ESTIMATION OF A MODEL OF LOW COST CARRIER ENTRY

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ABSTRACT

Competition between low cost carriers in rapid expansion and full-service network carriers has recently become one of the most relevant issues of the airline industry. The present paper addresses this matter by analysing the entry of the low cost Gol Airlines, in the Brazilian domestic market, in 2001. 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 low cost carrier segment – short-haul and high-density markets – is investigated; evidence is found that although Gol initiated operations by reproducing the standards of Southwest, she quickly diversified her portfolio of routes and, at the margin, became more in accordance with JetBlue Airways's entry pattern, focusing mainly on longer-haul markets, although with some relevant country-specific idiosyncrasies.

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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 LCCs. Whereas the former is aimed at studying the implications for further growth of the LCCs 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 regions 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 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 3 presents the empirical model and the econometric issues. Section 4 reports the results and includes an analysis of Gol's entry patterns consistency, which is followed by final conclusions.

2 BACKGROUND: LCC NICHE AND ENTRY OF GOL AIRLINES IN BRAZIL

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[1]. 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[2]. Moreover, LCCs 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[3].

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 short-haul routes and markets where the carrier can benefit from a dominant position, 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

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[1] 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).

[2]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).

[3] Tretheway (2004) points out that the introduction of low one way fares ultimately served to undermine the ability of the FSCs 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.

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 that the concept has rapidly achieved global recognition[4].

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[5]; and 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[6].

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 LCCs, 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 LCCs. 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 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 LCCs 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 LCCs 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 LCCs.

Nevertheless, even with carriers having a more diversified range of routes nowadays, it is clear that, by making use of the notion of paradigms as benchmarks one has useful reference in order to analyse and pinpoint patterns of entry behaviour by LCCs. For example, one can study a carrier'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. Figure 1 presents a diagram with this sort of analysis:

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[4] 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).

[5] 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.

[6] 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).

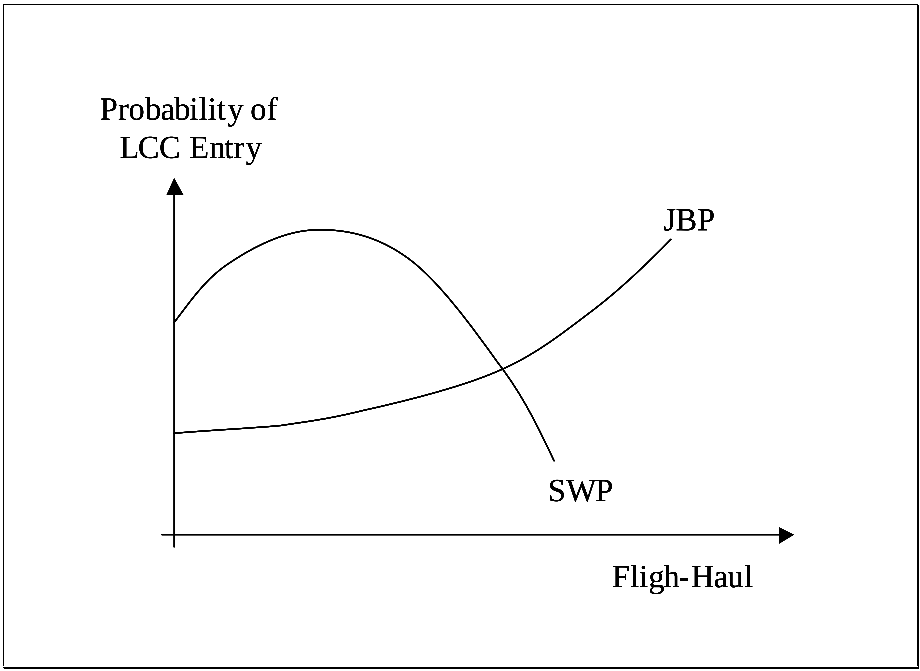

Figure 1 – SWP versus JBP: Effects of Flight-Haul on LCC Entry Probability

As Figure 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 flights. As one can see, by performing a simple inspection of the marginal effects of distance on the probability to enter a market by LCCs, 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[7].

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.

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[7] 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, however.

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.

In the *First Round of Liberalisation* (1992-1997), the then-existing regional airlines' monopolies were almost fully abolished, and newcomer entry was stimulated, leading to a wave of small, full-service carriers in the market. It virtually represented the end of the "four national and five regional airlines" policy of the seventies. Also, price competition was now seen as "healthy" for the industry, and was therefore encouraged; fare bounds were used as temporary instrument of enhancing price rivalry.

In the late nineties, DAC decided to remove two relevant regulatory devices remaining in the market: the fare bounds and the exclusivity of operations of some very dense and profitable routes by regionals[8]. This generated the *Second Round of Liberalisation* (enacted in Dec/97-Jan/98), which triggered much more strategic rivalry by airlines than the previous round of measures, with intense price and frequency competition. The removal of bounds was not totally effective, however, due to interference by macroeconomic authorities (inflation-targeting), not allowing price increase in response to the change of monetary regime and currency devaluation of January 1999.

Most of the remaining economic regulation was removed in 2001 (*Third Round of Liberalisation*), and airlines could set their prices freely from that period on. It can be viewed as a quasi-deregulation period, as entry, fares and frequencies were almost entirely liberalised. This was concomitant with Gol's entry and innovative positioning as LCC, generating the most effective threat to the so-called "Big Four" legacy majors, Varig, Vasp, Tam and Transbrasil, since the establishment of liberalisation in 1992[9].

