelling with LCC is lower or the competitive advantage of incumbents is lower. And thus the probability of Gol capturing a broader range of consumers (not only budget travellers) is higher, as the product is perceived to be less heterogeneous than the FSC's' (LCC_1 is therefore near FSC_1, in Figure 3.1).

On the other hand, product differentiation becomes more evident in both long haul and well-served markets. In the first case, the longer flight time may be regarded as a disadvantage if passengers have lower in-flight comfort[55]; in the second case, one may find that route

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[55] This is even more clear in the Brazilian case, in which Gol usually offers flights with many stops and/or connections, specially for long-haul routes. The disutility associated with the LCC is, therefore, higher on routes

presence by incumbents is sufficient enough to provide them with competitive advantage (with a higher distance between LCC_2 and FSC_2, in comparison to LCC_1 and FSC_1). In both sorts of markets, it is expected to reactions to enter to be less tough.

Once having stated the stylised fact above, one is able draw inference on price reactions to entry. Undoubtedly, one expects intensive incumbents' reactions in price following LCC's entry, a fact extensively reported by literature; for instance, Whinston and Collins (1992) described a "*dramatic fall of roughly 35% in the average price of incumbents on the 15 markets entered by People Express in a given year [of the mid eighties in the US market]*". However, one issue that remains to be investigated is how (and if) incumbents' responses to LCC's entry vary across routes, and what the determinants of such variation are. This issue can be illustrated by having a brief inspection on data available, in the light of the stylised fact. For example, by isolating short from medium and long-haul routes, one is able to investigate whether there is uniformity of price reactions across routes.

Table 3.1 permits having a general idea on the matter, comparing the average yields on routes entered with routes not entered by Gol within the same flight-distance classification. **"Yield"** is defined here as total operating revenues divided by the multiplication of total revenue passengers and kilometres flown[56].

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with higher flight sector.

[56] Note that whereas yields are defined on per-kilometre basis, the average price is defined on a per-passenger basis.

Table 3. 1 - Impacts of Entry under Alternative Route Classification[57]

Classification	Cut-Off (Km)	N	Average Yield		Diff. %
			Entry = 0	Entry = 1	
Short Haul	0-500	42	0.609	0.386	-37%
Medium/Long Haul	501-	72	0.371	0.304	-18%
Short Haul	0-600	52	0.576	0.380	-34%
Medium/Long Haul	601-	62	0.363	0.296	-18%
Short Haul	0-700	62	0.565	0.367	-35%
Medium/Long Haul	701-	52	0.347	0.288	-17%
Short Haul	0-800	70	0.542	0.365	-33%
Medium/Long Haul	801-	44	0.333	0.284	-15%
Short Haul	0-900	84	0.513	0.355	-31%
Medium/Long Haul	901-	30	0.324	0.274	-16%

As one can infer from Table 3.1, the price reactions caused by entry (measured by the percentage difference in incumbents' "Average Yield") were much tougher in short-haul routes (that is, higher than 30%) than on medium-to-long-haul routes (below 20%). This is robust to alternative route classification with respect to distance (cut-offs of 500, 600, 700, 800 and 900 km).

The present paper approaches this issue by considering product characteristics and market niche positioning as a possible explanation for this sort of variation in incumbents' intensity of response. One can expect the patterns of both entry and reactions to entry to be determined by the degree of perceived product differentiation by the newcomer airline. This issue of entry and product differentiation is empirically inspected by analysing the ***actual patterns of price reactions of incumbents*** in some selected city-pairs in the domestic airline market.

[57] Data supplied by DAC, as will be detailed in Section 3.4. Unfortunately, data is not disaggregated by fare class and therefore it is not possible to pinpoint different patterns of price reactions for business and leisure segments.

3.4 Empirical Analysis

3.4.1 The Methodology

Following Evans and Kessides (1993), airline pricing studies can be classified into the following categories: first, the **inter-routes analysis**, in which data is disaggregated at the route level, and usually a cross-section of routes is considered; market-level variables such as flight distance, number of airlines, concentration, route presence of LCC's, presence of LCC on adjacent routes, etc. are used in order to estimate an average price equation. Examples in the literature being Dresner, Lin and Windle (1996) and Morrison (2001), among others.

And second, the **intra-routes analysis**, in which data is disaggregated at the airline level; carrier-specific characteristics such as route market share, airport market share and network size out of an airport, percentage of seats in direct or round-trip flights, etc., are used to control for effects of heterogeneity among firms in the market. Examples being Borenstein (1989), Berry (1990) and Evans and Kessides (1993).

The methodology I follow here is an intra-routes analysis of the pricing decisions of FSC incumbents in response to Gol Airlines' entry in the Brazilian airline industry. In order to do so, the basic framework considered here is the fixed effects procedure of Evans and Kessides (1993)[58]. In their study, Evans and Kessides control for inter-route heterogeneity in price by having individual route effects, a procedure that can be implemented in a very straightforward way by, for example, employing the least-squares dummy variables (LSDV) estimator with route-specific dummies. These dummies ultimately serve to "*control for (...) omitted route-specific variables that can significantly bias the parameters estimates of the price equation*" (Evans and Kessides, 1993). Their econometric framework can be summarised by the following pricing relation:

$$\ln\left(price_{ikt}\right) = X'_{ikt}\beta + v_k + \varepsilon_{ikt} \qquad (7)$$

[58] In their words, "*we note that most of the sample variation in price is due to differences at the route level that are unmeasured and invariant to a carrier's identity*"

where $price_{ikt}$ is the average price of airline i on route k and time t (see the empirical definition in 3.4.3), X_{ikt} is a vector of variables that are airline, route and time specific. v_k are route-specific effects, and ε_{ikt} are the disturbances, whereas β is the parameter vector of interest.

Nevertheless, it is important to emphasize that the econometric procedure described above is subject to a major limitation with respect to the identification of variables that do not have within-route variation, such as concentration level and LCC presence, the latter a major issue in the present paper. In order to overcome this problem, without disposing of the controls for heterogeneity across routes, the authors also make use of a random-effects model, and then estimate the following model:

$$\ln\left(price_{ikt}\right) = X'_{ikt}\beta + Z'_{kt}\gamma + v_k + \varepsilon_{ikt} \qquad (8)$$

where Z_{kt} is a vector of variables that are route-specific and γ is the associated parameter vector. This procedure is not immune to criticism, however, as the main hypothesis of this approach is that route effects v_k are not correlated with X and Z[59] – otherwise estimates of β and γ will be biased. In fact, when testing for such correlation by making use of the Hausman test of the equivalence between fixed and random effects, they thoroughly rejected the no-correlation hypothesis. This caused severe problems of inference with respect to route-specific variables, potentially making their framework inappropriate for investigating the impacts of LCC entry, the ultimate goal here.

Fortunately, it is possible to devise an econometric procedure that overcomes this problem without completely abandoning the core idea of the analysis of Evans and Kessides (1993), which aims at the control of most of route-specific idiosyncrasies. Here I propose controlling for the effects of route origin and destination cities (CFE), instead of controlling for route-specific effects (RFE). Therefore, for each city k there will be two effects to be controlled – one for the city-of-origin k_1 (v_{k1}) and another for the city-of-destination k_2 (v_{k2}):

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[59] This assumption is likely to be invalid; for example, unobserved advertising effects on airline's pricing might be correlated with the presence of LCC, or the unobserved premium due to a higher proportion of business travellers might be correlated with the proportion of non-stop flights, etc.

$$\ln\left(price_{ikt}\right) = X'_{ikt}\beta + Z'_{kt}\gamma + v_{k1} + v_{k2} + \varepsilon_{ikt} \quad (9)$$

By following the above procedure, one is able to control for unobservable effects at both the origin and destination endpoint cities, which can be done by city dummies – these provide an economical way to capture and control for a large number of truly significant variables, which can be regarded as being actually city-specific, instead of route-specific: also, most of them are in fact unobservables (from the point of view of the researcher). See Section 2.3.2 for a list of some of the effects that may be controlled by the city dummies.

Most of these effects are expected to generate persistent heterogeneity in the error structure across cities, which can be controlled via the city-specific dummies. Besides that, and provided that each city possesses at least one route (and ideally groups a reasonable deal of routes), it has the advantage of permitting the identification of the subset of variables that do not vary within routes, and particularly the presence of the LCC. Another advantage is that it is not necessary to rely on the hypothesis of no-correlation between X and Z and the route effects, as with the random effects model[60].

3.4.2 Data Discussion

The data sample used here was collected from published and non-published data disaggregated by airline at the directional city-pair level[61]. Kindly supplied by Brazil's Department of Civil Aviation (DAC), the sample consists of airline-specific data for 82 city-

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[60] One point must be emphasised, however: although the proposal of controlling for the effects of groups of routes (endpoint cities) instead of individual route effects can be thought as permitting a consistent estimation under the LSDV approach, further investigation into the asymptotic properties of this particular setting are still required. Asymptotically, if the number of routes, k, goes to infinity, the number of cities tends to increase at a lower rate, which might confirm its properties. Moreover, as it will be pointed out in next section, as the number of airlines per route in the data sample is notably low (the average is between 2 and 3 airlines per route), one would think as a reasonable procedure to control for groups of routes instead, in order to increase the statistical significance of estimates (the average number of routes per city is between 8 and 9).

[61] In the sense that flights going from A to B are treated differently as the ones from B to A. Evans and Kessides (1993) also use the city-pair definition of a route; in contrast, Morrison (2001) implements an analysis disaggregated at the airport-pair level, in order to capture the effect of "adjacent" route presence. Berry, Carnall and Spiller (1996), Evans and Kessides (1993) and Borenstein (1989) use directional markets also makes use the assumption of directional markets; on the other hand, Ito and Lee (2003b) and Richard (2003) use non-directional markets.

pairs over October and November 2001 (all information is monthly supplied from all scheduled airlines to DAC according to specific legislation within the country). This sample is representative of 76 out of the country's 100 densest airport-pairs[62], and accounts for 61% of total regular domestic air traffic in Brazil. Final sample size consists of 408 observations, for an average number of airlines between two and three per route.

The dataset corresponds almost entirely to the selection present in DAC's **Average Yield of Monitored Airport-Pairs Report**. Although data in this report is unique in a sense that there is no other more accurate source of information on yields in the Brazilian airline industry, this dataset contains at least three major problems: in terms of potential selection bias, there can be concerns regarding the period involved and the choice of routes; and in terms of data reliability, there is a principal-agent problem.

Firstly, one could argue that the subsequent months after the events of September 11, 2001, could not be representative of typical airline activities. Notably, this could be a major problem if the dataset consisted of international routes, which were more subject to the structural change in economic conditions of the occasion; however, DAC's dataset is formed only by domestic airport-pairs, which served to minimise problems of abnormal interference in demand and cost conditions. This can be illustrated by inspecting traffic figures in DAC's 2001 Statistical Yearbook: in the fourth quarter of 2001, there were 6,982 million domestic pax-km against an average of 6,909 million in the first three quarters of that year, which clearly indicates that the industry was operating as usual during the period[63].

Secondly, it would be possible to indicate the relevant problem of route choice, as the sample does not consist of a complete set of densest airport-pairs. On the contrary, it is formed by a selection of routes sampled from a broader population of routes. When conducting the final process of liberalisation, in 2001, DAC selected a set of 126 airport-pairs in order to monitor airline's pricing behaviour; this set was chosen by using a mix of strategic, geographic, and economic criteria, rather than one homogeneous criterion of relevance such as density, and ultimately comprised the Average Yield of Monitored Airport-Pairs Report mentioned above.

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[62] As it will be seen below, airport-pairs were aggregated into city-pairs in order to generate the final database.

[63] The typical seasonality in Brazil consists of Q-2 and Q-3 with most of the business traffic (and business travellers constitute more than 60% of total traffic).

On account of that, here some procedures were employed in order to reduce the potentiality of selection bias in the sample choice, and thus only routes between airports present in the ranking of the thirty largest airports (in terms of traffic) were considered[64]. As a consequence, twelve routes were dropped from the original dataset; also, airport-pairs were aggregated into city-pairs, in order to permit comparison with the results of Evans and Kessides (1993)[65], and therefore the 82-city-pairs sample was generated[66].

Last but not least, it is important to mention the problem of asymmetry of information in the process of data collection. In fact, there is no Brazilian equivalent to the U.S. Department of Transportation's **Origin and Destination Survey**, a 10 % random sample of all tickets in domestic markets of that country. On the contrary, DAC relies on information provided monthly by airlines – more specifically, the average yield per airport-pair in the sample, aggregating all non-stop and one-stop traffic in a given market. In spite of the fact that DAC's price analysts double-check information provided by airlines by consulting fares on ATPCO's screens[67], one must take into account that database is subject to relevant principal-agent problems[68].

A final caveat related to the sample is the definition of city-pair used here. Due to the procedures of data collection employed by DAC, here a **city-pair** includes only a subset of the direct traffic between two given cities: the non-stop and the one-stop flights. This explicitly excludes more-than-one stop flights and indirect traffic (flight connections), which certainly constitutes a major limitation for the analysis. It is important to emphasise, however,

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[64] Other criteria were also experimented in conjunction with the 30-largest-airports rule. For example, the criterion of routes' density was used, with similar estimation results.

[65] Evans and Kessides (1993) use observations of only the fourth quarter of 1988, for the US airline industry. In that case, they had data disaggregated by airline, and controlled for route-specific effects.

[66] Some city-pairs were discarded from the original database due to some inconsistencies between the Average Yield Report and the HOTRAN Report, and also in order to drop observations from routes in which the participation of small regional airlines was abnormally high.

[67] ATPCO: Airline Tariff Publishing Company. ATPCO is the world's leader in the collection and distribution of airline fare and fare-related data, gathering information from more than 500 airlines over the world and distributing it to computer reservation systems, such as the ones of global distribution systems like Amadeus, Galileo and Sabre.

