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Financial distress, survival network design strategies, and airline pricing: An event study of a merger between a bankrupt FSC and an LCC in Brazil

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Financial distress, survival network design strategies, and airline pricing: An event study of a merger between a bankrupt FSC and an LCC in Brazil

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Abstract

This paper develops an event study to investigate the airfare effects of the bankruptcy of a financially distressed full-service carrier (FSC) and its subsequent acquisition by a low-cost carrier (LCC) in Brazil. We account for the distressed carrier's survival network design strategies (SNDS) pursued during its reorganization—a suspected source of sample selection bias. Additionally, as rivals' pricing could be aimed at driving the distressed/bankrupt carrier out of the market, we treat the carrier's distress as endogenously determined with it. Our results do not uncover any survival pricing behavior stemming from SNDS, but reveal fiercer price competition from rivals in periods preceding both the distressed carrier's bankruptcy filing and acquisition. We also find evidence of enduring price competitiveness in the long run of the acquisition event, shedding light on the potential facilitating role played by bankruptcy protection regulations in keeping and sustaining market contestability after the bankruptcy-filing period.

Keywords: airfare; airline; acquisition; bankruptcy; econometrics; merger; network management; sample selection.

JEL Classification: D22; L11; L93.

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1. Introduction

A staple of the air transportation industry since deregulation, bankruptcies have never ceased to catch regulators, governments, and the public off guard (Davalos et al., 1999; Gong, 2007). European carriers Air Berlin's, Monarch Airlines', and Primera Air's collapses in the late 2010s illustrate just that, as they burden the taxpayers and leave thousands of stranded passengers behind (*Reuters*, February 9, 2018).

With fuel prices, pilot wages, and borrowing costs on the rise to blame for many of these casualties (*CNN business*, October 22, 2018), not to mention the impacts of intense competition, merger talks between rivals should not be too surprising—even when failing to materialize.[1] The industry's "inevitable" trend of consolidation, as frequently suggested by European airline executives (*Air Transport World*, March 7, 2018; *Forbes*, October 30, 2018), remains, however, a possibility, while a certain sense of *déjà vu* to the merger and acquisition (henceforth merger) waves that took place in the US in the 80s and the 2000s and 2010s is brought to mind.

Focusing on the past decade, in the US, ten airlines were merged into four, as a series of major bankruptcies led to a second merger wave. Once again, the industry's attention was turned into a "market survival vs. market power" dilemma—whether the bankrupt airline should be left to its own resources, possibly ceasing its operations in the process, or whether it should be allowed to join efforts with a rival. Concerns of entry restrictions, downgraded quality, and higher fares were set aside, as the removal of the failing firms' assets was deemed more harmful for the market.[2]

While setting out to take a closer look at the aftermath of those events, researchers have so far weighted more towards the consolidations in themselves—e.g., Kim & Singal (1993) and Peters (2006) on mergers from the first wave, and Hüschelrath & Müller (2014) on mergers from the second. Despite their relevance, however, differing circumstances to which the failing firms were subjected to have been left out of the equation, most prominent being the influences on

[1] "*A tie-up is mooted between Emirates and Etihad*" – The Economist, September 27, 2018; "*Icelandair and WOW announce a merger*" – The Economist, November 6, 2018.

[2] For more information, the reader is referred to Section 11 "*Failure and Exiting Assets*" of the US Department of Justice's Horizontal Merger Guidelines (2010).

competition by their bankruptcy filings and by the degree of deterioration of their financial health.

Given that, we aim at addressing the following research question: "*What are the effects of an airline's financial distress as well as its bankruptcy filing and its subsequent acquisition on both its own and on its rivals' prices?*" We employ Brazilian domestic air transportation data corresponding to the period between 2002 and 2009, including the events of the bankruptcy of the full-service carrier (FSC) Varig, in 2005, and its acquisition by low-cost carrier (LCC) Gol, in 2007.[3]

As prior research has found evidence of considerable network reductions made by bankrupt carriers, specifically in periods preceding their filings (Lee, 2010; Ciliberto & Schenone, 2012), support is on hand for the hypothesis that distressed companies selectively reduce their networks, making ends meet by allocating their resources in their most profitable routes. These survival network design strategies (SNDS, as we will call) may come at a cost, however, since reductions in their number of destinations may negatively affect these companies' network attractiveness to customers while also impairing their competitive advantages—arising, for example, from lower costs associated with economies of scope. On the other hand, these strategies may prove to be an unambiguous signal of weakness to their rivals, turning them into easier preys. We suggest that the distressed/bankrupt carrier may put into practice a survival pricing behavior stemming from these SNDS, and that rival airlines, once aware of these network adjustments, may respond more aggressively with prices on routes perceived as having a higher probability of exit by this carrier. To the best of our knowledge, no previous research has considered this nonrandom selection of markets by financially distressed/bankrupt airlines. As the said airlines are typically forced to reevaluate continually the markets they operate in, the issue of sample selection bias becomes especially relevant, posing significant challenges to the understanding of the effects of bankruptcies.

Methodological contributions are further provided as we investigate the (possibly) endogenous relationship between financial distress and airfares. This hypothesis is motivated by the contention that low market prices may drive firms into financial distress, while the latter may

[3] The literature has tended to focus predominantly on effects on domestic markets. However, for an account of the effects of bankruptcy on international markets, the reader is referred to Bock et al. (2020).

induce the distressed (or already bankrupt) firm towards an aggressive pricing behavior and a spiral of price responses by rivals. In this context, these responses could be triggered by a goal of either keeping the existing market shares or even driving the distressed carrier out of the market altogether. The reader is referred to Barla & Koo (1999) and Hofer et al. (2009) for additional discussions concerning financial distress as a consequence or as a cause of price competition.