And finally, in 2003, the Brazilian aviation authorities, with the backing of the federal government, started implementing some measures of re-regulation aiming at controlling an alleged excess capacity and over-competition in the market. New aircrafts imports were banned, price competition controls were put in practice once again, and strategic movements increasing market concentration were not disallowed, such as the code-share agreement between the two major airlines, Varig and Tam.

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[8] Airport-pairs linking city centres of four major cities, and called "special" airport-pairs, SAP. The cities were São Paulo, Rio de Janeiro, Belo Horizonte and Brasília.

[9] Actually, Transbrasil exited the market in 2001; also, some measures of re-regulation were employed in 2003, which ultimately constituted a constraint to Gol's expansion in the market.

Gol Airlines was not only the first scheduled LCC of Brazil, but also within all Latin America, with operations started in January 2001[10]. 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/bus connections and establishing free bus 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 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%:

Table 1 - Comparison of Gol and Incumbent FSCs (2002)[11]

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.

[10] Gol Airlines and U Air (Uruguay) are the only scheduled LCCs based in Latin America nowadays. Some North-American LCCs 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).

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

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[12].

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 aircrafts. 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.

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, 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.

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

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[12] 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".

had a 11.5 decrease in traffic density within the same period[13].

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:

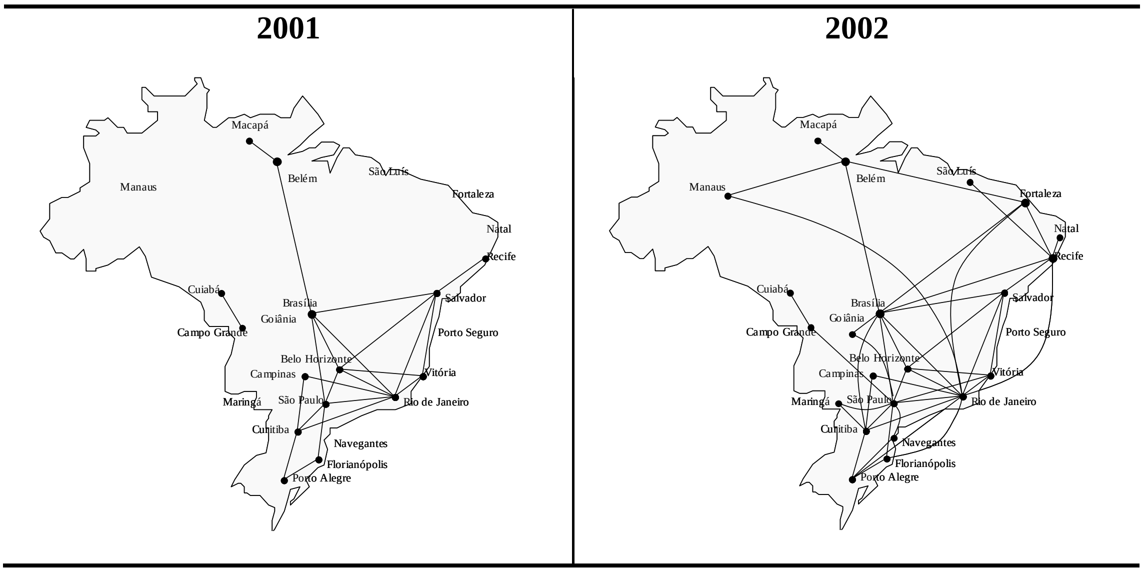

Figure 2 – Evolution of Gol's Network within Brazil

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 aircrafts 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 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 aircrafts 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[14]. For example, routes like Rio de Janeiro – Manaus (2,860 km), Rio de Janeiro – Recife (1,863

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[13] 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.

[14] 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.

miles) and Brasília – Fortaleza (1,690 miles) 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 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 – 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, 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 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 3.

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 under 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.

3.1 Discrete-Choice Framework

The intention here is to develop a framework of discrete choice with random utility[15] 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 limited dependent variable (LDV) representative of choice, $PRES_{ikt}$, which accounts for the presence of Gol on the k-th route at time t. Note that Gol is assigned with index i, in opposition to the FSC rivals, which here are considered as a whole and assigned with index j[16]. The probability of entry can then be regarded in the following way:

$$\Pr\left[PRES_{ikt}=1\right]=\Pr\left[\delta\pi_{ikt}^{*}-SC_{ik}>0\right] \tag{1}$$

Where $\delta\pi_{ikt}^{*}$ is the present value of the stream of equilibrium profits (δ is the discount factor) in case of entry, and SC_{ik} is the amount of sunk costs on the k-th route. One can develop (1) in the following way:

$$\Pr\left[\delta\pi_{ikt}^{*}-SC_{ik}>0\right]=\Pr\left[\frac{\delta\pi_{ikt}^{*}}{SC_{ik}}>1\right]=\Pr\left[\ln\pi_{ikt}^{*}+\ln\delta-\ln SC_{ik}>0\right] \tag{2}$$

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[15] 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 always select the alternative with the highest utility (profits).