[68] The principal-agent problem here refers to the difficulties that arise under conditions of incomplete and asymmetric information when DAC (the principal) requests data from the airlines (the agents) but has no (or inefective) means of enforcing them to provide the most accurate informartion.

that this definition usually comprises most part of the origin-and-destination traffic between two given cities in Brazil.

3.4.3 Model Specification

The model specification used in this paper is the following:

$$\ln\left(price_{ikt}\right) =$$

$$= \alpha_0 + \alpha_1 snst_{ikt} + \alpha_2 spk_{ikt} + \alpha_3 asz_{ikt} + \alpha_4 cpms_{ikt} + \alpha_5 cms_{ikt}$$

$$\alpha_6 cphhi_{kt} + \alpha_7 chhi_{kt} + \alpha_8 \ln km_k + \alpha_9 \left(\ln km_k\right)^2 + \alpha_{10} preslcc_{kt} \qquad (10)$$

$$+\alpha_{11} preslcc_{kt} \quad \ln km_k + \sum_l u_{0l} DC_l + \sum_j u_{1j} FSC_j + u_2 DM + \varepsilon_{ikt}$$

Where **ln price$_{ikt}$** is the logarithm of price of incumbent airline i in city-pair k and period t. It is calculated by multiplying yields available in DAC's Average Yield Report by the flight distance of city-pair k. Nominal prices were used as inflation is negligible within the two months. It is expressed in local currency (R$) for the monthly, point-to-point traffic, supplied by DAC, and represents R$ per trip (one way). Only incumbent's (FSC's) prices are considered. Average yields are not disaggregated by fare class.

snst$_{ikt}$ measures the percentage of seats available in non-stop flights of airline i, on route k and month t. This fraction was calculated with the following expression: the total number of seats in non-stop flights over the total number of seats in all direct flights with either zero or one stop – which is in line with the abovementioned definition of city-pair. Data for total number of flights disaggregated by airline and by each day of the week is available in the Department of Civil Aviation's HOTRAN, "Horário de Transporte", a data system that generates reports containing operational information of all scheduled flights within the country (non-published information). This information was extracted from their system on a monthly basis for the period 2001-2002, and subsequently aggregated by year. Non-stop flights represent both lower disutility for the consumer, and lower costs for the airline. Prices may be higher or lower, depending on the balance between those two effects.

spk_{ikt} measures the percentage of seats available in peak-hour flights of airline i on route k and month t, and was calculated by means of the division of the total number of seats in peak-hour flights over the total number of seats in all direct flights with either zero or one stop. For this calculation, "peak time" was defined considering all flights with departure within 5am to 10am (morning peak) and 4.30pm to 10pm (evening peak) on weekdays, and those with departure from 7pm to 10pm on Sundays. DAC's HOTRAN Report provides the information of flight number / weekdays / departure times, which made possible the segregation into "peak" and "off-peak" periods. One would expect that the higher is one airline's percentage of seats on flights during peak-time, in comparison to the average, the higher is the competitive advantage of this firm and the higher will be her prices[69].

asz_{ikt} is the average number of seats per flight for airline i; weights were calculated based on the number of flight frequencies on route k. As stated in Borenstein (1989), "*On flights of more than 500 miles, larger equipment has a lower per-seat-mile cost (...). On the other hand, the quality of the product is higher on larger planes, which are generally more comfortable and are thought to be safer*". Therefore the sign of coefficient of aircraft size depends on both effects.

$cpms_{ikt}$ is a proxy for route presence, and consists of the market share of seats available of the i-th (incumbent) airline in city-pair k and time t; **cms_{ikt}** is a proxy for airport presence, and measures the average percentage of seats available on all origin and destination routes in both endpoints cities (aggregation of all airports within a city). Both $cpms_{ikt}$ and cms_{ikt} represent firms' relative positions (capacity) in the market at, respectively, route and airport levels, serving as indicators of *localised pricing power*, as with Evans and Kessides (1993)[70]. They also can serve as proxies for convenient service of dominant airlines at the route and airport levels and higher advertising levels (if advertising is increasing in the level of operations out of a city); cms_{ikt} can also be regarded as a proxy for the effects of frequent flier programmes. $cpms_{ikt}$ and cms_{ikt} are expected to have coefficients with positive sign, meaning that

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[69] There can be much variability in prices according to flight-time, especially in more congestioned airports, such as Congonhas (CGH) in São Paulo.

[70] After the Second and Third Rounds of Liberalisation, changes in capacity were made easier via a simplification in the process of flight frequency requests to DAC (See Chapter One). One can argue that, apart from highly congested airports, such as CGH and PLU, capacity is short-run adjustable for most of the routes.

dominance of capacity in the market confers competitive advantage to airlines.

cphhi$_{kt}$ is the Herfindhal index of concentration calculated at the city-pair level (the market share variable used in this calculation was cpms$_{ikt}$); **chhi**$_{kt}$ is the same measure, calculated at the city level, that is, extracting a simple average of origin and destination endpoint cities' concentration (market share variable was cms$_{ikt}$).

ln km$_k$ and **(ln km**$_k$**)**^{2} are the logarithm of the distance of route k, and its square. These variables consider the one-way distance between origin and destination airports. This information was provided by Department of Civil Aviation's Laboratory of Simulation and was calculated by using the polar coordinates method. One important issue about these variables is related to distance calculation when the sample presents more than one airport in one or both endpoint cities of the given route. In both cases the latitude and longitude of the airports closest to the city centre were calculated and considered representative of the distance between cities.

preslcc$_{kt}$ is a dummy variable that accounts for the presence of Gol Airlines in the city pair on route k and time t. This variable is indicative of the price reactions to Gol's presence undertaken by the FSC's within the sample period. As the presence of the LCC was rather recent – ten months only, but could be lower, depending on the route –, one can regard it as controlling for the reactions to entry by incumbents in the market.

preslcc$_{kt}$ * **ln km**$_k$ is a slope shifter of preslcc$_{kt}$, that is, measures how the price reactions to entry were affected by the haul of the city pair, and thus serve, along with cpms$_{ikt}$ and cms$_{ikt}$, as a straightforward way to inspect the significance of the stylised fact presented in last section, with respect to the effects of flight distance on product differentiation in the market. One would expect a positive coefficient associated with this variable, in case of product differentiation effects.

And finally, the **DC's**, **FSC's** and **DM** are, respectively, city-specific, incumbent-specific and month-specific dummies.

Table 3.2 below presents descriptive statistics of the variables in the model:

Table 3. 2 - Descriptive Statistics[71]

Variable	Description	Mean	Std. Dev.	Min.	Max.
$price_{ikt}$	*Average Price*	275.063	124.330	57.883	791.395
$snst_{ikt}$	*Seats on Non-stop Flights (fraction)*	0.799	0.316	0.000	1.000
spk_{ikt}	*Seats on Peak-Hour Flights (fraction)*	0.491	0.315	0.000	1.000
asz_{ikt}	*Average Aircraft Size*	120.582	266.815	50.000	211.680
$cpms_{ikt}$	*City-Pair Market Share (fraction)*	0.339	0.167	0.097	1.000
cms_{ikt}	*City Market Share (fraction)*	0.337	0.129	0.077	0.647
km_k	*Flight Distance*	836.2354	527.296	84.342	2695.487
$cphhi_{kt}$	*City-Pair Concentration Level*	0.345	0.198	0.058	1.217
$chhi_{kt}$	*City Concentration Level*	0.355	0.042	0.294	0.578
$preslcc_{kt}$	*Presence of LCC in the City-Pair*	0.640	0.481	0.000	1.000

3.4.4 Endogeneity, Instruments and Estimation Technique

Equation (10) in 3.4.3 contains the following potential endogenous variables: ln $price_{ikt}$, $snst_{ikt}$, spk_{ikt}, asz_{ikt}, $cpms_{ikt}$, cms_{ikt}, $cphhi_{kt}$, $chhi_{kt}$, $preslcc_{kt}$ and $preslcc_{kt}$*ln km_k. In order to inspect this issue, the procedure here was to first define instrumental variables likely to be helpful in estimating the model – once these instruments were obtained, I performed tests of the validity of instruments and tests of exogeneity.

With respect to the problem of endogeneity and identification, and by having a brief inspection at the literature on airline pricing, one can conclude that the most common instruments consider a combination of the following procedures:

1. use of exogenous demand and cost shifters;
2. use of demand and cost characteristics of rivals on the route or of the same firms on other routes; and
3. use of lagged, artificial or transformed variables.

[71] Source: DAC.

A combination of approaches 1 and 2, for example, is found in Berry, Carnall and Spiller (1996) and Borenstein (1989). In the former study, population and network characteristics at the endpoint cities are used in conjunction with the characteristics of other products in the market. They treat prices, market shares and spoke densities as endogenous.

In the latter study, a measure of the presence at the endpoint airports (in terms of emplanements, which he considers exogenous) is used as an instrument for endogenous route market share of passengers. Also, he instruments route Herfindhal by using a measure that accounts for the squares of shares of rivals, assuming that "*the concentration of traffic on a route that is not carried by the observed airline is exogenous with respect to the price of the observed carrier, e.g. TWA's price on Boston-Los Angeles route does not affect how the passengers it doesn't get are divided between American and United*".

On the other hand, Evans and Kessides (1993) prefer making use of approach 3, and develop a "restricted rank" of firms on a route - calculated in descending order, that is, the largest firm on the route has a rank of one, etc - in order to identify route market share. This rank is restricted as they set the largest value of the rank at three, a procedure undertaken in order to avoid the effect of small carriers, which market shares are not significantly different from their next closest competitors in the rank: "*With the restricted rank, we lump all but the two largest carriers on a route into one category, and we must assume that changes in prices for (...) small carriers will not be large enough so as to move them out of this group*".

Moreover, approach 3 is also employed by Evans, Froeb and Werden (1993), and Marín (1995), which use lagged variables. The former instruments route Herfindhal by using a one-year lag of that variable, but assigning a value of 0 if the route was not among the top 1,000 in the previous year (their data sample). They also use a dummy variable indicating if the route was in the top 1,000 in the previous year as instruments. And the latter uses lagged variable to instrument a "relative advertising goodwill" variable, but combines this procedure with approach 1, making use of exogenous variables coming from an estimated demand equation.

In order to account for endogeneity of right-hand-side variables, I used a combination of approaches 1 and 3. Firstly, I used lagged variables (one year), example: $cpms_{ikt}$ (t = October 2001) is instrumented by $cpms_{ikt-12}$ (t-12 = October 2000). By using this kind of instruments, I take advantage of the fact that Transbrasil exited the industry in 2001 and then figures in 2000 year could reflect a market with roughly the same number of major airlines (that is, the three major airlines left and Gol), which served to increase correlation between instruments and endogenous variables.

With respect to the instrument for $preslcc_{kt}$, there was clearly a problem of extraction of past realisations, as Gol entered the market only in 2001. On account of that, market share of Transbrasil Airlines and a dummy of her presence in 2000 was used, considering, as seen in Chapter 2, that Gol had significant incentives to avoid entering routes left by the bankrupt. I also make use of the market share of Transbrasil, and of variables accounting for the percentage of flights made by Fokker, Boeing and Embraer aircraft on the route, all lagged of one year[72]. Two tests of endogenous variables were performed and both rejected the null hypothesis that the abovementioned regressors were exogenous: Wu-Hausman F test, F(6,369) = 5.66764 with a P-value of 0.00001; and Durbin-Wu-Hausman chi-squared test: Chi-sq(6) = 34.42726, with a P-value of 0.00001.

The following tests of overidentifying restrictions confirmed the validity of the instruments, that is, the null that instruments were orthogonal to the error term: Sargan N*R-sq test, Chi-sq(7) = 7.453, P-value = 0.3833; Sargan (N-L)*R-sq test, Chi-sq(7) = 6.850, P-value = 0.4447; Basmann test, Chi-sq(7) = 6.847, P-value = 0.4450; Sargan pseudo-F test, F(7,375) = 0.979, P-value = 0.4464; Basmann pseudo-F test, F(7,368) = 0.978, P-value = 0.4468.

The following heteroskedasticity tests in IV regressions were performed, and, apart from the first one, all rejected the hypothesis that disturbance is homoskedastic: Pagan-Hall general test statistic: Chi-sq(39) = 44.555, P-value = 0.2495; Pagan-Hall test with assumed normality, Chi-sq(39) = 111.717, P-value = 0.0000; White/Koenker nR2 test statistic, Chi-sq(39) = 51.008, P-value = 0.0943; Breusch-Pagan/Godfrey/Cook-Weisberg, Chi-sq(39) = 165.140, P-value = 0.0000. In the presence of heteroskedasticity, the IV estimator is inefficient, and the usual approach is to employ the Generalised Method of Moments; here I use two-step GMM efficient in the presence of arbitrary heteroskedasticity. The Hansen J statistic for overidentification test of all instruments was Chi-sq(7) = 8.253, with a P-value of 0.31079, further confirming the validity of instruments.

72 The mix of aircraft (jets, regional, etc.) on a given route can be regarded as one of the determinants of the level of service, which is certainly a demand shifter.