To sum up, our study makes three main contributions: (1) we develop a unifying approach to investigate the effects on airfares of a company's financial distress and both its bankruptcy filing and acquisition events in one econometric framework; (2) we explicitly account for the possible endogenous relation between the distressed company's financial condition and its rivals' airfares; and (3) given the SNDS undertaken by the distressed company in response to changes in its financial health, we extend the previous literature by considering a model that accounts for nonrandom, bankruptcy-related network adjustments that may bias the estimates.

The remainder of this paper is organized as follows. Section 2 reviews the existing literature regarding the effects of bankruptcies, financial health, and mergers on airfares. Moreover, results related to network adjustments and the financial condition of airlines are also discussed. This review is accompanied in Section 3 by a historical account of the sample carriers in the period analyzed. Section 4 then specifies our research design, with the data set, the development of our empirical models, and the estimation strategy being presented. The results are evaluated in Section 5, followed by the conclusions in Section 6.

2. Literature review

2.1. Effects of bankruptcy filings on airfares

Studies of the impacts of bankruptcies in airline markets have consistently pointed to reductions in airfares in the periods preceding and during bankruptcy filings (Borenstein & Rose, 1995; Barla & Koo, 1999; Hofer et al., 2005; Lee, 2010; Ciliberto & Schenone, 2012; Bock et al., 2020), although these authors have obtained varied results for the periods following the event.

Concerning the effects of bankruptcies on rivals' airfares, studies such as Lang & Stulz (1992) have suggested that filing for bankruptcy could serve as an unambiguous signal of a company's financial vulnerability, making the period associated with the said event more prone to predatory behaviors by their financially sound counterparts given the limitations of the bankrupt company in financing a price war (similar arguments can also be found in Borenstein & Rose, 1995, and Barla & Koo, 1999). Nevertheless, consistent empirical evidence supporting those arguments has not yet been found. While Barla & Koo (1999) and Lee (2010) provide indications of airfare reductions, the results of Borenstein & Rose (1995) and Bock et al. (2020) point to increases in airfares by the bankrupt's competitors—suggested by Borenstein & Rose (1995) as following from the shift of the bankrupt companies' passenger demand towards their rivals. Furthermore, Ciliberto & Schenone (2012) did not find robust results in their research.

2.2. Effects of financial distress on airfares

With the bankruptcy filing being the outcome of a continuous process of deterioration of a company's financial health, Borenstein & Rose (1995) propose that the degree of financial distress culminating in a bankruptcy filing could be the real reason behind the price reductions observed. Hofer et al. (2005, 2009) and Hofer (2012) support the claim that higher levels of financial distress result in lower prices. Moreover, regarding the bankruptcy, their results corroborate those previously obtained in that literature.

The findings of Phillips & Sertsios (2013), while treating the financial distress and bankruptcy as endogenous, back up Hofer et al. (2005) in that they report prices being negatively affected by the financial distress. Phillips & Sertsios (2013), however, do not find statistically significant results of price changes associated with the bankruptcy relative to the financial distress variable. Nevertheless, none of the abovementioned studies pursued the analysis of effects on competitors' prices nor accounted for both the bankruptcy event and the financial distress variable in the same model.

Regarding the effects on competitor's prices, in a similar vein to Lang & Stulz (1992), the works of Opler & Titman (1994) and Hofer (2012) justify its appraisal, arguing that a firm's *financial distress* may induce aggressive responses by rivals, aiming at taking advantage of the firm's weakened condition to gain its market share. To the best of our knowledge, no previous study of the airline industry has explicitly investigated this relation.

2.3. Effects of mergers on airfares

The literature on the effects of airline mergers on prices, in contrast, has presented consistent results of price increases. As examples related to the American market, we cite the studies of Borenstein (1990), Werden et al. (1991), Kim & Singal (1993), Singal (1996), Morrison (1996), Kwoka & Shumilkina (2010), Luo (2014), Hüschelrath & Müller (2013, 2015) and Shen (2017). We note that similar results are also found in the cases of Spain (Fageda & Perdiguero, 2014) and China (Zhang, 2015).

A distinction between the effects on airfares arising from mergers between healthy companies and those involving a company in financial distress is presented in Kim & Singal (1993). Their results indicate that fares much lower than average are exerted by distressed companies in periods preceding their mergers, with fare increases in periods following it being substantially higher than those practiced after mergers between healthy companies (a result also found in Peters, 2006).[4] Besides, Kim & Singal (1993) further observe the reproduction of this pricing pattern by the companies' rivals (a finding corroborated in Hüschelrath & Müller, 2014).

2.4. Financial distress and network adjustments

Aside from the effects of bankruptcies on airfares, we also mention research providing results of the impacts of bankruptcies on capacities. We note Lee (2010), who investigates this issue through the number of seats offered, and Ciliberto & Schenone (2012), who also employs combinations of airports, number of routes, flight frequencies, and load factors. Both studies have indicated significant reductions in the bankrupt carriers' capacities in periods preceding their filings, with lower levels being kept throughout the bankruptcy process. Along these lines, additional results are also provided in Liu (2009), who evaluates the effects of financial ratios on the propensity of distressed carriers to enter new markets. Her findings suggest that, as the

[4] Interestingly, Gudmundsson et al. (2020) also find a distinction between these two groups of mergers from a cost perspective, as mergers involving unprofitable firms were shown to be associated with ensuing reduced variable costs and increased fixed costs, when compared with mergers between healthy companies. Still, a prior study (Gudmundsson et al., 2017) would suggest that these effects offset each other in such a manner as that unit costs are not significantly different between groups—and, as a matter of fact, not affected by the merger in a considerable way, except for cases of a large relative size difference between the merging parts (regardless of their financial condition).

financial leverage of a legacy company is increased, its propensity to enter new markets is reduced, a piece of evidence not found by the author in the case of LCCs.