[16] The main assumption here is that there are two possible niches in the market: the LCC and the FSC niches, and one observes competition among niches. The intuition for that is that travellers first need to decide whether they are travelling with either LCCs or FSCs and then decide with which specific airline they will travel; this is consistent with the idea of stages of budgeting of Gorman (1971).

By introducing ε_{ikt}, 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_{ikt}*):

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

where ε_{ikt} is assumed to be iid ~ N(0,1)[17].

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

$$PRES_{ikt} = \tau\left(\Pi^*_{ikt}\right) = \begin{cases} 1 & if \quad \Pi^*_{ikt} > 0 \\ 0 & if \quad \Pi^*_{ikt} \leq 0 \end{cases} \tag{4}$$

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

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[18], provides annual figures of domestic origin and destination traffic and this constituted the basis for data sample delimitation.

The sample was collected by using the following steps: firstly, figures from 1998 to 2002 were aggregated in order to represent total traffic by route during those five years. This period was considered representative as it captures the liberalisation rounds of 1998 and 2001 - which probably influenced Gol's original entry decisions –, and does not contain the re-regulation phase initiated in 2003, an unpredictable change in government's policy orientation which certainly was not anticipated by Gol when planning entry.

Secondly, data aggregation was performed in order to make effective the following definition of "route": the service of passenger air transportation between two given cities[19], either by

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

[18] 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).

[19] 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.

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 the market Brasília-Rio de Janeiro[20]. Therefore, routes were aggregated to represent non-directional city-pair markets. Thirdly, the 500 routes with highest density of traffic were selected from the transformed database.

And finally, some additional procedures of sample delimitation were performed in order to reduce potential heterogeneity across routes, specially with respect to demand attributes such as the 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 abnormally higher competition either within 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 – which engender lower relative disutility associated with coaches, for example –, and with exceptionally highly tourism-related routes – in which there is higher availability of charter flights[21].

In order to deal with this problem, the procedure here was to dispose of routes with unusual low flight haul and with high percentage of seats available during weekends – the latter considered a reasonable proxy for pinpointing tourism-related routes. Therefore, the sample delimitation was conducted in the following way: first, exclusion of routes with flight-haul that is lower than the 5^{th} percentile (160 kilometres, as measured for the top-500 densest routes sample)[22]; and second, exclusion of routes with a percentage of seats available during weekends that is higher than the 95^{th} percentile (also for the top-500 sample)[23]. This resulted in a final data sample with 448 routes. With this set, one could be able to capture the traffic of an average of 27 million passengers per year, which represents approximately 966 out of 1000 domestic trips during that whole period.

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[20] 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.

[21] 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.

[22] 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).

[23] 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 Aviation's HOTRAN reports (various).

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 be regarded as flexible in such a way that it can represent any equilibrium profits function of unknown form and does not impose restriction on the substitution elasticities between arguments (permits a full modelling of substitution and complementarity).

Besides that, and more specifically, it is possible to demonstrate that a translog-type equation can reasonably approximate an equilibrium post-entry profit equation emerging from a two-stage pricing game with product and cost asymmetries, having LCC entry in the first stage and price competition with product differentiation between niches in the second stage, and with Bertrand-Nash equilibrium assumed[24].

On the other hand, however, the translogarithmic can be viewed as limited as multicollinearity may emerge among its many terms, and thus not being suitable for much disaggregate models. As the number of second-order terms in the right-hand side increases quickly as the list of independent variables increases, 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 constraining all 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 4.

With respect to the *empirical specification* of (3), there are a large list of potential candidates for variables to participate as regressors, and many 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 opponents FSCs), the chosen empirical specification was then:

$$\Pi^*_{ikt} = \Pi\left[\pi^*_{ikt}\left(den_{kt}, km_k, sdr_{jkt}\right), DC_l, \varepsilon_{ikt}\right] \quad (5)$$

Where den_{kt} is route density on route k and time t, km_{kt} is flight distance on route k, and sdr_{jkt} is the number of seats available per passenger on direct flights of FSC rivals (index j), on route k and time t; the DC's (l = 1, 2, ..., L) are city-specific dummies. The translog representation of (5) would then be:

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[24] These demonstrations are presented in the Appendix, which can be sent upon request to the author.

$$\Pr\left[PRES_{ikt}=1\right]=\Pr\left[\Pi^{*}_{ikt}>0\right]= \tag{6}$$

$$\Pr\begin{bmatrix} \upsilon_0+\upsilon_1\ln den_{kt}+\upsilon_2\ln km_k+\upsilon_3\ln sdr_{jkt}+ \\ +\upsilon_4\ln den^2_{kt}+\upsilon_5\ln km^2_k+\upsilon_6\ln sdr^2_{jkt}+ \\ +\upsilon_7\ln den_{kt}\ln km_k+\upsilon_8\ln den_{kt}\ln sdr_{jkt}+ \\ +\upsilon_9\ln km_k\ln sdr_{jkt}+\sum_l u_l DC_l+\varepsilon_{ikt}>0 \end{bmatrix}$$

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

$PRES_{ikt}$, is a limited-dependent variable that accounts for route presence of Gol Airlines. When assigned with one, this variable ultimately means the initial activation of the low-cost niche on the route, given that she was the first scheduled LCC to enter the Brazilian market.