3.5 Estimation Results and Discussion

Here I implement the GMM estimation of a pricing equation with city effects (CFE) and, for comparison purposes, also present the estimation with route effects (RFE), as in Evans and Kessides (1993). Results for the estimated models are presented in Table 3.3:

Table 3. 3 - Estimation Results[73]

Variables	ln ($price_{ikt}$)	
	RFE	CFE
constant	5.551 ‡	0.310
	(0.071)	(0.682)
$snst_{ikt}$	-0.045	-0.052 *
	(0.047)	(0.029)
spk_{ikt}	0.045	0.061 †
	(0.050)	(0.027)
asz_{ikt}	-0.071 †	-0.077 ‡
	(0.036)	(0.029)
$cpms_{ikt}$	0.162 †	0.133 †
	(0.066)	(0.067)
cms_{ikt}	0.691 ‡	0.759 ‡
	(0.139)	(0.143)
$cphhi_{kt}$		0.041
		(0.068)
$chhi_{kt}$		-0.180
		(0.998)
ln_km_k		1.051 ‡
		(0.175)
$(ln\_km_k)^2$		-0.042 ‡
		(0.015)
$preslcc_{kt}$		-1.210 ‡
		(0.361)
$preslcc_{kt} * ln\ km_k$		0.170 ‡
		(0.058)
Centered R2	0.961	0.946
N. Observations	408	408

*, †, ‡ mean significant at, respectively, 10% , 5% and 1% levels. Fixed-effects not reported.

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[73] Wald test of joint significance of the city-effects: chi2(18) = 69.55, P-Value = 0.0000.

Firstly, let us make some comments on the significance and magnitude of $cpms_{ikt}$ and cms_{ikt}. One can see that both variables are significant, whatever the estimation procedure employed: this probably means that they are both relevant as indicators of localised competitive advantage. In contrast to Evans and Kessides (1993), which reports reality in the United States, results for the Brazilian airline industry reveal that structure at the route level still has considerable significance in conditioning intra-firm heterogeneity in prices.

Whereas Evans and Kessides (1993) found that "*a firm's perceived pricing power at the route level is actually power conveyed to it through control of airport facilities*", here I find that dominance at the route level can by itself be a source of competitive advantage along with airport presence. These findings are of extremely relevance when analysing price responses to entry ($preslcc_{kt}$), as one would question the role of routes as relevant market place (and source of pricing power) in favour of airports nowadays in the airline industry, and these results serve as an indicator that routes are still a locus of competition in recently-liberalised airline markets[74].

There are two main reasons for the significance of $cpms_{ikt}$ in conjunction with cms_{ikt}: First, the still immature stage of liberalisation in Brazil, which means that well-known strategies typical of airline deregulated markets, such as hub-and-spoke method, are not fully developed yet, and maybe never become as sophisticated as in the US, as a consequence of the competitive pressure from the LCC's' hub bypassing tendency. And second, the existence of a centralised federal airport management, performed by INFRAERO (Federal Airport Enterprise) in conjunction with DAC: as the main directions over the years were towards giving equal access to airport facilities and terminals to all airlines, airport dominance has been rather rare to happen until very recently.

With respect to the LCC's route presence, one can see, as discussed before, that only the "city-effects model" proposed here is able to identify price reactions to entry, in opposition to the "route effects"[75]. The estimated effect is, as expected, negative and significant, meaning

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[74] In fact the airport as a locus of competition would be representative of the evolution towards a hub-and-spoke network, in which the definition of a complex O-D pair structure confers more competitive advantage than local (route) attributes.

[75] Actually, the "route effects model" would require a detailed inspection in the values of the estimated coefficients of the route dummies in order to permit this kind of analysis.

that, independent of airline and route-specific characteristics, incumbents have a propensity to react in prices against the LCC. These results are in line with the findings of Whinston and Collins (1992), Windle, Lin and Dresner (1996) and Morrison (2001), for the US industry.

One can observe that the variables representative of the effects of flight distance on product differentiation ($preslcc_{kt}$ * ln km_k) is significant and have a positive coefficient, which is in line with the Stylised Fact of 2.3. This means that competition is softer in markets with longer hauls. With respect to the effects of route dominance on heterogeneity and price reactions, also described by the Stylised Fact, one would need to calculate the marginal effects via a given change in $cpms_{ikt}$. The marginal effects of the LCC entry can be extracted from equation (10) in the following way:

$$\frac{d\ln\left(price_{ikt}\right)}{dpreslcc_{kt}} = \alpha_{10} + \alpha_{11}\ln km_k + \alpha_4 \frac{dcpms_{ikt}}{dpreslcc_{kt}} + \alpha_5 \frac{dcms_{ikt}}{dpreslcc_{kt}} \qquad (10')$$

The issue with (10') is related to the definition of the impacts of entry on $cpms_{ikt}$ and cms_{ikt} (the two last terms in the right-hand side of the marginal effects relation). With this purpose in mind, scenarious were then built, by considering a LCC entry with a market share of 20%, 25%, 30%, 35%, 45%, 50% and 60% of the route's seats available, and thus by calculating the effect of a corresponding decrease in $cpms_{ikt}$ in the price of the k-th FSC airline. Also, these scenarios considered a hypothetical route with an average of 10% of traffic in the endpoint cities (that is, with a proportional decrease in cms_{ikt}).

Results of these exercises are reported in Table 3.4, which provides the marginal effects of Gol's route presence on incumbents' reactions, by considering both the market share scenarious and a selection of representative flight distances[76]:

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[76] For a better understanding of Table 3.4, consider the first entry (km_k = 350, $lccms_{ikt}$ = 20%). It is clear that -0.228 = -1.210 + 0.170 * ln(350) + 0.133 * (-20% * 0.339) + 0.759 * (-20% * 0.339 * 10%), where 10% is the assumed relation between the relative size of the route with respect to the total traffic out of a given airport, 0.339 is the sample mean of $cpms_{ikt}$, and the other figures are the coefficients α_4, α_5, α_{10} and α_{11} of equations (10) and (10').

Table 3. 4 - Marginal Effects of the LCC's Route Presence

$lccms_{ikt}$ \ km_k	350	500	650	900	1,250	1,600	1,750
20%	-0.228 ‡ (0.035)	-0.168 ‡ (0.027)	-0.123 ‡ (0.031)	-0.068 (0.042)	-0.012 (0.058)	0.030 (0.071)	0.045 (0.076)
25%	-0.232 ‡ (0.035)	-0.171 ‡ (0.027)	-0.127 ‡ (0.031)	-0.071 * (0.042)	-0.015 (0.058)	0.027 (0.071)	0.042 (0.076)
30%	-0.235 ‡ (0.035)	-0.175 ‡ (0.027)	-0.130 ‡ (0.031)	-0.075 * (0.042)	-0.019 (0.058)	0.023 (0.071)	0.038 (0.076)
35%	-0.239 ‡ (0.035)	-0.178 ‡ (0.027)	-0.134 ‡ (0.031)	-0.078 * (0.043)	-0.023 (0.058)	0.019 (0.071)	0.035 (0.076)
45%	-0.246 ‡ (0.035)	-0.185 ‡ (0.028)	-0.141 ‡ (0.031)	-0.085 † (0.043)	-0.030 (0.059)	0.012 (0.071)	0.028 (0.076)
50%	-0.250 ‡ (0.035)	-0.189 ‡ (0.028)	-0.144 ‡ (0.031)	-0.089 † (0.043)	-0.033 (0.059)	0.009 (0.071)	0.024 (0.076)
60%	-0.257 ‡ (0.036)	-0.196 ‡ (0.028)	-0.151 ‡ (0.032)	-0.096 † (0.043)	-0.040 (0.059)	0.002 (0.072)	0.017 (0.077)

Notes: i. figures calculated holding $cpms_{ikt}$ at the sample mean; ii. represent an even decrease in the participation of the FSC incumbents in the market; iii. $lccms_{ikt} = 1 - cpms_{ikt}$; iv. values of are representative of the following percentiles: 0.20, 0.35, 0.50, 0.65, 0.80, 0.90 and 0.95.

By inspecting Table 3.4, one can see that there are some markets potentially subject to a **"not-to-react" tactic** by incumbents[77], on account of the degree of product heterogeneity described by the Stylised Fact on LCC's of Section II.3. Indeed, on the one hand, marginal effects are negative and very significant for shorter-haul markets and markets in which the incumbents have higher dominance (or alternatively, in which Gol have lower market share of seats available, measured by $\mathbf{lccms_{ikt}}$).

On the other hand, marginal effects of Table 3.4 are increasing, that is, competition becomes softer, the higher is the flight distance and the lower is Gol's market share. Actually one cannot reject the hypothesis of "not-to-react" in all cases of entry in markets with flight sector higher or equal than 1,250 km; also, if one consider, for example, a given distance of 900, one cannot reject a "not-to-react" tactic in all cases where the LCC's market share is lower than 25%. Therefore, it is possible to infer from this analysis that product differentiation between

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[77] One could use "to acquiesce" or "to accommodate" for this case, but, as these terms are strongly associate with very specific situations in the game theory literature, they were therefore avoided here, and "not-to-react" or "not-to-fight" was then used as meaning "not-to-change-prices".

the LCC and the incumbent FSC's is indeed a very relevant feature in this industry, at least for the period under consideration (2001, the first year of operations of Gol Airlines): these elements of heterogeneity were decisive in conditioning the patterns of price reactions to the LCC's entry.

3.6 Conclusions

The present paper targeted at examining the entry of the Brazilian LCC Gol Airlines, in the domestic market, in 2001. By making use of a price equation with city-specific effects, it was in a position of developing an analysis of reactions to entry which shares the advantages of both the intra and inter-routes traditions of the airline pricing literature.

In particular, it was possible to perform a study of the determinants of localised competitive advantage in the industry, as Evans and Kessides (1993). Also, and within the same econometric framework, it was possible to investigate the causes of price variation *between* routes, and thus having an analysis of the patterns of price reactions to LCC entry. This was made possible due to a proposal of extension of the authors' procedure, in which the focus on the control for route-specific fixed-effects was changed to account for city-specific fixed-effects instead, without recurring to the use of random-effects.

Final results permitted arriving at the conclusion that competition is located at both the route and the airport (city) levels, in contrast to the results found in the previous literature (US market). One can infer that a route is still a locus of competition in recently-liberalised airline markets, mainly those not fully characterised by hub-and-spoke operations.

Also, a significant and negative effect on prices caused by LCC entry was found, indicating that incumbents have indeed high propensity to react in prices, other things held constant. And finally, an analysis of the marginal effects of entry permitted reaching the conclusion that product differentiation between the LCC and the incumbent FSC's is certainly a very relevant feature in this industry and that these elements of heterogeneity were decisive in conditioning the patterns of price reactions to the LCC's entry in her start-up year (2001).

Those findings can be compared with the results of Chapter 2, which investigated the entry patterns of Gol Airlines. There, we reached the conclusion that the LCC preferred routes with higher presence of the rivals in terms of direct seats available per passenger (a good proxy for market size and underlying route profitability), and from 2002 on, started entering a broader variety of markets and thus including longer-haul routes in her portfolio.

The results here are certainly in line with the conclusions obtained before: firstly, we can consider that the tougher price reactions on shorter-haul routes, uncovered in the present chapter, can be thought as stimulating entry on longer-haul routes; additionally, one could regard the tougher price reactions associated with entry on routes with higher presence of rivals (on direct routes, the focus of the analysis of this chapter) as a stimulus for the LCC to avoid focusing only on either non-stop or one-stop flights in those situations, in order not to engage in excessive head-on competition with the FSC's[78]. This is certainly in accordance with the fact that Gol started providing several flights with stops and connections since 2002.

It is important to emphasise, however, that the price reactions investigated in this chapter were mainly *short-run related* and, due to the usual state of financial distress of all FSC incumbents in Brazil, one would not expect predatory behaviour to be observed in the market. On account of that, it is not expected to observe Gol Airlines avoiding to enter some specific markets solely because of anticipated tougher short-run price reactions of incumbents, but, on the contrary, it is likely that she takes more into consideration a set of variables that affect the long-run conditions for profitability (as investigated in Chapter 2). To sum up, the newcomer's entry behaviour is certainly determinant of incumbent's pricing tactics, but the reverse was not necessarily observed in the industry, probably because the Brazilian FSC's have not been in a position of creating a reputation of tough players.

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[78] The behaviour is more likely to be observed on medium-to-long-haul routes.

4. The Impacts of Liberalisation on an Air Shuttle Market

4.1 Introduction

This paper aims at developing an empirical model for assessing the impacts of economic liberalisation on competition in a relevant subset of the Brazilian airline industry: the air shuttle service on the route Rio de Janeiro - São Paulo. In this market the first air shuttle in the world, the 'Ponte Aérea', was created in 1959, by an agreement of airline managers, and had a dominant position in the airport-pair linking both city centres for almost forty years.

Air shuttles are usually characterised by very frequent service, walk-on flights with even intervals, no reservations and short-hauls. This concept is nowadays widespread in the airline industry, usually providing service for highly time-sensitive passengers, with classic 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[79].

The competition model presented here is developed to represent the rivalry and strategic interdependence among airlines in a shuttle market with product differentiation, a relevant feature in the post-liberalisation setting. Firms are assumed to play static oligopoly game in which price is the strategic choice variable. Demand is represented by Gorman's model of stages of budgeting; an Almost Ideal Demand System (AIDS) with two levels is then developed and own and cross-price elasticities are estimated in a flexible way. As route level costs are non-observable by the econometrician, an extension of the approximation proposed by Brander and Zhang (1990) is then performed in parallel with the estimation of first-order conditions for firms' profit maximisation.

The framework for analysing the impacts of liberalisation on competition is based on the conduct parameter approach of the New Empirical Industrial Organisation, NEIO (see Bresnahan, 1989 and Genesove and Mullin, 1998), in order to infer the extent of deviation

[79] 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.

from Bertrand-Nash equilibrium in the market. Therefore it was possible to pinpoint the change of airlines' behaviour due to three major exogenous events in the market: the measures of price and entry liberalisation (from January 1998), and two exogenous supply shocks (from, respectively, January 1999 and January 2001) on account of exchange rate depreciation – notably the main source of cost variation in the industry.

Final results indicate a remarkable increase in competition due to liberalisation, represented by a plunge in the estimated conduct parameter. The shocks in costs tended to have somewhat ambiguous effects across firms, however, but overall did neither compensate nor exacerbate the changes in the degree of competitiveness permitted by liberalisation.