The results of the above literature, therefore, imply that, as the distressed company's financial condition is worsened, its number of markets is strategically reduced, as the company resources are allocated in its most profitable routes. We use the term "survival network design strategies" (SNDS) to refer to these changes. However, such bankruptcy-related adjustments pose notable challenges to the study of the effects of bankruptcies on airfares. In particular, they present serious generalization issues associated with the nonrandom selection of markets by distressed firms, who are typically forced to reevaluate on a frequent basis the routes and markets they operate.

3. The Brazilian air transportation industry in the 2000s[5]

Being the first airline to be established in Brazil and one of the first airlines in the world in 1927, Varig won its place among the most prestigious companies in the country, even going as far as holding the title of the largest airline in Latin America. The company received considerable attention from the international media in the late 1990s, as it began to show noticeable signs of financial distress. However, none of its major competitors at the time—namely TAM, Transbrasil, and Vasp—were financially sound either: the "freeze" of airfares (but not of costs) caused by the "Cruzado" inflation stabilization plan in 1986, together with the Gulf War and its accompanying rise in oil prices in 1991, were decisive factors for the deterioration of the industry's financial health that took place at that time. Vasp was in even worse financial shape, having several of its flights canceled, with many of them due to aircraft arrests following the non-payment of leases.

Following the entry of Gol Airlines in 2001, at the time an adept of the low-cost model, the Brazilian domestic market experienced fiercer and fiercer competition. This environment would lead Varig and TAM to announce merger plans in February 2003, signing a Letter of Intent for a codeshare agreement. Signs of improvements in Varig's financial health appeared in 2004

[5] The following discussion is based on articles gathered from the electronic media, mainly The New York Times and the Brazilian newspaper Folha de São Paulo. For example: "*World Business Briefing | Americas: Brazil: Airlines to End Agreement*" – New York Times, February 16, 2005; and "*Gol to Resurrect Varig*" – New York Times, March 29, 2007; among many others.

when it reported a reduction of approximately half of its losses compared to the previous year. Those were, in turn, mainly associated with the codeshare agreement with TAM and the recovery of the Brazilian air transportation demand—but that did not prevent the company from continuing to lose its market shares to Gol. Its merger plan with TAM ended up being dismissed, causing Brazilian competition agencies to determine the suspension of their codeshare agreement, suggesting that it was damaging the consumers with undue airfare increases.

Consequently, in April 2005, TAM and Varig extinguished the agreement, forcing Varig to discontinue several routes and allowing Gol to exceed its share of the domestic market. On June 17, 2005, with its deteriorating financial conditions, Varig became the first company in Brazil to file for the judicial reorganization institute, following the new Brazilian bankruptcy law, in force since June 9, 2005—a legal provision in many aspects similar to the regulations of Chapter 11 in the US.

On July 21, 2006, Varig suspended all its flights except for its most profitable market, the Rio de Janeiro–São Paulo route. There, the company chose to increase the number of weekly flights from 10 to 36. The company had already suspended 230 flights in the previous week, with the government having no choice but to provide an emergency plan so that 16,000 international passengers could return to the country should Varig be liquidated in the meantime. The company claimed it would keep its flights canceled until July 28 due to a shortage of aircraft and insufficient cash flows, resulting from the arrest of its planes by leasing companies. Following these events, the airline started to show difficulties in paying its landing and take-off fees and its fuel costs, with more than two-thirds of its planes being arrested. Furthermore, in less than a week, on July 29, 2006, Varig had 5,500 out of its 9,485 employees fired, following its restructuring plan. However, it would not take long for the company to change hands, being incorporated by Gol on March 28, 2007.

4. Empirical models

4.1. Data

Data utilized in this research is publicly made available by the National Civil Aviation Agency (ANAC) and the Brazilian Institute of Geography and Statistics (IBGE).[6] The data panel utilized is composed of monthly observations of routes of the Brazilian domestic market comprising the period between January 2002 and June 2009, mostly related to the carriers Varig, Vasp, TAM, and Gol. As can be seen in Figure 1, presenting the market share evolution at the national level of these companies from January 2000 to June 2009, at any given time, these four carriers held more than 80% of the market.

We defined a route as a directed city-pair market. Routes that contained on average less than 30 passengers per month in each direction or less than three observations with Varig's presence in the period before its bankruptcy filing were excluded. Furthermore, we also discarded routes containing less than 60 observations overall. Thus, a total of 84 markets were analyzed.

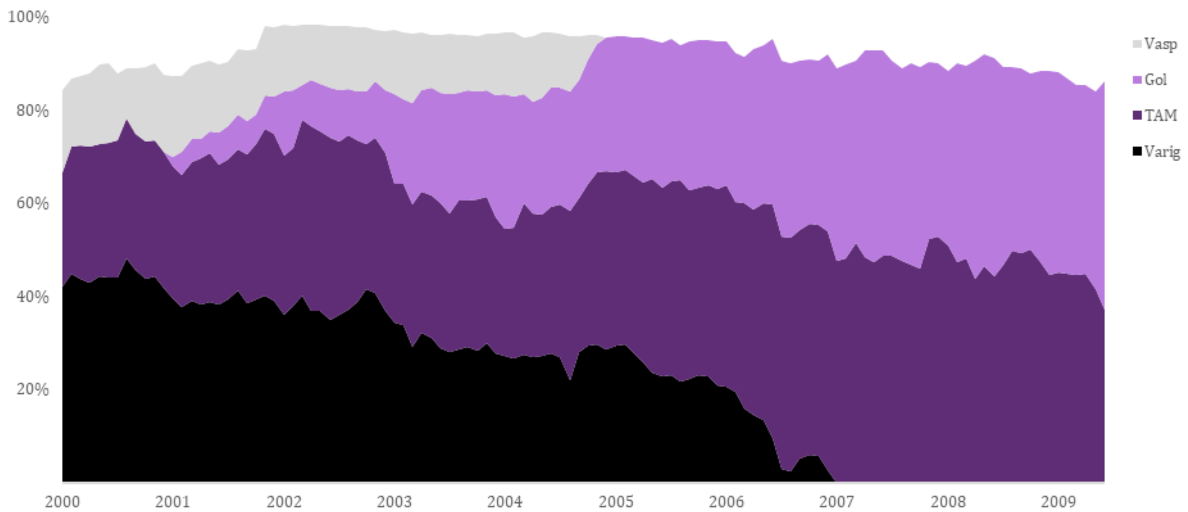

Figure 1 - Market shares of the analyzed companies at the national level

Source: National Civil Aviation Agency, with own calculations, 2000-2009.