$PRES_{ikt}$ then means presence of 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[25] in any of the possible origin-to-destination (O-D) markets, within the period under consideration (2001-2002); this is 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. By making use of O-D markets in a broader way, the researcher is in a position of investigating into the conformity of Gol's operations with the "Southwest Paradigm" (short-haul and dense routes), as discussed before. The information of the presence of Gol in the O-D markets was collected from Panrotas' Domestic and International Schedules and Fares Guide[26] and Airwise's website.

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[27], 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

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[25] As the data sample consists of only the first two years of operations by Gol, it is reasonable to treat "entry" as the same of "presence"; if the sample was formed by a long time series, like in Toivanen and Waterson (2001), this assumption would not be reasonable.

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

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

was to adapt Evans and Kessides (1993)'s approach by using the minimum percentage of (observable) seats available at the endpoint cities[28], considering then "entry" when actual figures are higher than 1%.

den_{kt} is route density of traffic 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 captures all total (non-airline-specific) domestic number of trips, aggregating all direct and indirect, single-trip and round-trip, traffic.

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 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[29].

Another aspect of km_k it 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 represents higher actual distance flown than can be assessed by km_k.

Besides that, the lower the participation of non-stop flights on one given route the more one would underestimated the effect of actual flight distance on profits, specially because the higher distance would permit lower unit costs - a phenomenon known as "cost taper" in the transport literature, see Brander and Zhang, 1990. One has to be cautious with that argument, however, as more stops are also known to increase costs – for instance, by additional landing/departure fees and higher fuel consumption; besides that, 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[30].

sdr_{jkt} is the number of seats available *per* passenger on direct flights of FSCs on route k and time t. A relative measure, that is seats per passenger, was considered better than the absolute figure of seats available, as it avoids strong collinearity with den_{kt}. 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

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

[29] 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 aircrafts) is located closer to the city centre. Source: INFRAERO's website (February, 2004).

[30] Some collinearity with sdr_{jkt} is expected *ex-ante*, however.

data). This information was extracted from their system on every month for the period 2001-2002, and subsequently aggregated by year. Sdr_{jkt} is then both a measure of product differentiation – that is, more seats available meaning more convenient flights and service levels generated by the FSCs –, and of the degree of how well or underserved a given route actually is.

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

i. *sunk costs associated with entry in one particular city;*
ii. *consumers' purchasing behaviour, like the percentage of the travellers which frequently makes use of the internet when searching and buying;*
iii. *consumers' attributes: income, niche preferences, propensity to make either tourism-related or business-related trips, etc;*
iv. *airport accessibility and costs of the access (price of taxi, distance from the zones-of-trip-generation, etc);*
v. *the size of the zone of influence of the city's airport(s) in terms of trip generation (nearby cities);*
vi. *size of the airlines' network out of a particular city (unobservable degree of product differentiation, economies of scope, etc. at the airport level);*
vii. *presence of hub or mini-hub in a city;*
viii. *airport dominance by particular airlines;*
ix. *presence of charters and travel agents out of a city;*
x. *commission fees to travel agents of a city;*
xi. *frequent flyer effect: number of possible destinations out of a city;*
xii. *operational costs and expenses related to a particular city (airport fees, cost of hiring personnel, cost of contracts in general, etc.);*
xiii. *presence of a capacity-constrained airports (slots) or airports with large spare capacity;*
xiv. *subsides and incentives given by authorities to operations in one given city;*
xv. *presence of airports owned by the public enterprise Infraero;*
xvi. *number of airlines operating out of a city and concentration levels;*
xvii. *vacant slots or frequencies left by the bankrupt Transbrasil;*
xviii. *city's gross domestic product and wealth in general, as a factor of business-trips generation;*
xix. *levels of advertising and forms of effective media in one city;*
xx. *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);*
xxi. *Airport and airway infrastructure in one give city: size of the runway, air traffic control capacity, etc.*
xxii. *Number of flights and excess capacity out of a city.*

Most of these effects are expected to generate persistent heterogeneity in the error-term structure across cities, which can be controlled via the city-specific dummies, DCs[31].

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 $PRES_{ikt}$[32]. 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 will be entered. The extreme alternative, namely the drop of 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 effects which are city-specific and to avoid the aforementioned sort of artificial correlation, I then focused on the *network decisions of any potential newcomer*, either LCC or FSC, 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, 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.

Descriptive statistics for all variables used in the empirical model are presented in Table 3:

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[31] 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).

[32] The other extreme would be the case of the sample containing cities with all routes actually entered, and thus generating the same problem – a case not present in the current data sample.

Table 3 –Descriptive Statistics

Variable	Designation	Mean			Std. Dev. (Full Sample)
		$PRES_{ikt}$=0	$PRES_{ikt}$=1	Full Sample	
$PRES_{ikt}$	LCC Presence	-	-	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_{jkt}	Route Direct Seats per PAX	2.827	2.626	2.787	7.362
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_{jkt} 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[33]. 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.

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_{jkt} with the error term ε_{ikt}. In fact, one would expect both variables to be jointly determined with Π_{ikt}* 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_{ikt}, 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_{ikt}. Similar effect is expected to happen with sdr_{jkt}: a positive ε_{ikt} would cause post-entry reactions in terms of increase in route presence via higher capacity and sdr_{jkt} (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_{jkt} after Gol enters. 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.

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[33] Note that in both cases sdr_{kt} was set equal to zero.