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 (4.2). Then, main elements of air shuttle markets are provided and the evolution of the Rio de Janeiro - São Paulo air shuttle is described (4.3); data description is presented in 4.4, which is followed by the demand system specification (4.5) and by the first-order conditions specification (4.6); the system of equations estimation and the assessment of the impacts of liberalisation on conduct are performed in 4.7. Finally, the conclusions are presented.

4.2 Historical Background

As seen in Section 1.2, economic liberalisation of the Brazilian industry was launched as a part of a broader governmental program for deregulation of country's economy. Initial liberalisation measures were effectively accomplished in 1992. During this *First Round of Liberalisation*, regionals' monopolies were abolished, except for the airport-pairs linking city centres of four major cities[80] (called "special" airport-pairs, SAP). What is more, the policy of "four nationals & five regionals" of the seventies was abolished, and thus entry was stimulated by the authorities, which led to a wave of new small airlines in the market[81]. Also, there were now reference prices and bounds of -50% up to +32% of their values, and price

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

[81] Some of the most important newcomers were actually affiliates of the majors, like Nordeste (Varig), Tam Regional (TAM) and Interbrasil Star (Transbrasil).

competition was now seen as "healthy" for the industry, and therefore encouraged.

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 SAP's by regionals. This generated the *Second Round of Liberalisation* (enacted in Dec/97-Jan/98), which triggered much strategic interaction by airlines, with intense price and frequency competition.

This phenomenon was exacerbated on the Rio de Janeiro - São Paulo route, one of the SAP's and the country's densest flow linking its most 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 so-called "Special Airport-Pairs", SAP. 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 where the first air shuttle in the world was created, the 'Ponte Aérea' (literally, "air bridge"[82]), in 1959 - two years before the pioneer service of Eastern Airlines shuttle in the United States.

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, cartel on the route, being an exception to regional's monopolies in SAP markets, since the seventies. With the gradual deregulation measures of the nineties, the agreement started losing strength and 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 an ordinary pooling agreement.

With the Second Round of Liberalisation, the consequent increase in contestability led to relevant boost in price competition; even the fire at SDU, in February 1998, did not represent an impediment to it[83]. Airlines started having own strategies on the route, in a process that ultimately led to the dissolution of the forty-year-old cartel, announced in June 1998.

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[82] Also "airlift"; this term 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).

[83] In fact, prices fell by 27% during the closing of SDU, as a result of the liberalisation measures of January.

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 after liberalisation.

Another relevant isuue of the period was the strong instability of currency exchange rates (specially the US dollar), which usually affects not only demand for international travel, but also aircraft lease, maintenance, and fuel costs, causing recurrent financial distress. Between 1997 and 2001 – the sample period here –, two relevant shocks in costs due to currency devaluation were observed after the federal government changed the country's monetary regime allowing fluctuation, in early 1999. The two exchange rate shocks (EXRS) were observed from, respectively, January 1999 (EXRS99) and January 2001 (EXRS01). Figure 4.1 permits observing the degree of correlation among the effective exchange rate US$/R$ and average costs of the three major airlines on the occasion[84]:

[84] Unit costs include expenses on fuel and oil, maintenance and overhaul, flight crew (deck and attendants), flight equipment insurance, rental, depreciation, landing and en route charges, passenger service and other operating expenses. Output is number of passengers times kilometres flown. Source: Department of Civil Aviation. The source of the effective exchange rate index is Instituto de Pesquisa Econômica Aplicada's website (IPEADATA). Both indexes were normalised at the mean of the period (1997-2001) with the base equal to 100.

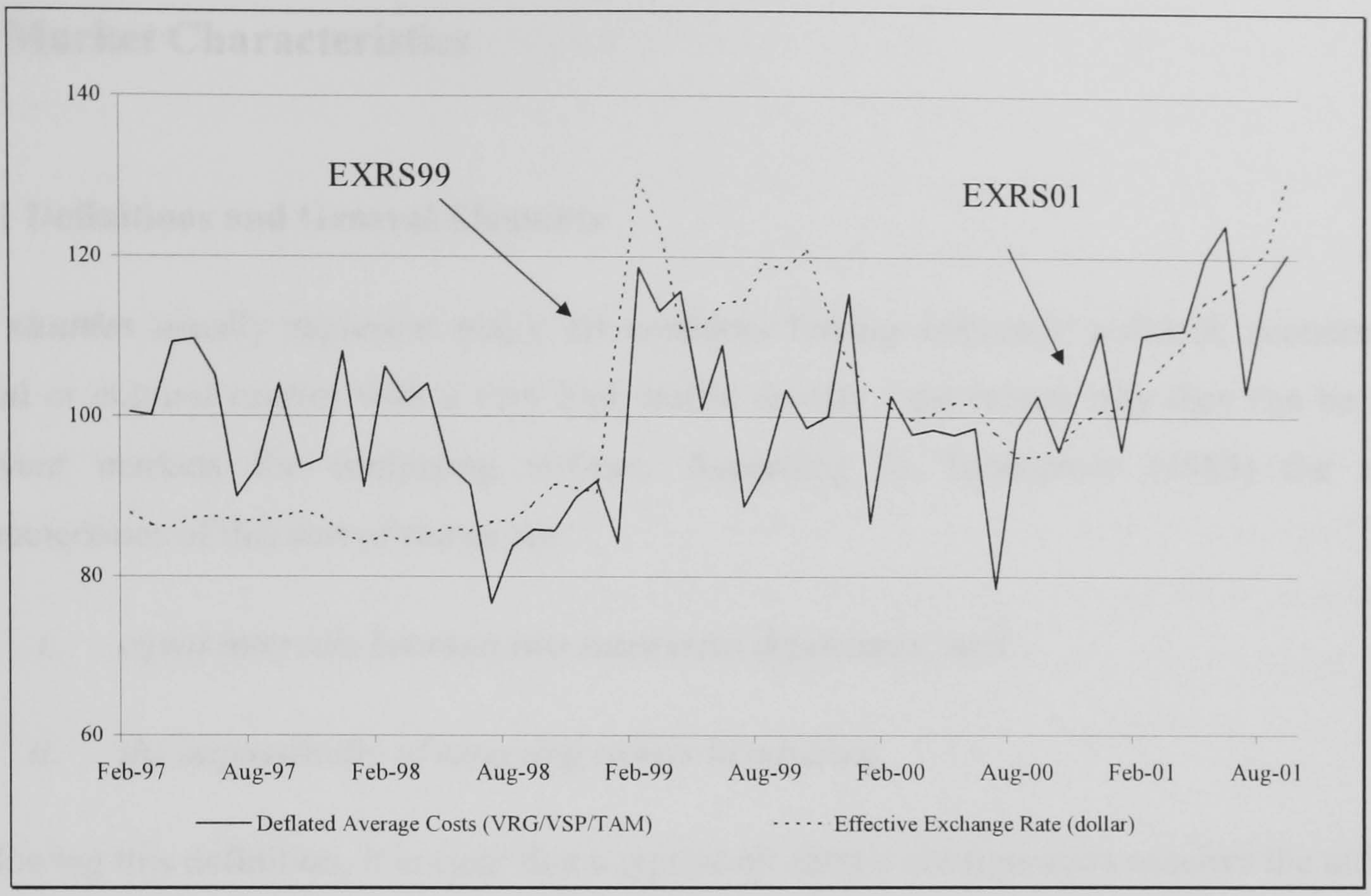

Figure 4. 1 - Evolution of Airlines' Average Costs and Effective Exchange Rate

As Figure 4.1 shows, there is relevant correlation between the exchange rate and the unit costs in the industry, meaning that the former is a major source of variation of the latter. The two exogenous supply shocks engendered strong pressures for price increase in the whole economy, and as a result, the country's macroeconomic authorities started interfering in many industries in order to avoid inflation propagation. This represented a relevant constraint to airlines' strategies, as they could not increase prices whenever they wanted; besides that, antitrust authorities were now closely monitoring the market.

4.3 Market Characteristics

4.3.1 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 for 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)[85].

In practice, air shuttles (also known as "multi-frequency" markets) are characterised by very frequent service, with intervals between flights from fifteen minutes to an hour, depending on the time of day; 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). As a consequence, they are 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"), Glasgow-London (approximately 640 km, with BA's "Super Shuttle", created in 1975 and relaunched in 1989), etc.

It is important to emphasise that one might find slight variations in air shuttles around the world, specially related to its "walk-on" features - that is, the last-minute availability without

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[85] 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.

having to book -, due to country-specific airline regulation, which may impose relevant constraints. 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 airlines are still not allowed to sell tickets during the flight. Nevertheless, airlines have recently developed mechanisms of increasing customer's flexibility of time, by introducing automatic ticketing machines and dedicated counters and boarding gates. 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); therefore, it is important to emphasise that the "*impossibility of reserving tickets in advance*" feature pointed out by Teodorovic (1985), is not as relevant nowadays for air shuttles as it used to be in the past[86].

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). With approximately ten percent of the total number of passengers within the country[87], 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-pairs combinations, GIG-GRU is the most relevant alternative to SDU-CGH. Table 4.1 presents how demand distributes across airport-pairs in the city-pair market:

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[86] Although at the cost of making the distinction between air shuttles and other routes much more abstract.

[87] Source: Department of Civil Aviation's Statistical Yearbook, 2002.

Table 4. 1 - Demand Distribution across Airport-Pairs[88]

Airport-Pair	Jan-Jul 1997		Jan-Jul 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 R.Janeiro - S.Paulo	**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[89]. 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, of the three aforementioned alternatives, GIG-GRU, coach and telecommunications, only the first one was explicitly regarded in this study; the main reason is that here I aimed at focusing on the behaviour of the typical traveller of SDU-CGH market, which means a given (and more homogeneous) standard of disutility to travel times. The argument here is that the typical traveller of the SDU-CGH market has little incentive to bypass the shuttle via other alternatives, such as the international airports or coach, as these are certainly less convenient markets (for example, the travel time by coach is more than seven times longer, almost six hours); also, telecommunication effects can be seen as affecting behaviour only in the long run.

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

[89] 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").

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

The main rationale for establishing an air shuttle service is the provision of higher service levels to passengers, and the soothing of competition between flights[90]. The former is reached by providing departure times closer to passengers' preferred times due to the more even spread (and dominance) of the 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 across a day of operations (as in Borenstein and Netz, 1999, and Salvanes, Steen and Sørgard, 2003).

On the other hand, however, air shuttle operations may represent 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 willing and able to catch 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 may, *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 balance of the two aforementioned effects, that is, the spread of departure-times *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[91]), can be decisive in terms of determining market outcome, ie., either product homogeneity or product heterogeneity.

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[90] 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.

[91] 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 even way across the relevant time period of a day, without causing much increase in departure intervals, conjoint operations are usually considered a reasonable strategy, 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 and full ticket endorsement and similar guarantees, operational features and fares across airlines (due to regulation or a "pooling agreement", for example), 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, Varig, Vasp, and the extinct Transbrasil and Cruzeiro, operated in 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 period of classic air shuttle.

In the nineties, however, with the liberalisation measures and the allowed entry of *regionals* on the route (Tam and Rio-Sul), 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 Santos Dumont Airport[92]: firstly, "Ponte Aérea" was split into individual shuttles; and secondly, explicit efforts of demand segmentation were then performed. Indeed, one could observe Varig and Tam offering frequent flyer programmes, more flight time options, higher peak-dominance, better service levels at the airports, newer aircraft, etc, focusing on the more frequent travellers in order to enhance brand loyalty, whereas Vasp and the extinct Transbrasil were providing a basic service with deep discounts, focusing on the less frequent consumers. Table 4.2 provides details of firms' products in the

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[92] 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.

market since August 1998.

Table 4. 2 - Airlines' Attributes in the Market[93]

ATTRIBUTES		VRG	TAM	VSP
Average Price		*176*	*172*	*126*
Market Share (Passengers %)		*0.50*	*0.22*	*0.17*
Route Presence (Share of Seats %)		*0.40*	*0.33*	*0.17*
Airport Presence (Share of Seats %)		*0.38*	*0.34*	*0.11*
City Presence (Share of Seats %)		*0.42*	*0.23*	*0.17*
CodeShare Agreement		*With subsidiary RSL*	-	-
Departure Lounge		*One exclusive*	*One Exclusive / One Shared (TAM VSP TBA)*	*One shared (TAM VSP TBA)*
Seat Assignement		*Available*	*Available*	*Not available*
Average Distance Between Flights (mins)		*45*	*51*	*147*
Average Distance Between Flights in Peak Hours (mins)		*30*	*30*	*92*
Aircraft Type		*Boeing/Embraer*	*Fokker Airbus*	*Boeing*
Frequent Traveller Advantages	**Alliances and Mileage Exchange**	*Star Alliance: Air Canada, Lufthansa, SAS, Thai e United Airlines*	*American Airlines*	-
	Counting Scheme	*Miles*	*Trips*	*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*	*9 trips = 1 free trip on the route*
	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*	-

By examining Table 4.2, one can see that Varig and Tam are the airlines with the highest price in the market, which is consistent with the superior bundle of attributes they possess, in comparison to Vasp. In terms of an air shuttle market, characteristics such as the average distance between flights (or route presence) are decisive in order to confer localised competitive advantage when providing service to premium travellers, that is, those with higher willingness to pay. These product heterogeneity elements serve as explanation for the

[93] Source: DAC's Statistical Yearbooks (various) and newspapers. Table 4.2 is representative of typical attributes from 1998 to 2000; data on route presence and price coincides with the sample used for the empirical modelling.

fact that Vasp has the lowest market share in spite of having the lowest price, a fact that would certainly be puzzling if the product was homogenous. Indeed, this is further confirmed if one considers the survey of Oliveira (2003), which examined travellers' declared preference: brand loyalty was found to be a strong attribute for the travellers of Varig and Tam, but not of Vasp; moreover, when asked "*How does price influence your choice*", the vast majority of Vasp's travellers expressed a high or very high influence, again, in contrast to Varig and Tam's travellers. Details of the survey can be found in Appendix 4.1.