[6] See the references for a list of data sources. All information is also available at www.nectar.ita.br/avstats.

4.2. Survival network design strategies

The SNDS performed by a distressed airline may have a substantial impact on the results obtained by any empirical model investigating the effects of bankruptcy and/or financial distress on competitive behaviors in a set of markets. In this research, we will focus particularly on behaviors as related to prices.

One can note two distinct situations arising from such strategies. On the one hand, the estimates of the distressed carrier's airfare model may be biased given its nonrandom selection of markets to keep its operations. This is the case since airfare values are only observed on routes where the company does operate, and the company chooses these routes based on a set of meaningful criteria, continually reevaluating the profitability of maintaining these connections as part of its network. These nonrandom, bankruptcy-related adjustments, however, are a potential source of sample selection bias and can provide severe distortions in estimated results.

On the other hand, when considering its rivals' airfare model, one must recognize that regardless of the said company's financial health or bankrupt status, its presence might be correlated with its rivals' unobservable airfare determinants—a concern previously raised in Ciliberto & Schenone (2012). Furthermore, this relation may also be endogenous, since rivals' airfares may affect a company's decision to remain in a given route and vice-versa. In such a case, the conditional mean of the error term with respect to the regressors—most importantly, to the bankrupt carrier's presence—would be different from zero. With a variable indicating its presence assuming only two values (either the company is "in" or it is "out" of a route), such a situation would require a procedure able to deal with an endogenous binary variable.

Given these considerations and the *ceteris paribus* effect of each variable in an econometric model, controlling for the impact of a company's presence on its rivals' airfares and taking into account its possible endogeneity allows us to make better inferences about the *isolated* effects of its financial distress, its bankruptcy, and its acquisition.

4.2.1. Heckman correction procedures

To account for both sample selection bias (in the case of the bankrupt carrier's airfare model) and the inclusion of an endogenous binary variable (in the case of its rivals' airfare model), we employed the procedures proposed by Heckman (1978, 1979). These procedures consist of two stages, with the first stage (common to both) comprising the formulation of a model to estimate the sample selection process. In our case, this process is captured by the distressed/bankrupt carrier's decision to operate a given route at a given time.

The procedure introduced in Heckman (1978) is employed in cases where both values of the independent binary variable—e.g., the company's presence or absence—are observed. It produces a variable, the "inverse Mills ratio" (henceforth IMR), to be inserted in the second stage (the rivals' airfare model) as a regressor. The statistical significance of its coefficient is then interpreted as an indication of an endogenous relationship between the unobservable determinants of the distressed/bankrupt carrier's presence and its rival's airfares.

In the distressed/bankrupt company's airfare model, only routes where the company is present are observed. In this case, the correction proposed by Heckman (1979) for sample selection bias is used instead. Here, the IMR's coefficient represents the correlation between the unobservable determinants of the company's airfares and the unobservable determinants of the company's presence—its network design decisions, with its statistical significance implying the existence of sample selection bias in the uncorrected model.

4.3. Empirical specifications

4.3.1. Route selection model

We first present the route selection model, which is consistent with the Heckman correction procedures and which can be used to provide us with evidence of SNDS. In the probit framework, we set $PRES\_VRG$ to account for Varig's presence on route (individual) i and at month (time) t, which is designated by the value '1.' This variable is regressed in the following set of regressors, all of which present route and monthly variability, unless otherwise stated: POP_GRAV and GDP_GRAV, the product of the populations and GDPs of the origin and destination (OD) cities of a route, respectively (where $\_GRAV$ is shorthand for "gravity model"); $FUEL\_COST$, the average unit fuel cost per available seat kilometer (ASK) over all aircraft on a given route; $DIST$, the Vincenty distance between the endpoints of a route, presenting only *route* variability; $FUEL\_EFF\_ASK$, the route's fuel efficiency, as defined by the number of ASK divided by the liters of fuel consumed; LF and M_SHARE, Varig's load factor and market share in the route, respectively; TR_DEN, the traffic density of the OD market—or, in other words, the total number of passengers associated with the OD market while accounting for connecting passengers (in contrast to REV_PAX, the number of passengers associated with the flight leg); $FREQ\_CGH$, a variable only differing from zero on routes containing São Paulo as one of its endpoints, calculated as the flight frequency associated with the original city pair replacing São Paulo airports with the Congonhas airport (CGH), a slotted airport where Varig held a considerable share of slots; $PRES\_GOL$, a binary variable accounting for the presence of Gol, thus controling for an LCC rival; $PRES\_VSP$, a binary variable accounting for the presence of Vasp, assessing the effects of a distressed competitor;[7] $CODESHARE$, a binary variable assuming the value '1' in city pairs and periods in which the codeshare agreement between TAM and Varig was in force—i.e., from March 2003 to April 2005; $TREND\_PRE\_BKT$, an increasing discrete linear variable, differing from zero in periods before June 2005; $TREND\_BKT$, defined similarly to the previous one, only differing from zero in periods after June 2005 (inclusive) and before April 2007; and $TREND\_POST\_ACQ$, differing from zero in

[7] As noted in Section 3, Vasp was in a bad financial situation throughout the period of our dataset. Nevertheless, the company was liquidated before the new Brazilian bankruptcy law was introduced. It had its last regular flights reported in November 2004, as can be seen in Figure 1, providing a sufficient time window for the isolation of the effects of Varig's bankruptcy, filed in June 2005.

periods after April 2007 (inclusive). All monetary variables are adjusted by the IPCA deflator (provided by IBGE) to a value comparable to January 2015. For the computation of the GDPs and populations, which are made available by IBGE, we considered the entire geographic area of the associated mesoregion as defined by the same institute, with São Paulo cities having additional mesoregions. $FUEL\_COST$ comes from unpublished data of costs, expenses, and monthly operations disaggregated by aircraft and air carrier (ANAC) and from ANAC's Active Scheduled Flight Historical Data Series (VRA). $FREQ\_CGH$ is also extracted from VRA. $CODESHARE$ comes from the Secretariat of Economic Monitoring (SEAE) of the Brazilian Ministry of Finance. All other variables are obtained from ANAC's Air Transport Statistical Database.