As endogeneity is potentially present, one needs to perform a test for exogeneity in the model; the variables under suspicion were den_{kt}, sdr_{jkt} and their second-order terms sdr_{jkt}^2, $sdr_{jkt} * den_{kt}$, $sdr_{jkt} * km_k$, den_{kt}^2, $den_{kt} * km_k$. The test employed was the one suggested by Smith-Blundell (1986), which is more suitable for LDVs 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-value of 0.04), permitting the rejection of the null[34].

Once exogeneity of den_{kt} and sdr_{jkt} (and related terms) is rejected, one needs an instrumental variables estimator for limited dependent variables. Moreover, GMM estimation would be required in case of rejection of the hypothesis of homoskedasticity of ε_{ikt}. In order to test for this, a likelihood-ratio test of heteroskedasticity in the LDV 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 $[sdr_{jkt-1}, den_{kt-1}, km_k]$[35]. 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 LDV 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 LDVs (for example, the 2SIV estimator of Rivers and Vuong, 1984[36]).

The steps of AGLS estimation are the following: in the first stage, a set of regressions is estimated by OLS to obtain the reduced form parameters and the respective residuals are computed; this is followed by running a probit with the exogenous variables, the predicted endogenous variables and the residuals as regressors; then, in the final stage, a generalised least square estimator is performed in order to obtain efficient estimates of the structural parameters. 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[37].

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

[35] 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".

[36] 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.

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

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_{jkt-1}, stt_{jkt-1} (total direct seats available), swe_{jkt-1} (total direct seats available during weekends) and asz_{jkt-1} (average size of aircraft); it also comprised respective second-order terms: $(\ln den_{kt-1})^2$, $(\ln sdr_{jkt-1})^2$, $\ln den_{kt-1} * \ln km_k$, $\ln den_{kt-1} * \ln sdr_{jkt-1}$, $\ln km_k * \ln sdr_{jkt-1}$. The validity of instruments is supported by the following diagnostics:

1. By having a look at the matrix of correlations between endogenous and instrumental variables (reported in Appendix 1) one can have an idea of the reasonably high correlation among them;

2. The t-tests on the instrumental variables for the first-stage regressions (also reported in Appendix 1) further indicated they are fairly correlated with the endogenous variables;

3. The R-squared of the first stage regressions usually indicated high explanatory power (ranged from 0.55 to 0.82);

4. Since the number of instruments exceeds the number of endogenous regressors I made use of over-identification restrictions tests (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 further confirm the validity of instruments. Tests used: Sargan N*R-squared test (2.039, Chi-squared(3), P-value = 0.5644); Basmann test (1.989, Chi-squared(4), P-value = 0.5747; Sargan pseudo-F test (0.664, F(4,875), P-value = 0.5745); Basmann pseudo-F test (0.663, F(4,871), P-value = 0.5750); all tests failed in rejecting the null hypothesis that the excluded variables are valid instruments.

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 simultaneous equations bias.

4 ESTIMATION RESULTS

The estimation results of the empirical modelling developed in Section 3 are reported in the first column of Table 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 4 – Estimation Results

Dependent Variable	**PR [ENTRY = 1]**			
	(1) AGLS	(2) $AGLS^{-}$	(3) PROBIT	(4) RFM PROBIT
$\ln den_{kt}$	0.079 *	0.049 ‡	0.074 *	0.074 *
	(0.042)	(0.009)	(0.034)	(0.037)
$(\ln den_{kt})^2$	0.002		0.006 ‡	0.008 ‡
	(0.003)		(0.002)	(0.002)
$\ln km_k$	0.475 †	0.076 ‡	0.552 †	0.644 †
	(0.216)	(0.020)	(0.220)	(0.237)
$(\ln km_k)^2$	-0.034 †		-0.037 †	-0.043 †
	(0.015)		(0.016)	(0.018)
$\ln sdr_{jkt}$	-0.210 †	0.024 †	-0.129 *	-0.114 *
	(0.077)	(0.011)	(0.060)	(0.060)
$(\ln sdr_{jkt})^2$	0.013 *		0.005	0.008 †
	(0.006)		(0.003)	(0.003)
$\ln den_{kt} * \ln km_k$	-0.013 †		-0.010 *	-0.011 *
	(0.006)		(0.005)	(0.005)
$\ln den_{kt} * \ln sdr_{jkt}$	0.018 †		0.007 †	0.007 ‡
	(0.006)		(0.003)	(0.003)
$\ln km_k * \ln sdr_{jkt}$	0.017		0.015 *	0.011
	(0.010)		(0.008)	(0.008)
Control for Endogeneity	YES	YES	NO	NO
Second-Order Terms	YES	NO	YES	YES
LR χ^2 Statistic	137.64 ‡	141.10 ‡	184.22 ‡	178.25 ‡
# Predicted = 0 / # Actual = 0	675/719	675/719	682/719	684/719
# Predicted = 1 / # Actual = 1	116/177	109/177	108/177	107/177
Lave-Efron Pseudo-R2	0.495	0.460	0.513	0.504
McKelvey-Zavoina Pseudo-R2	0.790	0.645	0.741	0.737
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 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 4, with respect to column (1), can be inspected by analysing the estimated elasticities of variables den_{kt}, km_k and sdr_{jkt}. These figures are reported in Table 5:

Table 5 – Estimated Elasticities

Variable	(1) AGLS	(2) AGLS⁻	(3) PROBIT	(4) RFM PROBIT	(2)-(1) %	(3)-(1) %	(4)-(1) %
den_{kt}	0.099	0.089	0.239	0.214	*-9%*	*142%*	*116%*
km_k	0.044	0.139	0.199	0.138	*218%*	*356%*	*216%*
sdr_{jkt}	0.123	0.045	0.145	0.160	*-63%*	*18%*	*31%*
all	0.227	0.268	0.550	0.478	*18%*	*142%*	*110%*

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;

By examining the differences (in percentage) between estimated elasticities across estimators, in Table 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 3, all supportive of the AGLS estimator. Also, by inspecting Table 5 one can infer that there is no single estimator which 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 is a positive bias related to density (+142%), 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[38]. What is more, the positive simultaneity bias caused by not controlling

[38] 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).

for endogeneity of sdr_{jkt} (+18%) provides some evidence that LCC entry causes FSC presence to adjust upwards – and therefore rejecting 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 bias (+365%); although flight distance is not *per se* an endogenous variable, its full effect measured by the elasticity presented in Table 5 is formed by endogenous variables, namely, the second-order terms $\ln den_{kt} * \ln km_k$ and $\ln km_k * \ln sdr_{jkt}$. 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_{jkt}.

I now turn to the analysis of the signs and magnitudes of the estimated elasticities (the AGLS column). From Table 5 one can see that the elasticities of the original, not log-transformed, variables den_{kt}, km_k, and sdr_{jkt} were, respectively 0.099, 0.044 and 0.123, 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_{jkt}.

Firstly, we have an overall positive elasticity of sdr_{jkt}, 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 in order to make her own route choices[39]; in fact this would be clearly suggestive that route presence is quite an indication 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 LCCs: by positioning herself close to well-served direct markets, Gol is able to detect market opportunities once not perceived by the FSCs; 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 6 below presents a disaggregation of the elasticity of sdr_{jkt} with respect to own values of that variable, with both den_{kt} and km_k held constant; one can observe that a negative elasticity associated with markets with no direct flights, followed by an ever positive elasticity, confirms the lower preference for creating new markets or entering underserved routes, contrary to the SWP:

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[39] The "learning" argument is in line with the results of Toinaven and Waterson (2001).

Table 6 – Sdr_{ikt} Disaggregated Elasticities (1)

sdr_{jkt}	0.00	0.75	0.95	1.30	2.30	4.20
Elasticity	*-0.45*	*0.81*	*0.68*	*0.49*	*0.19*	*0.03*

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.

Table 7 presents another disaggregation of the elasticity of sdr_{jkt}, with respect to kilometres and density, this time holding sdr_{jkt} constant at the mean:

Table 7 – Sdr_{ikt} Disaggregated Elasticities (2)

den_{kt} \ km_k	350	500	750	1,150	1,850	2,250	2,600
1,750	*2.62*	*2.49*	*2.34*	*2.24*	*2.24*	*2.29*	*2.34*
3,500	*2.56*	*2.31*	*2.07*	*1.91*	*1.88*	*1.92*	*1.97*
8,000	*2.12*	*1.79*	*1.50*	*1.33*	*1.29*	*1.33*	*1.39*
20,000	*1.33*	*1.00*	*0.76*	*0.64*	*0.63*	*0.67*	*0.72*
55,000	*0.45*	*0.28*	*0.18*	*0.14*	*0.16*	*0.18*	*0.21*
150,000	*0.05*	*0.02*	*0.01*	*0.01*	*0.02*	*0.02*	*0.03*
300,000	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*

Notes: i. figures calculated holding sdr_{jkt} at the sample mean; ii. calculated as a 10% increase in each variable at the mean.

Undoubtedly, Table 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_{jkt}, 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. 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 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 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 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 8 – Disaggregated Elasticities of km_k

den_{kt} \ km_k	**350**	**500**	**750**	**1,150**	**1,850**	**2,250**	**2,600**
1,750	*10.75*	*7.03*	*4.34*	*2.56*	*1.30*	*0.91*	*0.66*
3,500	*7.43*	*4.79*	*2.89*	*1.65*	*0.77*	*0.50*	*0.33*
8,000	*4.47*	*2.79*	*1.60*	*0.85*	*0.35*	*0.19*	*0.09*
20,000	*2.18*	*1.26*	*0.65*	*0.30*	*0.09*	*0.03*	*-0.02*
55,000	*0.67*	*0.32*	*0.13*	*0.05*	*0.01*	*-0.01*	*-0.02*
150,000	*0.08*	*0.03*	*0.01*	*0.00*	*0.00*	*0.00*	*0.00*
300,000	*0.01*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*

Notes: figures calculated holding sdr_{jkt} at the sample mean.

As one can see in Table 8, Gol's propensity to enter a route is marked by diminishing returns of flight-haul, with steadily decreasing effects of density. Again, one can observe two regimes: first, for routes with traffic density values up to approximately 55,000 pax/year, where distance has an ever increase effect on entry, 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 55,000 pax/year), flight haul has no influence on entry; this is the outcome of the same factors affecting the elasticities of sdr_{jkt} on the same set of routes, as seen above.

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.