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 individual shuttles aiming at different positioning in the market, according to the degree of product quality and brand loyalty. Both periods represented a clear departure from the "classic" standards of air shuttle operations.

4.4 The Data

Data for this paper were kindly supplied by Brazil's Department of Civil Aviation (DAC) and were available in published and non-published reports and yearbooks. DAC monthly collects information from all scheduled airlines to DAC according to specific legislation within the country. It is relevant to mention the problem of asymmetry of information in the process of data collection. In fact, there is no Brazilian equivalent to the U.S. Department of Transportation's "Origin and Destination Survey", a 10 % random sample of all tickets in domestic markets of that country. Therefore, in spite of the fact that DAC's analysts from both the statistics and economics departments are in charge of assessing the accuracy of the information provided by airlines, one must take into account that database is subject to relevant principal-agent interference.

4.4.1 Demand

Here I employed the definition of "route" being the *non-directional airport-pair*. By considering a non-directional route, I then treated traffic on flights going from SDU to CGH as aggregated with traffic on flights from CGH to SDU. Ito and Lee (2003b) and Richard (2003) also make use of the assumption of non-directional markets. By considering the airport-pair, I then focused on the typical traveller between the central airports of both cities; Morrison (2001) is a notable example of an analysis disaggregated to the airport-pair level.

DAC's Statistical Yearbook – Volume I (Statistical Data) contains data on origin and destination traffic (in number of passengers) disaggregated by airport-pair and available yearly. The traffic data for this research was the unpublished report used for preparing the Yearbook, extracted from DAC's system in January 2002. This report contains data on all passengers with departure at Rio de Janeiro's Santos Dumont Airport (SDU) and landing at São Paulo's Congonhas Airport (CGH), and *vice versa*; passengers with flight connections in both airports could not be discarded, unfortunately, but are a minor fraction of the traffic in the airport-pair[94].

Therefore, contrary to the Yearbook, the data collected for this research is disaggregated by airline and available on a monthly basis, from January 1997 to October 2001 (DAC's unpublished **Monthly O&D Traffic Report**). It contains information of all airlines in the market, namely, Varig, Tam, Vasp, Transbrasil and Rio-Sul. However, as Transbrasil exited twice within the sample period (May 2000 to December 2001, and from June 2001 on) due to bankruptcy, and accounted for less than ten percent of the market, data for this carrier was discarded. Also, as Rio-Sul is a subsidiary of Varig and had a formal code-share agreement with that airline since August 1998, data for both airlines was aggregated.

Another very important peculiarity of the data set with respect to demand is the existence of a gap due to the fire at Santos Dumont Airport in February 1998, as mentioned before; this forced the airport to be closed for six months and airlines to cease virtually all operations

[94] This problem is certainly more serious if one considers traffic on the routes linking the international airports of both cities; as this is not the case here, the data are accurately representative of the real O&D traffic on the route.

from or to it. In the majority of the cases (air shuttle included) the alternative was to transfer flights to Rio's international airport, GIG, which 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 inexpressive figure if compared to more than 85,000 total pax in February, after the transfer of flights).

4.4.2 Fares

Information on fares was collected from ATPCO (Airline Tariff Publishing Company), the world's leader in the collection and distribution of airline fare and fare-related data from more than 500 airlines over the world and distributing it to computer reservation systems, such as global distribution systems like Amadeus, Galileo and Sabre. By consulting the ATPCO screens, it was then possible to collect the fares information for the 15th day of each month, disaggregated by airline and fare code[95], for the same period of the traffic data.

A general price index was used to deflate the fares series; the price index used was provided by the Brazilian Census Bureau (IBGE, Instituto Brasileiro de Geografia e Estatística), the Broad Consumer Price Index (IPCA), which the federal government uses as its measure for official inflation targeting.

[95] Codes representative of fares for business class were not considered, as it is not typically avaliable in the shuttle market.

4.4.3 Costs

DAC's Statistical Yearbook – Volume II (Economics Data) contains detailed information on costs disaggregated by airline. In particular, Chapter 1 provides detailed data on direct and indirect operating costs *by* aircraft in both domestic and international travel segments. This information is not route-specific, but refers to the aggregation of routes served by each aircraft. As the air shuttle market is mainly operated with Boeing 737-300s (Varig and Vasp) and Fokker-100 and Airbus A-319 (Tam), specific information on these aircraft was collected.

As with traffic/demand data, unpublished expenses and costs reports that constitute the basis for the Yearbook were obtained, and yielded monthly cost figures (DAC's unpublished **Monthly Costs and Operations Report**). Information was then gathered on expenses on fuel and oil, maintenance and overhaul, flight crew (deck and attendants), flight equipment insurance, rental, depreciation, landing and *en route* charges, and passenger service.

4.4.4 Operations

Data on total output by aircraft was collected in the same way as costs, that is, from DAC's unpublished operational figures report. A monthly series of total output by aircraft was then designed.

Route-specific data on flight operations was collected from DAC's **HOTRAN**, "Horário de Transporte", a data system that generates reports containing information of all scheduled flights within the country (non-published information), disaggregated by airline/flight code. Therefore, data on flight frequency and number of available seats were accessible on a monthly basis; as with the ATPCO's screens, information from HOTRAN was collected for the mid-point day of each month.

4.5 The Demand System

4.5.1 Theoretical Specification

In this paper I make use of a demand system based on Gorman's stages of budgeting approach. See Hausman, Leonard and Zona (1994) and Ellison et al. (1997) for similar implementations of this approach, which employs the Almost Ideal Demand System (AIDS) of Deaton and Muellbauer (1980), and which is very popular among applied demand analysts. Basically, the AIDS model allows for a demand system which is second order flexible, in a sense that "*the price elasticities are unconstrained at the point of approximation*" (Hausman, 1997). Therefore, it allows for free estimation of elasticities between every pair of airline in the market.

The basic idea of the framework is to consider a hierarchic decision making approach with a stepwise process of consumer's choice. Here I consider the two-levels structure, in a similar fashion of Ellison et al (1997): the top level indicating the overall demand for transport service in the airport-pair, and the bottom level specifying the competition among airlines within the airport-pair. Intuitively, this means the passengers first choose the desired pair of airports and then choose the preferred airline.

Consider first the demand at the top level:

$$q_t = f\left(p_t, Y_t, \Gamma\right) \tag{11}$$

Where q_t is the overall airport-pair demand, p_t is an average price, Y_t is a vector of demand-shifters, and Γ is a vector of parameters. Demand within the airport-pair (bottom level) is formed by the following system of equations:

$$s_{it} = \alpha_i + \sum_j^n \gamma_{ij} \ln p_{jt} + \beta_i \ln\left(TR_t / P_t\right) \tag{12}$$

Where s_{it} is the share of revenues of airline i at time t, p_{jt} represents the price of the j-th airline, TR_t is the overall expenditure in air transportation in the market (= $\Sigma p_i q_i$), P_t is a price index, and α_0, α_i, α_j, γ_{ij}, β_i are parameters. P_t is associated with the following expression:

$$\ln P_t = \alpha_0 + \sum_j^n \alpha_j \ln p_{jt} + \frac{1}{2}\sum_i^n \sum_j^n \gamma_{ij} \ln p_{it} \ln p_{jt} \tag{13}$$

According to Buse (1998), the linearisation of Deaton and Muellbauer (1980)'s AIDS by making use of the Stone price index approximation with respect to (13), has proved to be a popular method – known as the **LA-AIDS**, Linear Approximate Almost Ideal Demand System. The linearisation of the model is usually performed by making use of ln P_t with the Stone Index configuration:

$$\ln P_t^* = \sum_i^n s_{it} \ln p_{it} \tag{14}$$

By making use of (14) in (12) one is able to obtain the following expression:

$$s_{it} = \alpha_i^* + \sum_j^n \gamma_{ij} \ln p_{jt} + \beta_i \ln\left(TR_t / P_t^*\right) \tag{15}$$

However, Buse (2000) provides Monte Carlo evidence that the Stone and the Paasche indexes is "*unambiguously inferior to the Laspeyres and Tornqvist indices, specially if prices are not strongly positively correlated*". Table 4.3 presents the correlation among prices in the sample:

Table 4. 3 - Price Correlation Matrix

	VRG	TAM	VSP
VRG	1.00	-	-
TAM	0.84	1.00	-
VSP	0.09	0.24	1.00

As Table 4.3 shows, it is not evident that strong and positive price correlation is observed in the market; in fact, due to the market positioning of the airlines on the route (discussed in 4.3.2), whereas Varig and Tam tend to have stronger correlation, Vasp tends to have a more idyosincratic behaviour, avoiding close price movements with the higher-quality rivals. Therefore here I opted for the use of the Laspeyres index:

$$\ln P_t^* = \sum_j^n s_{j0} \ln p_{jt} \tag{16}$$

Where s_{j0} (j=1,...,n) is the market share in the base period, which was set at the sample mean for this analysis.

In order to properly estimate the model, some restrictions are necessary. Firstly we have adding-up conditions, which are given by:

$$\sum_j^n \alpha_j = 1, \quad \sum_j^n \gamma_{ij} = 0, \quad \sum_j^n \beta_i = 0 \tag{17}$$

As Buse (2000) describes: "*the adding-up conditions imply a singular variance-covariance matrix for the disturbances and this is handled in the conventional manner by deleting the n-th equation*". In the present setting, Varig's equation was dropped.

I also made use of homogeneity and (Slutsky) symmetry restrictions:

$$\sum_j^n \gamma_{ij} = 0, \quad \gamma_{ij} = \gamma_{ji} \tag{18}$$

4.5.2 Empirical Specification

The empirical specification of the top and bottom levels discussed in last section are presented in (19) and (20) below. See Section 4.4 for details on the sources of data. First, one have the overall demand equation:

$$\ln q_t = \delta_0 + \delta_1 \ln P_t + \delta_2 \ln gdp_t + \delta_3 \ln q_t^- + \delta_4 dfire + \delta_5 dlib + u_t \tag{19}$$

Which has a log-log specification, in the same way of Hausman, Leonard and Zona (1994) and Ellison et al. (1997).

$\mathbf{q_t}$ is the overall airport-pair demand, and, as discussed before, represents the number of total revenue traffic, that is, the total number of passengers excluding people travelling for free for any reason (source: DAC's Monthly O&D Traffic Report).

$\mathbf{P_t}$ is an average market price (source: ATPCO), deflated by IPCA (source: IBGE). Prices are expressed in Brazilian currency (reais, R$); it is calculated by weighting airline's average prices by their respective market share of passengers.

gdp$_t$ is an index of real gross domestic product, normalised by figures of January 1997 (source: Instituto de Pesquisa Econômica Aplicada – IPEA).

q$_t^-$ is the overall traffic of all other airport-pairs within the city-pair Rio de Janeiro-São Paulo, and controls for potential competition among airlines in different airport-pairs (source: DAC's Monthly O&D Traffic Report). The use of quantities instead of prices of the substitute goods (in this case, the alternative airport-pairs) is certainly not standard in the literature; however, due to limitations in terms of availability of a complete series of prices for these markets, this procedure was then employed.

dfire is a binary variable that controls for the period of closed SDU due to a fire (February 1998 to July 1998); **dlib** is a dummy assigned with one for the months subsequent to the liberalisation measures of January 1998 (once and for all). And finally, **u**$_t$ are the disturbances.

The share equations representative of the bottom-level were specified in the following way:

$$s_{it} = \alpha_{0i} + \alpha_{1i} sseats_{it} + \sum_{j}^{n} \gamma_{ij} \ln p_{jt} + \beta_1 \ln\left(TR_t / P_t^*\right) + \qquad (20)$$
$$+\alpha_{2i} dcshare\_paer + \alpha_{3i} dcshare\_vptb + \alpha_{4i} dcshare\_tatb + u_{it}$$

Where **s**$_{it}$ is the share of revenues of the i-th airline at time t: revenues are calculated by multiplying the number of revenue passengers by the average price of the airline at time t.

sseats$_{it}$ is an index of the share of seats available of airline i at time t. Available seats carried are calculated multiplying the number of daily flight frequencies by the average aircraft size for each airline, and this by the number of days in a given month (Source: DAC's HOTRAN).

The average airline-specific prices (**p**$_{jt}$'s) are calculated by weighting the assumed peak price (full fare) and off-peak prices (simple average of available discounts) by respective number of passengers. For this calculation, "peak time" was defined considering all flights with departure within 5am to 10am (morning peak) and 4.30pm to 10pm (evening peak) on weekdays, and those with departure from 7pm to 10pm on Sundays. As discussed before, DAC's HOTRAN Report provides the information of flight number / weekdays / departure times, which made possible the segregation into two periods ("peak" and "off-peak").

One final note on prices: Moschini (1995) argues that within the LA-AIDS framework, the condition for the price index to be valid and not to generate biased and inconsistent parameter estimates, one has to perform prices scaling. I then performed a normalisation of prices at the sample means to transform data in such a way that is in line with Moschini's criticism, in order to calculate P_t*. Also, individual prices p_{jt} were normalised at Varig's figures, which had the equation dropped.

TR_t/P_t^* is the index discussed in last section. **dcshare_paer**, **dcshare_vptb** and **dcshare_tatb** are dummies that are assigned with one in periods when a codeshare agreement is observed in the market and account for the alliance of, respectively, the "Ponte Aérea" until July 1998, the Vasp-Transbrasil codeshare from September 1998 to June 1999, and the Tam-Transbrasil codesharing from May 2000 to January 2001. **u_{it}** are the disturbances.