The time trend was included to control for the periods of expansion and contraction of Varig's network when performing its SNDS. This variable is interacted with the period during which the bankruptcy protection was in force and with the post-acquisition period, to identify possible moderating effects of these events. In different specifications, we also experimented with the following variations: $TREND$, without any interaction; and $TREND\_POST\_BKT$, merging the periods associated with $TREND\_BKT$ and $TREND\_POST\_ACQ$.

A remark is due given the inclusion of the rivals' presence variables, given the endogeneity that may be introduced in the model. Since this could contaminate our estimations in the second stage, we created alternative IMR variables consisting of different specifications, excluding these terms. After these changes, however, no significant differences in the results of the airfare models (both for Varig's and its rivals') were found. Other possible endogeneity issues that could be introduced by including strategic decision-making variables—namely, TR_DEN, FL_EFF_ASK, LF, and M_SHARE—are controlled for by lagging these terms by one period.

Lastly, we also emphasize the use of route *random effects* (RE) at this first stage, rather than fixed effects (FE). FE are based on the conservative hypothesis that time-independent characteristics (in the case of individual-specific FE) may be correlated with the independent regressors. For time-specific FE, moreover, the control would be directed at individual-independent characteristics. In our case, where the individuals are routes, their distances are an example of a time-independent characteristic.[8] Additionally, within an appropriate timeframe, route FE will also be able to control for a route's profile (whether it caters more to the business or the leisure segments), the accessibility of the OD airports, these airports' catchment area sizes, whether one or both airports are hubs or have slots, the air traffic control capability, the number of travel agents in the endpoint cities, among many others. Furthermore, time FE (controlling for route-independent characteristics) will be able to account for influences such as national government policies (taxation, air traffic regulation), strategic behavior of airlines across the country, and so on.

RE, in contrast, rely on the assumption that these characteristics are not correlated with the independent regressors, which may not necessarily hold in general. Nevertheless, the econometrics literature points to methodological shortcomings of employing FE estimators on nonlinear panel models, as these can be severely biased due to the incidental parameters problem, also raising questions about the statistical properties of the maximum likelihood estimator in such settings (e.g., Greene, 2004; Fernández-Val, 2009). Given the relatively modest sample sizes utilized (around 4,000 observations for Varig's model and around 6,000 for the route selection and the rivals' models), we opted to employ RE in the first stage, which is preferred to no control at all. Still, FE are used in the models of the second stage, given that those models are linear and, hence, don't suffer from these shortcomings.

We conclude this section with descriptive statistics of the variables of the route selection model, presented in Table 1.

[8] We experiment with a time-varying version distance, namely, distance divided by each carrier's average stage length. This procedure is consistent with the suggestion of Brander & Zhang (1990). The results are not significantly impacted by the insertion of this proxy in our airfare models.

Table 1 - Descriptive statistics - variables of the route selection model

Variables		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Pearson's Correlation															
PRES_VRG	(1)	1.000													
DIST	(2)	0.010	1.000												
ln GDP_GRAV	(3)	0.078	0.098	1.000											
ln POP_GRAV	(4)	0.093	0.120	0.944	1.000										
ln TR_DEN (lagged)	(5)	0.109	-0.223	0.675	0.633	1.000									
ln FUEL_COST	(6)	-0.086	-0.583	-0.090	-0.101	0.152	1.000								
FL_EFF_ASK (lagged)	(7)	0.022	0.766	0.137	0.121	-0.064	-0.518	1.000							
LF (lagged)	(8)	0.073	0.351	0.119	0.152	0.047	-0.287	0.300	1.000						
M_SHARE (lagged)	(9)	0.204	0.287	-0.037	0.021	-0.500	-0.309	0.058	0.236	1.000					
FREQ_CGH	(10)	0.089	-0.313	0.567	0.556	0.666	0.188	-0.272	-0.092	-0.162	1.000				
PRES_GOL	(11)	-0.009	0.117	0.211	0.219	0.245	-0.100	0.182	0.214	-0.167	0.071	1.000			
PRES_VSP	(12)	0.145	-0.034	-0.117	-0.077	-0.090	0.005	-0.090	0.066	0.236	-0.022	-0.001	1.000		
CODESHARE	(13)	0.073	-0.121	-0.034	0.020	-0.025	0.032	-0.134	0.134	0.208	-0.003	-0.026	0.309	1.000	
TREND	(14)	-0.190	0.127	0.312	0.239	0.337	0.000	0.263	-0.067	-0.447	0.114	0.127	-0.716	-0.271	1.000
Univariate statistics															
Mean		0.616	988.852	4.788	17.030	9.986	-2.302	21.069	0.602	0.316	159.458	0.978	0.298	0.204	47.549
Standard deviation		0.486	625.420	1.500	1.311	0.918	0.424	4.793	0.150	0.247	429.779	0.145	0.458	0.403	25.327
Minimum		0.000	163.000	-0.007	13.831	3.045	-7.344	3.782	0.030	0.000	0.000	0.000	0.000	0.000	1.000
Maximum		1.000	2694.993	8.120	19.792	12.495	-0.787	46.143	1.000	1.000	3053.000	1.000	1.000	1.000	90.000