If the above argument is correct, however, the aggregated 2001-2002 regressions of Table 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 $\ln km_k * \ln sdr_{jkt}$ were multiplied by a dummy of year 2002, 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 $\ln km_k * \ln sdr_{jkt} * d02$. Table 9 reports the results for the same AGLS estimates but with those variables included:

Table 9 – Estimation Results Disaggregated by Year

Dependent Variable	PR [ENTRY = 1]
	AGLS 2
$\ln den_{kt}$	0.069 *
	(0.036)
$(\ln den_{kt})^2$	0.001
	(0.003)
$\ln km_k$	0.405 †
	(0.191)
$(\ln km_k)^2$	-0.030 †
	(0.014)
$\ln sdr_{jkt}$	-0.180 †
	(0.066)
$(\ln sdr_{jkt})^2$	0.011 *
	(0.005)
$\ln den_{kt} * \ln km_{k01}$	-0.012 †
	(0.005)
$\ln km_k * \ln sdr_{jkt}$	0.015 *
	(0.009)
$\ln den_{kt} * \ln sdr_{jkt}$	0.015 †
	(0.005)
$\ln km_k * d02$	-0.039 †
	(0.024)
$(\ln km_k)^2 * d02$	0.006 †
	(0.004)
$\ln den_{kt} * \ln km_k * d02$	0.002 *
	(0.001)
$\ln km_k * \ln sdr_{jkt} * d02$	-0.002
	(0.001)
LR χ^2 Statistic	141.68 ‡
Predicted = 0 / Actual = 0	674/719
Predicted = 1 / Actual = 1	111/177
Lave-Efron Pseudo-R2	0.457
McKelvey-Zavoina Pseudo-R2	0.817
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 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 10 and 11 report the results:

Table 10 – Disaggregated Elasticities of km_k – 2001

den_{kt} \ km_k	350	500	750	1,150	1,850	2,250	2,600
1,750	*9.23*	*5.83*	*3.42*	*1.84*	*0.68*	*0.30*	*0.03*
3,500	*6.17*	*3.83*	*2.18*	*1.10*	*0.30*	*0.03*	*-0.16*
8,000	*3.52*	*2.09*	*1.12*	*0.50*	*0.05*	*-0.12*	*-0.25*
20,000	*1.56*	*0.85*	*0.40*	*0.14*	*-0.05*	*-0.13*	*-0.20*
55,000	*0.39*	*0.17*	*0.06*	*0.01*	*-0.03*	*-0.06*	*-0.08*
150,000	*0.03*	*0.01*	*0.00*	*0.00*	*-0.01*	*-0.01*	*-0.01*
300,000	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*

Note: figures calculated holding sdr_{jkt} *at the sample mean.*

Table 11 – Disaggregated Elasticities of km_k – 2002

den_{kt} \ km_k	350	500	750	1,150	1,850	2,250	2,600
1,750	*16.71*	*10.93*	*6.84*	*4.18*	*2.37*	*1.84*	*1.51*
3,500	*11.27*	*7.32*	*4.50*	*2.67*	*1.45*	*1.10*	*0.88*
8,000	*6.64*	*4.18*	*2.45*	*1.36*	*0.67*	*0.49*	*0.37*
20,000	*3.19*	*1.85*	*0.96*	*0.46*	*0.19*	*0.13*	*0.09*
55,000	*0.95*	*0.44*	*0.17*	*0.06*	*0.02*	*0.01*	*0.01*
150,000	*0.10*	*0.03*	*0.01*	*0.00*	*0.00*	*0.00*	*0.00*
300,000	*0.01*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*

Note: figures calculated holding sdr_{jkt} *at the sample mean..*

Firstly, with Table 10 one can assess Gol's entry strategy in her start-up year. In this case one can observe three regimes: first, for routes with traffic density lower than 3,500 pax/year, with distance having an ever increase effect on entry, which is consistent with the JBP. Second, for a broader range of medium-sized routes (density from 3,500 to 55,000 pax/year), in which a more parable-shaped probability curve is observed and the highest probabilities roughly being observed within 750 and 1,850 kilometres; this could be associated with the SWP[40]. And third, for routes with very thick density (higher than 150,000 pax/year), distance again has no influence on entry. On the other hand, in Table 11, the estimates for 2002 resulted in two clear

[40] In comparison, the average stage length of Southwest Airlines is approximately 680 kilometres.

regimes: an ever-positive flight-haul elasticities for any route density lower than 150,000 pax/year, which is certainly more in line with JBP; and, again, a set of almost null elasticities for thick-density routes. The pattern of entry on medium-sized routes, 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.

The aforesaid findings noticeably reject the notion that Gol follows a pure standard of operations like the SWP or the JBP, but, consistently 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, tougher incumbents' reactions on shorter sector routes, or 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 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.

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, but also the tougher incumbents' reactions on shorter routes, which 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, considering long-haul markets but with many stops and connections.