4.5.3 Endogeneity and Instruments

Undoubtedly, the demand system specified in 4.5.2 engenders a relevant issue on identification of the endogenous variables. In particular, prices (P_t, P_t* and p_{jt}'s), quantities (q_t), expenditures (TR_t) and passenger shares (s_{it}) are usually thought to be endogenously determined. In order to deal with this issue, the procedure here was to first define instrumental variables likely to be helpful in identifying these variables.

Once instruments were obtained, I then performed tests of the relevance and validity of instruments (F tests of excluded instruments, and Hansen J-tests) and tests of exogeneity of some other variables under suspicion of endogeneity, like q_t^- and $sseats_{it}$ (C tests or "difference-in-Sargan" tests, as described by Baum, Schaffer and Stillman, 2003).

With respect to the problem of endogeneity and identification, and by having a brief survey of the procedures found in the literature on airline economics, one can conclude that the most common instruments consider a combination of the following procedures:

1. use of exogenous demand and cost shifters;
2. use of demand and cost characteristics of rivals on the route or of the same firms on other routes; and
3. use of lagged, artificial or transformed variables.

A combination of approaches 1 and 2, for example, is found in Berry, Carnall and Spiller (1996) and Borenstein (1989). In the former, population and network characteristics at the endpoint cities are used in conjunction with the characteristics of other products in the market. They treat prices, market shares and spoke densities as endogenous. On the other hand, Evans and Kessides (1993) prefer making use of approach 3, and develop a "restricted rank" of firms on a route - calculated in descending order, that is, the largest firm on the route has a rank of one, etc - in order to identify route market share on their pricing equation. Moreover, approach 3 is also employed by Evans, Froeb and Werden (1993), and Marín (1995), which use lagged variables.

In order to account for endogeneity of right-hand-side variables, I used a combination of all three approaches. Firstly, I used two sets of exogenous cost shifters: input prices and an index of effective currency exchange rate. Unit prices of fuel and maintenance of Varig, Vasp and Tam were used. The unit cost of fuel disaggregated by airline was calculated by dividing expenditures on fuel by the consumption of fuel. Consumption was measured in thousands of litres of aviation fuel (mainly aviation kerosene). Unit costs of maintenance disaggregated by airline was calculated by dividing expenditures on maintenance by the number of flight hours. Information on unit costs are disaggregated at the aircraft level, as discussed before (DAC's unpublished **Monthly Costs and Operations Report**). The effective exchange rate index was collected from Instituto de Pesquisa Econômica Aplicada's website (IPEADATA) and was lagged of one period.

Secondly, I used the prices of the same firms on another route of the Brazilian airline system: the airport-pair Congonhas-Brasília. The major source of problems of quality of this sort of instrument is related to the existence of common shocks, due to national advertising, for example; in fact, this problem is aggravated as both airport-pairs share one same endpoint city, São Paulo, which is also potentially problematic due to the existence of local advertising. In order to avoid I these problems, I used lagged realisations (one period) of prices and expenditures for that route[96].

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[96] One observation in the final market share data sample was dropped on account of that.

The relevance and validity of the abovementioned instruments were challenged by the following procedures, after regressing a GMM procedure for (19) and (20). Results of the tests are presented in Appendix 4.3, Tables 4.11 and 4.12.

1. Firstly, in terms of the relevance of the proposed instruments. *partial R-squared of the first-stage regressions*, accounting for the squared partial correlation between excluded instruments and endogenous regressor were extracted, along with *Shea Partial R-squared.* Baum, Schaffer and Stillman (2003) report that, in general, the literature consider that one must not have low values for both statistics, in order not to have instruments which lack significance; and the minimum R-squared computed (of all total demand and share equations) was 0.66, which was considered satisfactory.

2. Also in terms of relevance, the *F-tests of joint significance of instruments in the first-stage* were used. Again, Baum, Schaffer and Stillman (2003) report a common use of an F-statistic that is higher than 10 in order for the instruments to be relevant. The minimum F-statistic was 18.40.

3. Moreover, in terms of validity (orthogonality), Hansen J tests were employed for both the market share and the total demand equations, with the null hypothesis being that the instruments are uncorrelated with the error term. All tests failed to reject the null at 5% of significance.

4. And finally, one may cast doubts on the exogeneity of share of available seats, even if one argues that airlines still need to submit changes in the number of flight frequencies and aircraft type (and size) to the authorities' consideration, in a process that may still be considered slow, and exogenously determined. C-tests of the exogeneity of the variable ln $sseats_{it}$ (and also of q_t^-) were performed and did not reject the null.

4.6 The Pricing Game

Once the demand system was specified, it was then possible to design a framework to investigate the impacts of the liberalisation measures of 1998 (the *Second Round of Liberalisation*) on the conduct of the firms. In this section I make use of a standard model from the New Empirical Industrial Organisation (NEIO) tradition[97], and which is suitable for markets with product differentiation, in order to perform the analysis of the changes in behaviour due to exogenous shocks, such as the policy measures of January 1998, and the supply shocks of 1999 and 2001 (currency devaluation).

4.6.1 Theoretical Structure

Consider static price competition in a product-differentiated (Chamberlinian) setting. Prices as choice variables are also assumed by Berry, Carnall and Spiller (1996)[98]; this can be justified by the evidence on airlines' behaviour since liberalisation: for example, TAM reduced her single fare by 27% in 1998, in a movement that industry analysts claimed to target an expansion in market shares, and this price reduction was soon followed by "Ponte Aérea"; also, there were fare wars in 2001 and 2002, after Gol Airline's entry on the city-pair; and finally, Vasp advertised a "buy-one-way-and-get-the-return-free" sale, effectively reducing prices by 50%, in January 2000.

Suppose q_{it} is quantity and p_{it} is the price of the i-th airline at time t. Consider the following first-order conditions for profit maximisation of airline i:

$$\underset{p_{it}}{Max}\left(p_{it}q_{it} - tc_{it}\right) \longrightarrow q_{it} + p_{it}\frac{\partial q_{it}}{\partial p_{it}} - \frac{\partial tc_{it}}{\partial q_{it}}\frac{\partial q_{it}}{\partial p_{it}} = 0 \qquad (21)$$

Where tc_{it} are the route-specific total costs. By performing some algebraic manipulation:

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[97] See Bresnahan (1989) and Genesove and Mullin (1998).

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

$$q_{it} + p_{it}\frac{\partial q_{it}}{\partial p_{it}} = mc_{it}\frac{\partial q_{it}}{\partial p_{it}} \longrightarrow mr_{it} = p_{it} + \frac{1}{q_i'}q_{it} = mc_{it}, \quad q_i' = \frac{\partial q_{it}}{\partial p_{it}} \tag{22}$$

Where mr_{it} and mc_{it} are, respectively, the (route-specific) marginal revenue and marginal cost of airline i. Suppose now there is a *parameter θ_i that measures the extent of deviation from Nash-Bertrand behaviour of airline i* (which would be represented by equating marginal revenue to marginal cost); following Bresnahan (1989), I define the "perceived marginal revenue" of the i-th airline (pmr_{ii})[99] as:

$$pmr_{it} = q_{it} + \theta_i \frac{1}{q_i'} p_{it} \tag{23}$$

Where θ_i is the conduct parameter, an index of the competitive nature of the i-th airline in the market. θ is usually known as the firm's conjecture, although here I interpret it in the same way as Slade (2001) – see also Slade (2004) –, 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 airline's marginal revenue to equate marginal costs ($\theta_i = 1$, for all i). The lower the θ, the more competitive firms are and, in the 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. Therefore we have the following expression:

$$pmr_{it} = mc_{it} \longrightarrow p_{it} + \theta_i \frac{1}{q_i'} q_{it} = mc_{it} \tag{24}$$

We finally have the standard pricing equation of the New Empirical Industrial Organisation (NEIO):

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[99] 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, which is controlled by θ. Check Bresnahan (1989) and Appendix 4.

$$p_{it} = mc_{it} - \frac{\theta_t}{q_i'} q_{it} \tag{25}$$

4.6.2 The Costs Side

The problem with (25) is that costs at the route level are typically non-observables[100]. In contrast, costs at a more aggregate level can usually be observed, either at the system level (global figures for the whole network) or even with some disaggregation (any subset of the network). Consider then the following total cost function at the "aggregate level":

$$TC_{it} = TC(Q_{it}, W_{it}, Z_{it}, \gamma) \tag{26}$$

Where TC_{it} and Q_{it} are, respectively, total cost and total output, W_{it} is the vector of input prices, Z_{it} is a cost shifter vector, all with respect to airline i, at time t and at the more aggregate level. γ are unknown parameters.

Suppose now there exists a link between the route-level costs and the aggregate-level costs:

$$mc_{ikt} = c_{ik}\left(\frac{\partial TC_{it}}{\partial Q_{it}}\right) = c_{ik}\left(MC_{it}\right) \tag{27}$$

Where mc_{ikt} is the (unobservable) marginal cost of airline i on route k and time t. $c_k(.)$ is a function representative of the adjustment between the two levels. Brander and Zhang (1990)[101] make further simplification by assuming constant marginal cost, and then make use of the following relation:

$$mc_{ikt} = \phi_{ik}\left(d_k, AVSTL_{it}\right) AVC_{it} = d_k\left(\frac{AVSTL_{it}}{d_k}\right) AVC_{it} \tag{28}$$

Where AVC_{it} is the average cost at the aggregate level, $AVSTL_{it}$ is the average stage length of airline i at time t; and ϕ_{ik} is a non-linear function of the route's fligh distance (d_k) and the airline's $AVSTL_{it}$. Actually, ϕ_{ik} is a route-specific function which accounts for the

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[100] 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).

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

phenomenon of "cost taper", that is, when "*total cost per passenger-mile drops as the length of the trip grows*" (O'Connor, 1995). In Brander and Zhang (1990)'s words: "*There are (...) strong a priori reasons to believe that cost is not linear in distance. A lot of crew time is used in boarding and deplaning, and fuel consumption is highest during take-off and landing (...)*". 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[102].

In the present case I also assume a non-linear relation between route marginal costs and distance/average stage length; I use a less restrictive model, however, as costs in the air shuttle market in relation to overall unit costs may need to be adjusted on account of other factors apart from distance, like the marginal opportunity cost of flights and passengers, relative daily utilisation of aircraft, average load factors, etc[103]. Here I propose the following expression for route-specific marginal costs:

$$mc_{ikt} = \varphi_{0ik} + \varphi_{1ik} \ln AVSTL_{it} + \varphi_{2ik} AVC_{it} + \varphi_{3ik} AVC_{it}^2 + \varphi_{4ik} AVC_{it}^3 \quad (29)$$

Where φ_{0ik}, φ_{1ik}, φ_{2ik}, φ_{3ik} and φ_{4ik} are route-specific parameters. Note that here I allow for a non-linear relation between costs at the route level and $AVSTL_{it}$, which is a systemwide measure, in order to control for the cost tapering effects; also, one is able to more freely estimate the adjustment of aggregate average costs to route level marginal costs (the AVC_{it}'s).

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102 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.

103 In fact, Brander and Zhang (1990) are aware of this problem (see p. 575).

4.6.3 Empirical Specification

Here I define the following empirical counterpart of equation (26):

$$p_{it} = \varphi_{0i} + \varphi_{1i} \ln AVSTL_{it} + \varphi_{2i} AVC_{it} + \varphi_{3i} AVC_{it}^2 + \varphi_{4i} AVC_{it}^3 + \\ +\delta_{0i} q_{it} + \delta_{1i} q_{it} dlib + \delta_{3i} q_{it} dexrs_{99} + \delta_{4i} q_{it} dexrs_{01} + \varepsilon_{it} \quad (30)$$

Note that I am now removing the index k of (29), which refers to the route-level, because there is only one route in the sample (non-directional airport-pair CGH-SDU, see Section 4.4); also, it is important to keep in mind that variables with capital letters are not available at the route level, but are only representative of the more aggregate level (aircraft).

As discussed before, **AVC_{it}** and **$AVSTL_{it}$** are, respectively, the average cost and average stage length of airline i at time t, at the observable aggregate level. As explained in 4.4.3, here I have data on direct and indirect operating costs, and output, *disaggregated by aircraft*, a information which refers to the *aggregation of routes served by each aircraft*. By making use of specific data available in DAC's unpublished Monthly Costs and Operations Report, aggregate average cost figures were calculated for Varig's Boeing 737-300s, Vasp's Boeing 737-300s and Tam's Fokker-100 (until July 1999) and Airbus A-319 (from August 1999). In the case of Tam, I also included a dummy of change of operating aircraft, assigned with one from August 1999 on (**dairbus**).

In order to calculate average costs, one needs figures of total production and costs. Firstly, the measure of production used here is the number of passengers times kilometres, a standard and commonly used measure of output in the industry.

And secondly, in terms of total costs, one relevant issue arises: it is certainly debatable whether all costs figures have influence in a given airline's short-run pricing; Brander and Zhang (1990), for example, report a similar problem of cost definition: "*it is not clear which costs should be taken as variable costs and which should be taken as fixed costs*"; in this sense, by making use of a rather broad definition of costs would probably cause noise in the estimation of route-level marginal costs, especially if one considers that the price variability across inputs is far from similar.

Besides that, as I allow for a more flexible estimation in (30), one would only need to consider costs figures with high variability within the sample period, in order to provide a reasonable estimation of marginal costs. In other words: it suffices to have good cost shifters in order to identify costs at the route level. On account of that, only the following operating costs were used in order to calculate an aggregate unit cost figure: fuel, maintenance and flight crew. I also experimented with more aggregative costs, by considering, for example, expenses on flight equipment rental, landing and *en route* charges, and passenger service, but results in identifying route-level marginal costs proved to be inferior.