4.3.2. Airfare models

Given the results of the previous model, the IMR variable is generated, being incorporated as an explanatory variable in both airfare models. In this second stage, for Varig's airfare model, we set $ln\ YIELD\_VRG$ as a proxy for the average price paid by Varig's passengers per kilometer flown in a given route i and at a given month t, where ln denotes the logarithm. This variable is regressed in the following set of regressors, all of which present route and time variability: $ln\ FUEL\_COST$, $PRES\_GOL$, $PRES\_VSP$, $CODESHARE$, M_SHARE, and IMR, as previously defined; $ln\ HHI\_MAX\_AIRP$, the maximum Herfindahl-Hirschman index between the OD cities of a given route, controlling for the market concentration at the airports (or cities, for multi-airport regions); $ln\ REV\_PAX$, the number of paying passengers; $DISTRESS\_VRG$, a variable based on the *negative* of Altman's Z"-score (2002), similar to its presentation in Hofer et al. (2005, 2009), to facilitate its coefficient interpretation in the regressions. Moreover, given its lack of route variability and the use of FE in all of our specifications—which do control for its effect, with the proviso that it cannot be distinguished from other factors varying only in the time dimension—the variable that we ultimately employ is an interaction between Varig's financial distress and its passenger share per route per month. The adopted procedure is based on Lee (2010), who interacts the time dummies associated with the periods bookending the analyzed companies' bankruptcies and their respective market shares on each route. With this procedure, the author aimed at investigating effects that might be dependent on a route's degree of exposure to a bankruptcy; $KEPT$, a set of binary variables accounting for the quarterly evolution of the routes operated by Varig *throughout* the analyzed period; and $ABND$, accounting for the quarterly evolution of routes operated by Varig but abandoned after either its bankruptcy filing or its acquisition.

For the rivals' airfare model, we regressed $ln\,YIELD\_RIVALS$ as a proxy for the average price paid by their passengers per kilometer flown in a given route i and at a given month t. The variable is calculated as the weighted average of the yields of Varig's rivals, with the weights being the companies' respective passenger shares for each route i and month t. Additionally to the regressors of the previous model (except for Varig's market share), this variable is regressed in the following regressors, all of which present route and time variability: $ABND$, as previously defined but here encompassing a broader set for these variables; $DISTRESS\_RIVALS$, which is defined similarly to $DISTRESS\_VRG$, being, however, expressed as the passenger share-weighted average of the rivals' financial distress.

$YIELD\_VRG$ and $YIELD\_RIVALS$ are obtained from ANAC's Air Tickets Microdata. As monetary variables, they are adjusted by the IPCA deflator as previously discussed. $DISTRESS\_VRG$ and $DISTRESS\_RIVALS$ are constructed from ANAC's Air Transport Yearbook, Air Transport Statistical Database, and Financial Statements of Brazilian Airlines. Additionally, all remaining variables are from ANAC's Air Transport Statistical Database.

We note that, for both models, we employ route and time FE as well as monthly trends associated with the OD cities, created by the interaction of city FE and time trends. We also note that $ln\,HHI\_MAX\_AIRP$, $ln\,REV\_PAX$, M_SHARE, $DISTRESS\_VRG$, and $DISTRESS\_RIVALS$ are treated as endogenous regressors, with further details of their estimation strategy being provided in Subsection 4.4.

Lastly, we remark that we analyzed the bankruptcy and the acquisition using a difference-in-differences (DiD) approach dividing the routes into two groups. The first group contains routes operated by Varig throughout the sample—controlled by the set of variables $KEPT$; the second group includes routes exited by the airline during its bankruptcy filing or after its acquisition by Gol—controlled by the set $ABND$. With this, we aimed at supplementing the analysis of its SNDS, uncovering any differing effect of these events on each of those groups, as these could provide us with evidence of whether rivals, once aware of Varig's network adjustments, responded differently on markets perceived as having a higher probability of exit.

One significant issue to be aware of when using a DiD model is to assure the fulfillment of the parallel trend assumption, necessary for the validity of its results. The analyses of Varig's and its rivals' airfare models are illustrated in Figures 2 and 3, respectively, both containing the evolution of the mean yield in the two route groups. As shown, both kept and abandoned routes presented patterns suggesting a common trend before the bankruptcy, both for Varig's yields and for its rivals', providing evidence of the fulfillment of the said assumption.

We conclude this section with descriptive statistics of the variables used in Varig's and its rivals' models, found in Tables 2 and 3, respectively.