APPENDIX I – ADDITIONAL STATISTICS

Table A . 1 – Matrix of Correlations of Variables

Variable	$\ln den_{kt}$	$\ln sdr_{jkt}$	$(\ln den_{kt})^2$	$(\ln sdr_{jkt})^2$	$\ln den_{kt}$ $*\ln km_k$	$\ln den_{kt}$ $*\ln sdr_{jkt}$	$\ln km_k$ $*\ln sdr_{jkt}$
$\ln den_{kt}$	1.000						
$\ln sdr_{jkt}$	0.422	1.000					
$(\ln den_{kt})^2$	0.374	-0.177	1.000				
$(\ln sdr_{jkt})^2$	0.206	0.943	-0.287	1.000			
$\ln den_{kt}*\ln km_k$	0.992	0.420	0.375	0.208	1.000		
$\ln den_{kt}*\ln sdr_{jkt}$	0.847	0.310	0.630	0.083	0.844	1.000	
$\ln km_k*\ln sdr_{jkt}$	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
$\ln sdr_{jkt-1}$	0.246	0.734	-0.079	0.695	0.246	0.275	0.729
$(\ln sdr_{jkt-1})^2$	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
$\ln den_{kt-1}*\ln sdr_{jkt-1}$	0.762	0.347	0.602	0.156	0.762	0.865	0.340
$\ln km_k*\ln sdr_{jkt-1}$	0.244	0.717	-0.079	0.694	0.259	0.280	0.763
$\ln seats_{jkt-1}$	0.125	-0.425	0.383	-0.371	0.131	0.184	-0.379
$\ln swe_{jkt-1}$	0.667	0.596	0.427	0.460	0.667	0.762	0.604
$\ln asz_{jkt-1}$	0.289	0.017	0.315	0.073	0.309	0.396	0.118

Table A . 2 – First-Stage Regressions (AGLS)

Variables	ln den_{kt}	$(\ln denk_t)^2$	ln sdr_{jkt}	$(\ln sdr_{jkt})^2$	ln den_{kt} * ln km_k	ln den_{kt}* ln sdr_{jkt}	ln km_k* ln sdr_{jkt}
ln den_{kt-1}	0.836 ‡	-1.263 *	0.063	0.631	-0.143	0.478	0.101
	(0.197)	(0.705)	(0.192)	(1.348)	(1.304)	(0.525)	(1.278)
$(\ln den_{kt-1})^2$	0.047 ‡	0.837 ‡	-0.026 ‡	-0.232 ‡	0.310 ‡	0.199 ‡	-0.178 ‡
	(0.009)	(0.031)	(0.008)	(0.059)	(0.057)	(0.023)	(0.055)
ln km_k	3.948 ‡	-2.991	-0.201	-12.785	22.824 ‡	9.815 ‡	0.984
	(1.220)	(4.370)	(1.189)	(8.350)	(8.079)	(3.253)	(7.916)
$(\ln km_k)^2$	-0.261 ‡	0.114	-0.010	0.815	-1.501 †	-0.728 ‡	-0.179
	(0.091)	(0.327)	(0.089)	(0.625)	(0.604)	(0.243)	(0.592)
ln sdr_{jkt-1}	-0.955 ‡	3.785 ‡	-0.971 ‡	-7.093 ‡	-6.429 ‡	-1.148	-11.562 ‡
	(0.321)	(1.148)	(0.312)	(2.194)	(2.123)	(0.855)	(2.080)
$(\ln sdr_{jkt-1})^2$	0.178 ‡	-0.446 ‡	0.129 ‡	0.989 ‡	1.154 ‡	0.276 ‡	0.868 ‡
	(0.030)	(0.107)	(0.029)	(0.204)	(0.198)	(0.080)	(0.194)
ln den_{kt-1}*ln km_k	-0.030	0.309 ‡	-0.035	-0.311	0.649 ‡	0.021	-0.192
	(0.030)	(0.106)	(0.029)	(0.202)	(0.196)	(0.079)	(0.192)
ln km_k*ln sdr_{jkt-1}	0.123 ‡	-0.485 ‡	0.193 ‡	1.111 ‡	0.814 ‡	0.538 ‡	1.301 ‡
	(0.024)	(0.085)	(0.023)	(0.163)	(0.158)	(0.064)	(0.155)
ln den_{kt-1}*ln sdr_{jkt-1}	-0.071 †	0.031	0.088 ‡	0.628 ‡	-0.420 †	-0.120	1.357 ‡
	(0.032)	(0.114)	(0.031)	(0.217)	(0.210)	(0.085)	(0.206)
ln $seats_{jkt-1}$	-0.367 ‡	1.547 ‡	-0.261 ‡	-1.166 †	-2.371 ‡	-0.495 †	-1.665 ‡
	(0.084)	(0.302)	(0.082)	(0.578)	(0.559)	(0.225)	(0.548)
ln asz_{jkt-1}	-0.042	-0.138	-0.102	0.995	-0.498	1.246 ‡	-1.076
	(0.152)	(0.545)	(0.148)	(1.042)	(1.008)	(0.406)	(0.987)
ln swe_{jkt-1}	0.083	0.156	-0.038	-0.404	0.500	0.426 ‡	-0.273
	(0.052)	(0.187)	(0.051)	(0.357)	(0.346)	(0.139)	(0.339)
DY	-0.007	0.812 †	-0.200 †	-1.780 †	-0.119	-0.213	-1.463 †
	(0.101)	(0.363)	(0.099)	(0.694)	(0.672)	(0.270)	(0.658)
Constant	0.142	0.652	-0.290	-2.907 *	1.091	0.871	-1.667
	(0.230)	(0.826)	(0.225)	(1.578)	(1.526)	(0.606)	(1.496)
Adjusted R2	0.702	0.767	0.608	0.554	0.702	0.815	0.636
N. Observations	896	896	896	896	896	896	896

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

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