$\mathbf{q_{it}}$ is the number of revenue passengers flown with airline i at time t, available in DAC's unpublished Monthly O&D Traffic Report. In order to test for a structural change in q_{it} due to three main exogenous events on the route, I then make use of dummies of slope with respect to q_{it}: **dlib**, which controls for changes due to the liberalisation measures from January 1998 on; and $\mathbf{dexrs_{99}}$ and $\mathbf{dexrs_{01}}$, which account for changes in behaviour due to the exchange rate shocks of, respectively, January 1999 and January 2001. All variables are assigned with one from the following month of the event, on a *once and for all* basis. Finally, ε_{it} represents the disturbances.

4.6.4 Endogeneity and Instruments

Here I employ the same procedures of 4.5.3 to analyse the issues that arise during the estimations of the pricing equations (FOC) of the system of equations in (30). Here again, one have q_{it} as clearly jointly determined with p_{it}, and therefore one needs to find suitable instruments for identification; also, one might be suspect of the endogeneity of aggregate average costs (AVC_{it}) and therefore it is relevant to test for it.

The list of instruments for q_{it} are the following: firstly, the number of passengers flown and number of flights of the same firms on another route, the airport-pair Pampulha (Belo Horizonte)-Brasília. In contrast to 4.5.3, here the existence of common demand shocks is not a relevant issue, as that route does not share any endpoint city with the air shuttle market under analysis (CGH-SDU). And secondly, the average stage length of the rivals in the market is also used for identification. Both sets of instruments are in line with item 2 presented in 4.5.3, that is, the procedure of using characteristics of the rivals on the route or of the same firms on other routes.

Once again, the relevance and validity of the instruments were challenged by the following procedures, after regressing a 2SLS for the pricing equation (30) of each airline (discussion of the procedures are given on 4.5.3). All tests are presented in Appendix 4.3, Table 4.13.

1. *Partial R-squared of the first-stage regressions* (minimum): 0.53; F-test of instruments joint significance in the first-stage (minimum): 13.90.

2. *Hansen J tests of orthogonality*: in all equations, the tests failed to reject the null;

3. *C-tests of exogeneity* of AVC_{it}: again, the null was not rejected for all equations.

4.7 Estimation and Results

Once the empirical specifications were defined, and the instruments were considered relevant and valid, the econometric technique could then be chosen. Here I estimate all share, total demand and first-order condition equations as a system, by making use of an autocorrelation and heteroskedasticity consistent estimator.

The Generalised Method of Moments (GMM) for a system of equations was therefore used, with the weighting matrix set to represent heteroskedasticity and autocorrelation of unknown form (HAC). Here I used the Bartlett kernel with Newey and West's fixed bandwidth selection criterion.

4.7.1 Demand System and Estimated Elasticities

Results for the estimation of equations (19) and (20) are reported below. in Tables 4.4 and 4.5. Firstly, we have the overall demand equation:

Table 4. 4 - Estimated Results – Total Demand

Variable	$\ln q_t$
$\ln p_t$	-0.310 ‡
	(0.024)
$\ln gdp_t$	3.963 ‡
	(0.072)
$\ln q_t^-$	-0.352 ‡
	(0.070)
dfire	-0.195 ‡
	(0.004)
dlib	0.234 ‡
	(0.007)
Constant	-0.957 †
	(0.433)
Adj. R Squared	0.682
N. Observations	58

*Note: * means significant at 10%, † at 5% and ‡ at 1% level*

Then, we have results for the system of share equations:

Table 4. 5 - Estimated Results – Market Share

Variables	Market-Share (s_{it})		
	VRG	TAM	VSP
sseats $_{it}$	-1.888 ‡	0.625 ‡	1.263 ‡
	(0.014)	(0.009)	(0.021)
ln p $_{it}$ (VRG)	-0.324 ‡	0.163 ‡	0.161 ‡
	(0.003)	(0.003)	(0.004)
ln p $_{it}$ (TAM)	0.163 ‡	-0.204 ‡	0.041 ‡
	(0.003)	(0.005)	(0.003)
ln p $_{it}$ (VSP)	0.161 ‡	0.041 ‡	-0.202 ‡
	(0.004)	(0.003)	(0.003)
*ln (TR $_t$ /P $_{it}$ *)*	0.076 ‡	-0.023 ‡	-0.053 ‡
	(0.003)	(0.003)	(0.004)
dcshare_paer	-0.044 ‡	-0.036 ‡	0.080 ‡
	(0.003)	(0.001)	(0.003)
dcshare_vptb	0.004 ‡	-0.011 ‡	0.007 ‡
	(0.003)	(0.001)	(0.002)
dcshare_tatb	0.003 ‡	0.030 ‡	-0.033 ‡
	(0.003)	(0.002)	(0.001)
Constant	-1.383 ‡	1.083 ‡	1.300 ‡
	(0.044)	(0.036)	(0.049)
Adj. R Squared		0.932	0.855
N. Observations		57	57

*Notes: i. Varig-related coefficients were inferred from the coefficients in the remaining equations ii. * means significant at 10%, † at 5% and ‡ at 1% level*

It is important to note that overall demand is associated with a very low price elasticity in the market (-0.314). This is consistent with the fact that the route is strongly business-related, with travellers who are usually more time-sensitive than price-sensitive (as discussed in Section 4.3). This is also consistent with the process of purchase of tickets, in which approximately only 36% of the travellers actually pay for their trips (See Appendix 4.1). Therefore, one would also expect airline-specific price elasticities to be relatively low; those elasticities can be recovered from estimates in Table 4.5 from the following expressions, associated with equation (20), as in Buse (1994) and Ellison et al (1997) :

$$\eta_{ij} = -\delta_{ij} + \left(\gamma_{ij}/s_{ij}\right) - \beta_{ij}\left(s_j/s_i\right), \; i = 1, \ldots N \qquad (31)$$

Where n_{ij} is the elasticity of the demand for airline i with respect to the price of airline j. δ_{ij} is binary, and equal to 1 if i = j, and equal to zero otherwise. Calculated (Marshallian) elasticities are conditional on total expenditure in air transport on the route. Table 4.6 present the estimated elasticities for each airline in the sample, extracted at the sample mean of passenger shares:

Table 4. 6 - Estimated Conditional Elasticities

		Elasticity of the Demand for		
		VRG	**TAM**	**VSP**
	VRG	-1.722 ‡	0.794 ‡	1.077 ‡
With		(0.011)	(0.015)	(0.019)
Respect	**TAM**	0.292 ‡	-1.903 ‡	0.301 ‡
to the		(0.006)	(0.023)	(0.020)
Price of	**VSP**	0.295 ‡	0.204 ‡	-2.107 ‡
		(0.004)	(0.014)	(0.016)

*Note: * means significant at 10%,*
† at 5% and ‡ at 1% level

As one can inspect from Table 4.6, estimated price-elasticities are consistent with both the description of the market and of airlines' positioning presented in 4.3.2, and the results of the survey of Oliveira (2003), presented in Appendix 4.1: on the one hand, Varig and Tam have a higher perceived quality, due to higher route, airport and city presence, being able to focus more on the very time-sensitive traveller, typical of air-shuttle markets.

On the other hand, Vasp positioned herself as a more budget carrier, with lower-quality (for instance, fewer departures engendering a higher average distance between flight times) and lower price. The higher price-elasticity of Vasp (25% higher than Varig's, the airline with dominant market share) is a clear evidence of this positioning.

Also important to emphasise from Table 4.6 is the impact of the codeshare agreements on the route, which in most cases permitted market share to significantly increase for the participating airlines. This is the case of, for example, Vasp during both the "Ponte Aérea" (coefficient of dcshare_paer equal to 0.080) and the Vasp-Transbrasil (dcshare_vptb equal to

0.007) agreements, and also with Tam during the Tam-Transbrasil agreement (dchsare_tatb equal to 0.030). The only exception is Varig in the "Ponte Aérea" period. which could be representative of the fact that airlines with an already high participation in the market may not be as benefited from the agreement as the other airlines.

4.7.2 First-Order Conditions and the Estimated Evolution of Conduct

Results of the estimation of the empirical counterpart (30) are presented below:

Table 4. 7 - Estimated Results – FOC (2SLS)

Variables	ln (price$_{ikt}$)		
	VRG	TAM	VSP
ln AVSTL$_{it}$	842.4 ‡	165.3 ‡	-421.0 ‡
	(25.9)	(14.3)	(21.4)
AVC$_{it}$	-29.509 ‡	8.772 ‡	13.990 ‡
	(3.267)	(2.835)	(1.712)
(AVC$_{it}$)^2	0.889 ‡	-0.174 †	-0.342 ‡
	(0.105)	(0.067)	(0.046)
(AVC$_{it}$)^3	-0.008 ‡	0.001 †	0.003 ‡
	(0.001)	(0.000)	(0.000)
q$_{it}$	1.391 ‡	4.423 ‡	0.602 ‡
	(0.055)	(0.170)	(0.059)
*q$_{it}$ * dlib*	-0.655 ‡	-4.235 ‡	-0.809 ‡
	(0.019)	(0.136)	(0.030)
*q$_{it}$ * dexrs$_{99}$*	-0.027 ‡	0.104 ‡	-0.847 ‡
	(0.008)	(0.036)	(0.023)
*q$_{it}$ * dexrs$_{01}$*	0.093 ‡	-0.221 ‡	0.287 ‡
	(0.019)	(0.061)	(0.017)
dairbus		27.944 ‡	
		(1.472)	
Constant	-5196.0 ‡	-1063.2 ‡	2712.0 ‡
	(172.0)	(116.0)	(137.9)
Adj. R Squared	0.808	0.616	0.916
N. Observations	58	58	58

*Note: * means significant at 10%, † at 5% and ‡ at 1% level*

By inspecting Table 4.7, one is able to see how the costs model fits reasonably for Varig and Vasp; in contrast, Tam had somewhat poorer results, specially in the costs side, which is not only indicative that this airline utilised her fleet of Fokker 100 in other distinct routes in terms of cost generation (and thus the AVC terms could not be good proxies for marginal cost shifts on this particular route), but also that the change in flight equipment in 1999, when she started using brand new Airbus A319, was certainly a generator of noise in the estimation.

Now let us draw attention to the estimation of conduct and, more specifically, to the impacts of the liberalisation measures of 1998 on the behaviour of airlines. A relevant issue is related with how to identify the conduct of the airlines in the market from the estimates of Table 4.7. This is possible if one considers the relation between (25) and (30) in terms of the estimated coefficient of q_{it} (the base case, in which all dummies of events are set equal to zero):

$$\hat{\delta}_{0i} = -\frac{\hat{\theta}_i}{\hat{q}'_i} \longrightarrow \hat{\theta}_i = \hat{\delta}_{0i}\left|\hat{q}'_i\right| \qquad (32)$$

Where $\hat{\delta}_{0i}$ is the estimated parameter of q_{it} in the base case, $\hat{q}'_i$ is the estimated first derivative of the demand of airline i with respect to price, and $\hat{\theta}_i$ is the estimated conduct parameter of airline i. As we have already estimated the demand system, in Section 4.5, it is then possible to identify $\hat{\theta}_i$ from the pricing equations of (30), specially if we consider that price elasticities are related to first derivatives of demand in this way: $\eta_{ii} = q'_i\left(p_i/q_i\right)$. By considering the elasticity at the sample mean, that is, with q and p evaluated at the mean, $\overline{q}_i$ and $\overline{p}_i$, one can obtain the following expression:

$$\hat{\theta}_i = \hat{\delta}_{0i}\left|\hat{\eta}_{ii}\right|\frac{\overline{q}_i}{\overline{p}_i} \qquad (33)$$

By making use of (33), one can obtain the associated conduct parameters and, what is more, is able to recover the structural changes associated with the dummies of the three exogenous events considered here (liberalisation and two supply shocks). Results are presented in Table 4.8:

Table 4. 8 - Evolution of Conduct in the Air Shuttle Market

Period	VRG		TAM		VSP	
	θ_i	$\Delta\theta_i$	θ_i	$\Delta\theta_i$	θ_i	$\Delta\theta_i$
Pre-2nd Round of Liberalisation						
Base (1997)	1.046 ‡ (0.045)		1.172 ‡ (0.052)		0.107 ‡ (0.011)	
Post-2nd Round of Liberalisation						
1998	0.903 ‡ (0.053)	*-0.143 ‡ (0.008)*	0.117 ‡ (0.028)	*-1.055 ‡ (0.032)*	-0.042 ‡ (0.009)	*-0.149 ‡ (0.006)*
Post-EXRS99	1.030 ‡ (0.055)	*0.127 ‡ (0.008)*	0.206 ‡ (0.031)	*0.089 ‡ (0.024)*	-0.195 ‡ (0.010)	*-0.153 ‡ (0.010)*
Post-EXRS01	0.761 ‡ (0.041)	*-0.269 ‡ (0.025)*	0.052 (0.048)	*-0.154 ‡ (0.044)*	-0.286 ‡ (0.009)	*-0.091 ‡ (0.005)*

*Notes: i. * means significant at 10%, † at 5% and ‡ at 1% level*
ii. $\Delta\theta_i$ means the change in conduct between two events.

As we can infer from Table 4.8, liberalisation had a positive effect on competitive behaviour, as there are clear evidence that airlines had a substantial reduction in their parameters of conduct, θ_i. Indeed, when comparing the Base Case (1997) with figures of 1998, one can observe that there was a statistically significant plunge in conduct of all airlines: Varig, from 1.046 to 0.903 (-0.143, or -14%), Tam, from 1.172 to 0.117 (-1.055, or -90%), and Vasp, from 0.107 to -0.042 (-0.149, or -149%). This is certainly in favour of the effectiveness of governmental policy with respect to enhancing competition in this industry.

Also important are the tests of nullity of the conduct parameters in the post-liberalised environment (from 1998 on): actually, one cannot reject the hypothesis that both Vasp and Tam engaged in either marginal-cost or even below-marginal-cost pricing tactics after liberalisation. The changes in behaviour due to the supply shocks are somewhat ambiguous and not clear, however: whereas Vasp significantly reduced her conduct parameter after both events of exchange rate shock, in 1999 and 2001 (EXRS99 and EXRS01), Varig and Tam actually increased their conduct parameters in 1999 and then let them plunge in 2001.