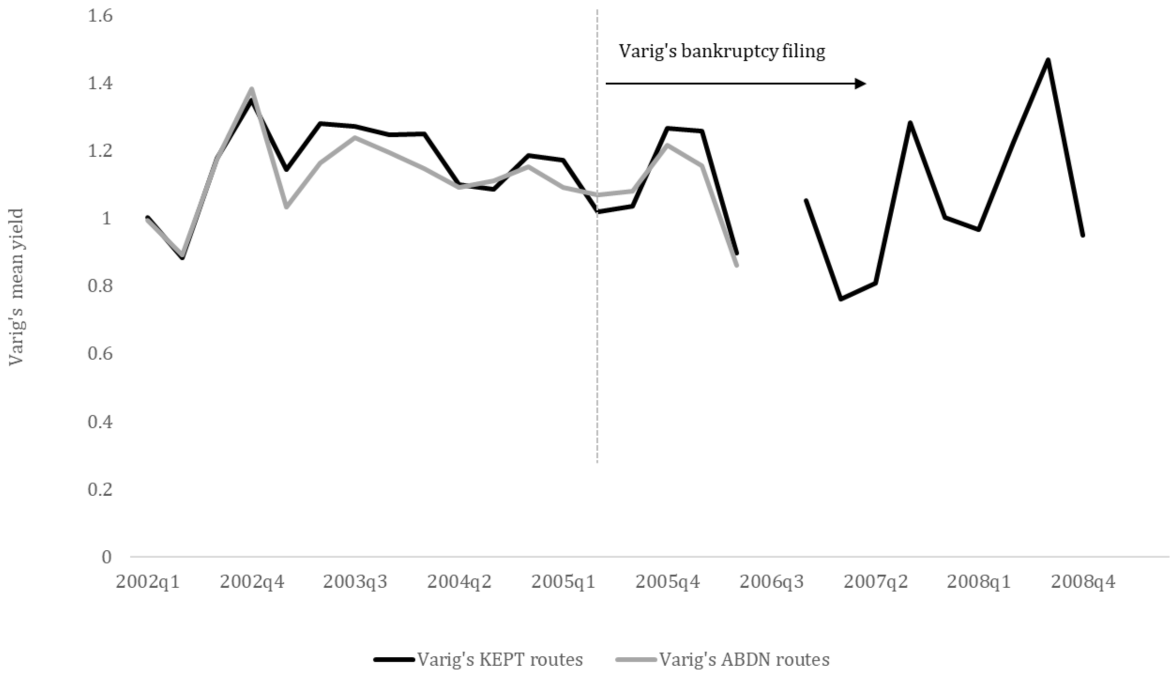

Figure 2 – Varig's mean yield trends of the two route groups

Source: National Civil Aviation Agency, with own calculations, 2002-2009.

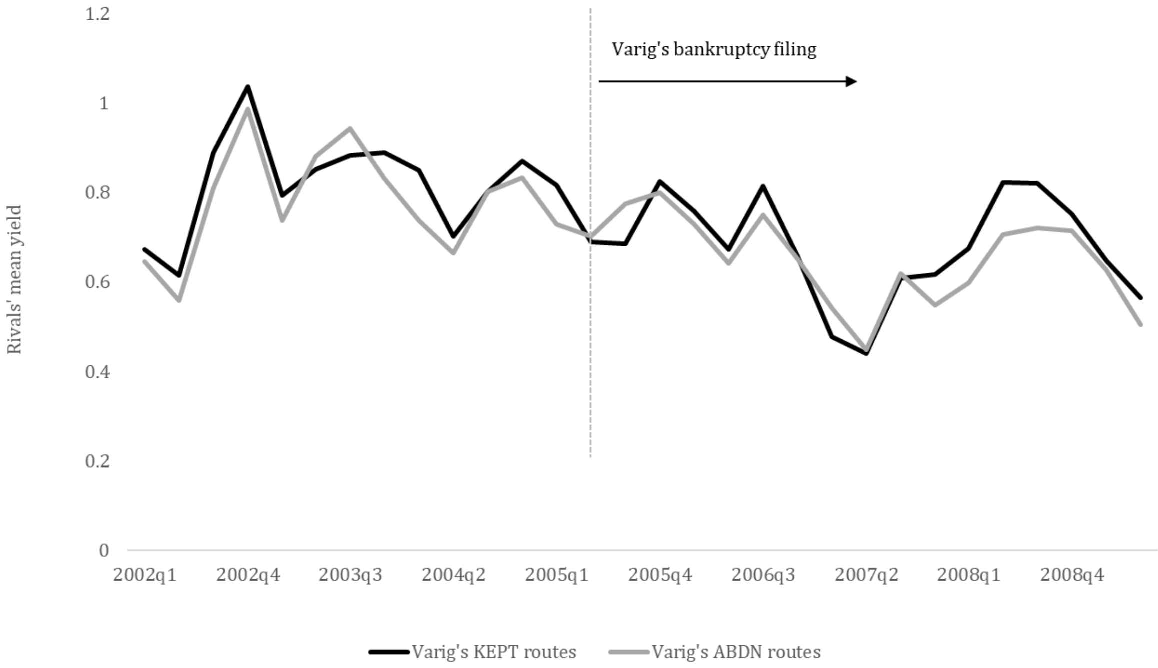

Figure 3 – Rivals' mean yield trends of the two route groups

Source: National Civil Aviation Agency, with own calculations, 2002-2009.

Table 2 - Descriptive statistics - variables of Varig's airfare model

Variables		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Pearson's Correlation											
ln YIELD_VRG	(1)	1.000									
ln REV_PAX	(2)	0.063	1.000								
ln FUEL_COST	(3)	0.478	0.090	1.000							
ln MAX_HHI_AIRP	(4)	-0.033	0.262	0.043	1.000						
M_SHARE	(5)	-0.099	-0.366	-0.361	-0.289	1.000					
PRES_GOL	(6)	0.054	-0.170	-0.050	-0.559	0.262	1.000				
PRES_VSP	(7)	0.005	-0.062	-0.001	-0.533	0.120	0.693	1.000			
CODESHARE	(8)	0.194	-0.010	0.025	-0.268	0.143	0.469	0.221	1.000		
DISTRESS_VRG	(9)	-0.011	-0.350	-0.148	-0.400	0.739	0.425	0.331	0.222	1.000	
IMR	(10)	0.088	-0.154	0.286	0.422	-0.451	-0.322	-0.247	-0.090	-0.411	1.000
Univariate statistics											
Mean		0.047	10.023	-2.298	-1.027	0.330	0.537	0.420	0.269	1.273	0.174
Standard deviation		0.385	0.984	0.468	0.154	0.243	0.499	0.494	0.444	1.389	0.377
Minimum		-1.308	6.851	-7.344	-1.472	0.000	0.000	0.000	0.000	0.000	0.000
Maximum		1.346	12.370	-1.009	-0.280	1.000	1.000	1.000	1.000	8.409	4.173