Another relevant issue is that Varig seemed not to be engaged in marginal-cost pricing, apart from the fact that her conduct have significantly decreased after liberalisation. This may be due to the strong brand loyalty this airline possess in the market, which permits her to successfully price above marginal cost.

In this case, the difference between Varig and Tam may be due to two relevant facts: first, as Varig is a dominant national carrier on most international routes from and to Brazil, and has higher presence in the route, airport and city levels, this airline is conferred with more competitive advantage with respect to frequent flyer travellers willing to accumulate mileage points; secondly, Tam's reputation on this route was somewhat damaged by an accident at Congonhas Airport, in 1996; and finally, as Tam's Airbus fleet was recently acquired, she certainly have higher lease payments and resulting higher operating costs associated with capital, which certainly constrained her price-cost margins on the route.

And finally, it is important to mention that the behaviour of Tam before the EXRS99 and of Vasp after it are clearly not consistent with the claims from some analysts that firms in the market play a leader-follower game.

4.8 Conclusions

The present paper developed a competition model to investigate the impacts of the Second Round of Liberalisation of the airline industry in Brazil, on one of its most relevant markets: the air shuttle service linking Rio de Janeiro to São Paulo. Quasi-deregulation measures were undertaken by the Department of Civil Aviation in order to enhance competition in the market.

By making use of both a two-stages budgeting representation of the demand system, and a competition model with product heterogeneity among rivals, and based on the framework of the New Empirical Industrial Organisation, it was then possible to infer whether a structural change on airlines' conduct parameter was observed. This exercise ultimately served as a test of the efficacy of the policy employed by the regulators since 1998.

The main conclusions were that regulatory reform effectively stimulated firms to significantly increase the degree of competitiveness on the route, and that marginal-cost pricing was not rejected for some airlines. On the other hand, the airline with the highest presence in the market was able to persistently sustain positive mark-ups due to product differentiation elements and brand loyalty permitted by a higher presence on the route, endpoint airports and city. Those attributes are usually associated as conferring localised competitive advantage and therefore final results were in line with the existing literature (e.g. Evans and Kessides, 1993), the findings of Chapter 2, and with the traditional wisdom among airline market analysts.

Appendix 4.1 - Summary of the Survey of Oliveira (2003)

In this survey, 402 passengers were interviewed at CGH airport, in January 2000, and were asked about their preferences when choosing an airline in the market.

Table 4. 9 - Main Results of the Survey - Disaggregated by Airline

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

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

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

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

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

Appendix 4.2 – Descriptive Statistics

Table 4. 10 - Descriptive Statistics – Demand Side

Variable	Mean	Std. Dev.	Min.	Max.
VRG				
s_{it}	*0.50*	*0.05*	*0.41*	*0.63*
$sseats_{it}$	*0.40*	*0.05*	*0.29*	*0.48*
p_{it}	*176.48*	*38.16*	*129.28*	*267.71*
TAM				
s_{it}	*0.22*	*0.08*	*0.08*	*0.35*
$sseats_{it}$	*0.33*	*0.11*	*0.14*	*0.51*
p_{it}	*172.30*	*32.09*	*124.32*	*226.23*
dairbus	*0.47*	*0.50*	*0.00*	*1.00*
VSP				
s_{it}	*0.17*	*0.07*	*0.05*	*0.26*
$sseats_{it}$	*0.16*	*0.04*	*0.09*	*0.23*
p_{it}	*126.33*	*37.12*	*76.23*	*199.46*
Market				
q_t	*233,415.40*	*51,398.48*	*73,670.16*	*314,796.00*
q_t^-	*63,594.34*	*14,708.28*	*42,291.00*	*103,698.00*
p_t	*164.98*	*30.16*	*126.14*	*214.29*
gdp_t	*108.78*	*4.80*	*97.87*	*117.76*
TR/P_t^*	*350,591.69*	*100,732.14*	*201,249.00*	*567,122.20*
dlib	*0.19*	*0.40*	*0.00*	*1.00*
dfire	*0.11*	*0.31*	*0.00*	*1.00*
dcshare_paer	*0.33*	*0.47*	*0.00*	*1.00*
dcshare_vptb	*0.17*	*0.38*	*0.00*	*1.00*
dcshare_tatb	*0.14*	*0.35*	*0.00*	*1.00*

Table A . 1 – Descriptive Statistics – Supply Side

Variable	Mean	Std. Dev.	Min.	Max.
VRG				
p_{it}	*176.84*	*37.92*	*129.28*	*267.71*
q_{it}	*117.00*	*29.30*	*62.08*	*180.79*
avc_{it}	*54.944*	*6.214*	*36.906*	*69.507*
$avstl_{it}$	*822.669*	*52.492*	*522.188*	*901.365*
TAM				
p_{it}	*172.73*	*31.98*	*124.32*	*226.23*
q_{it}	*54.33*	*27.59*	*13.07*	*104.93*
avc_{it}	*114.218*	*17.260*	*76.222*	*152.612*
$avstl_{it}$	*582.628*	*138.331*	*373.872*	*773.047*
VSP				
p_{it}	*127.56*	*37.96*	*76.23*	*199.46*
q_{it}	*38.61*	*13.45*	*14.36*	*63.06*
avc_{it}	*47.451*	*8.674*	*28.059*	*85.651*
$avstl_{it}$	*562.177*	*56.023*	*399.137*	*639.896*
Market				
dlib	*0.78*	*0.42*	*0.00*	*1.00*
dexrs99	*0.57*	*0.50*	*0.00*	*1.00*
dexrs01	*0.16*	*0.37*	*0.00*	*1.00*

Appendix 4.3 – Hypothesis Tests

Table 4. 11 - Hypothesis Tests – Market Share

Hypothesis	Description	H0	TAM		VSP	
			Statistic	P-Value	Statistic	P-Value
Autocorrelation	*Breusch-Godfrey test*	*No Autocorrelation (one lag)*	4.55	*0.03*	10.65	*0.00*
IV heteroskedasticity (with levels of IVs)	*Pagan-Hall general test*	*Homoskedasticity*	26.40	*0.39*	27.33	*0.39*
Endogeneity of specified regressor	*C/distance/difference-in-Sargan test*	*Variable ln sseats $_{it}$ is exogenous*	0.13	*0.72*	0.18	*0.67*
Relevance of instruments (test of correlation with included endogenous variable)	*Partial R-squared of excluded instruments (min)*	-	0.82	-	0.87	-
	Shea Partial R-squared (min)		0.66	-	0.67	-
	F Test of excluded instruments - joint significance (min)	*Instruments are not relevant*	18.40	*0.00*	24.77	*0.00*
Validity of Instruments (overidentification/orthogonality test of all instruments)	*Hansen J test*	*Instruments are orthogonal to the error*	25.36	*0.12*	29.62	*0.06*

Table 4. 12 - Hypothesis Tests – Total Demand

Hypothesis	Description	H0	Statistic	P-Value
Autocorrelation	*Breusch-Godfrey test*	*No Autocorrelation (one lag)*	0.17	*0.68*
IV heteroskedasticity (with levels of IVs)	*Pagan-Hall general test*	*Homoskedasticity*	29.78	*0.00*
Endogeneity of specified regressor	*C/distance/difference-in-Sargan test*	*Variable* q^{-}_{t} *is exogenous*	0.65	*0.42*
Relevance of instruments (test of correlation with included endogenous variable)	*Partial R-squared of excluded instruments*	-	0.81	-
	F Test of excluded instruments (joint significance)	*Instruments are not relevant*	61.50	*0.00*
Validity of Instruments (overidentification/orthogonality test of all instruments)	*Hansen J test (GMM)*	*Instruments are orthogonal to the error*	1.99	*0.58*

Table 4. 13 - Hypothesis Test – FOC

Hypothesis	Description	H0	VRG		TAM		VSP	
			Statistic	P-Value	Statistic	P-Value	Statistic	P-Value
Autocorrelation	*Breusch-Godfrey test*	*No Autocorrelation (one lag)*	19.87	*0.00*	27.30	*0.00*	6.09	*0.00*
IV heteroskedasticity (with levels of IVs)	*Pagan-Hall general test*	*Homoskedasticity*	13.99	*0.23*	18.95	*0.09*	13.03	*0.22*
Endogeneity of specified regressor	*C/distance/difference-in-Sargan test*	*Variable* AVC_{it} *is exogenous*	0.27	*0.60*	2.14	*0.14*	0.01	*0.91*
Relevance of instruments (test of correlation with included endogenous variable)	*Partial R-squared of excluded instruments*	-	0.58	-	0.78	-	0.53	-
	F Test of excluded instruments - joint significance	*Instruments are not relevant*	13.90	*0.00*	180.15	*0.00*	21.28	*0.00*
Validity of Instruments (overidentification/orthogonality test of all instruments)	*Hansen J test*	*Instruments are orthogonal to the error*	5.45	*0.14*	4.44	*0.22*	2.37	*0.31*

5. Contributions and Limitations

This thesis aimed at examining the behaviour of airlines in recently-liberalised airline markets, by considering the case of air transportation in Brazil. From the three essays contained in this study, one is able to extract analyses on: first, the entry behaviour of a low cost carrier (LCC), a theme of major relevance nowadays in the market, given that the path of expansion of the LCC's is clearly shaping the frontiers of competition of the industry.

Also, one has the examination of the pricing behaviour of the legacy carriers in this market with recent liberalisation and, from this evidence, can infer that the locus of in those markets is both the route *and* the airport/city – and is not located only at the airport/city level, as emphasised by previous literature.

And finally, one is able to better understand the impacts of liberalisation on competition on a major air corridor of a developing country, and infer that regulatory reform constitutes a relevant instrument in enhancing competition, but also that such countries are usually subject to other sources of exogenous interferences (eg. exchange rates instability), that could significantly affect airlines' conduct and performance.

In summary, here we have an examination of *how and where airlines compete and how governmental policy affects competition* in domestic markets of a developing country.

Next sections contain a brief description of the relevant issues that arose in terms of contributions and limitations of this research.

5.1 Data

- Empirical IO studies are very demanding on data. With this requirement in mind, a thorough plan of data collection was designed, and was implemented in the forth quarter of 2001.

- The author spent 4 months in a field research at the Department of Civil Aviation, DAC, and gathered *probably the most detailed database ever developed for an academic study of the Brazilian airline*;

- On the other hand, however, due to the fire at Santos Dumont Airport, where DAC was located in 1998, most of the post-liberalisation data was lost, which constituted a major limitation for the present research.

- Also, many of the data sets available at DAC were very recent, as the need for monitoring the airline market was as recent as the liberalisation measures; the availability of data was then restricted by the limited amount of information DAC had in possession.

5.2 Hypotheses

- Some hypotheses that whilst very relevant in understanding the airline industry, could not be implemented here: **multimarket contact**, as in Evans and Kessides (1994); **network competition**, as in Oum, Zhang and Zhang (1995); **airline alliances**, as in Park (1997); **competition on location**, e.g. considering departure-time differentiation, as in Borenstein and Netz (1999) or Salvanes, Steen and Sørgard (2003); **mixed strategies**, as in Perloff, Golan and Karp (1998); **dynamic competition**, as in Brander and Zhang (1993); **capacity as strategic variable**, as in Röller and Sickles (2000); among others.

- All those issues could be regarded as extensions to the present research, as the hypotheses involved permit useful insights in understanding competition in airline markets.

5.3 Entry Model of Gol Airlines

- The use of an estimator that controls for *endogeneity* of regressors within a *discrete-choice framework* (AGLS) was a major issue of the paper; along with the use of a flexible functional form for profits and city dummies to control for unobservables, these features were considered the contributions of the paper.

- The major limitation was the data, as there were few years available (2001 and 2002):

- The proposal of paradigms for LCC operations and positioning was considered a contribution, considered useful for a better identification of true LCC behaviour, especially because nowadays is becoming increasingly difficult to determine if a given airline is really operating in that niche.

- The analysis of LCC paradigms and the empirical investigation over the consistency of Gol with either the JBP or the SWP was a major challenge; the author recognises that the availability of additional data would improve the analysis. However, one can see this investigation as the *first study that systematically associates LCC behaviour with the classic standards for this increasingly relevant market niche*.

5.4 Competitive Advantage and Price Reactions to Entry

- A positive aspect of this study was that it generated *more evidence* for the debate of Borestein (1989) and Evans and Kessides (1993) over the location of competitive advantage in airline markets, that is, either the route level, or the airport/city level, or both; for the present case, new evidence from recently liberalised markets is used and results were indicative of the relevance of both levels in explaining the patterns of price competition.

- The use of city dummies effects, which permitted the *extension of the framework of Evans and Kessides (1993)* in order to allow for identification of route-specific effects such as the impacts of LCC entry, was considered a methodological contribution.

- Again, data scarcity constituted a major limitation (a very short time series).

5.5 The Air Shuttle Study

- As far as I know, and apart from Teodorovic (1985), this is the *first study to focus on air shuttle markets*, their characteristics and specificities; the discussion of the "classic air shuttle" versus a modern concept of shuttle operations, with heterogeneous product, is a major issue of the paper.
- Also, the use of *AIDS demand system is a novelty in air transportation studies*; an extension to the way it was used here would be not to use the linearised version (LAIDS), but to perform non-linear estimation of the system of demand.
- Again, the dataset was very limited, with 58 observations for each airline only;
- Unfortunately, apart from the studies of the US market, for which there are very detailed data on average prices (from the US DOT), one has instead to rely on information about the fare structures (available, for example, on ATPCO's screens), and therefore to design ways of calculating the average fare; this is a major limitation for many researchers of this industry all over the world, and was also an issue here.

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