Table 3 - Descriptive statistics - variables of the rivals' airfare model

Variables		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Pearson's Correlation											
ln YIELD_RIVALS	(1)	1.000									
ln REV_PAX	(2)	0.042	1.000								
ln FUEL_COST	(3)	0.542	0.030	1.000							
ln MAX_HHI_AIRP	(4)	-0.071	0.092	0.057	1.000						
PRES_GOL	(5)	0.169	-0.092	-0.008	-0.633	1.000					
PRES_VSP	(6)	0.148	-0.033	0.010	-0.609	0.775	1.000				
CODESHARE	(7)	0.196	0.001	0.038	-0.344	0.596	0.385	1.000			
DISTRESS_VRG	(8)	0.078	-0.163	-0.080	-0.561	0.569	0.498	0.324	1.000		
DISTRESS_RIVALS	(9)	0.163	-0.088	-0.045	-0.591	0.671	0.645	0.216	0.594	1.000	
IMR	(10)	0.058	0.007	0.030	-0.035	-0.014	-0.016	-0.011	0.015	0.050	1.000
Univariate statistics											
Mean		-0.449	9.843	-2.302	-0.958	0.389	0.298	0.204	0.818	-3.901	0.004
Standard deviation		0.474	0.907	0.424	0.173	0.488	0.458	0.403	1.266	2.659	0.449
Minimum		-1.758	6.806	-7.344	-1.472	0.000	0.000	0.000	0.000	-10.071	-3.747
Maximum		1.567	12.370	-0.787	-0.280	1.000	1.000	1.000	8.409	10.179	4.173

4.4. Estimation strategy

Due to established endogenous relationships concerning airfares, $ln\,HHI\_MAX\_AIRP$, M_SHARE, and $ln\,REV\_PAX$ are likely to bias our estimates, prompting us to employ an instrumental variable estimator. Likewise, we opted for addressing the endogeneity of both the bankrupt carrier's and its rivals' financial distress.[9]

Our identification strategy consists of structural, lagged, and Hausman instruments (Hausman, 1996). Hausman instruments exploit the panel structure of the data, assuming the correlation between the endogenous variable and the instrumental variable through markets, with the instrument being uncorrelated with local unobservable shocks to which the endogenous variable

[9] We highlight the works of Borenstein & Rose (1995) and Barla & Koo (1999), who conjecture about the possible endogenous relationship between the bankruptcy filing and the airfares. However, it is not expected that such a relation would have affected our results, given the steady improvement of Varig's financial health (as measured by the Z"-score) and the fact that the period before the bankruptcy filing did not indicate significantly lower airfares in relation to the base case of January 2002, in deflated values. A similar conclusion can be made regarding the rivals' airfares, since lower prices are more likely to increase the level of financial distress when compared to higher prices (concerning the rivals' average airfare evolution, one notes similar prices to those of the base case being charged before the bankruptcy filing). The interested reader is referred to Borenstein & Rose (1995) for further details of the issues addressed in this note.

may be subject. The procedure is similar to the one presented in, e.g., Bendinelli et al. (2016). The structural instruments consist of demand shifters, commonly used to identify variables in price models, which are expected to influence market concentration, number of passengers, and/or the extent of financial distress. All instruments employed were in logarithmic form. In the following, for ease of presentation, we denote a Hausman instrument by an "H" and a one-period lag by an "L."

The following instruments were employed in the specification of Column (1) of Table 5 of Subsection 5.2: the maximum observed share of passengers in a route (LH); maximum observed share of passengers between the OD airports (LH); average GDP between OD cities; and the number of destinations from the origin airport (H). Likewise, for Column (2) of the same table, we utilized: the maximum HHI between OD airports (LH); the maximum observed share of passengers in a route (LH); the maximum Gini inequality index between OD cities; and Varig's distress (LH). We note that we handled the endogeneity of M_SHARE by including it as a lagged regressor in these specifications instead of employing instrumental variables. This procedure was used as no instrument that was both valid and relevant was found. As such, given the relatively modest size of our database, especially for Varig's model, and the number of endogenous variables, we opted to refrain from overstraining the specifications.

Moving on, for Column (1) of Table 6 of Subsection 5.3, we used: the minimum GDP between OD cities; the maximum HHI between OD airports (LH); the load factor of the route (LH); the average income between OD cities; and the number of destinations from the destination airport (H). Finally, for Column (2) of the same table, we included: the maximum HHI between OD airports (LH); the maximum observed share of passengers in a route (LH); the route's percentage of delayed and canceled flights (L); the maximum percentage of connections between OD airports (LH); and the minimum number of destinations between OD airports (H).

We ran a series of tests to verify the validity (i.e., orthogonality) and the relevance of the proposed instruments. In all models, the set of instruments utilized had one variable over the number of endogenous variables. The tests employed were the Hansen-Sargan J test, for assessing the validity of the full set of over-identifying conditions, and the Kleibergen-Paap rk LM under-identification test (KP) together with the Cragg-Donald Wald F and the Kleibergen-Paap rk Wald F statistics (Weak CD and Weak KP, respectively), for assessing their relevance.

All tests supported the orthogonality and relevance of the set of instruments. Their results are provided in the tables of Section 5.

Moreover, we implemented the Cumby-Huizinga test for autocorrelation and the Pagan-Hall, White/Koenker, and Breusch-Pagan/Godfrey/Cook-Weisberg tests for heteroscedasticity of the residuals. All tests suggested the presence of both autocorrelation and heteroscedasticity. Consequently, heteroscedasticity- and autocorrelation-consistent standard error estimates were employed.

As previously mentioned, the Heckman corrections employed require a first stage where we considered an RE probit estimator. The estimation method utilized in the second stage, in contrast, was the two-step feasible efficient generalized method of moments estimator (2SFEGMM), with arbitrary heteroscedasticity- and autocorrelation-consistent standard error estimates (see, e.g., Hayashi, 2000). This estimator was chosen to account for instrumental variables. Moreover, we utilized a bootstrap method to correct the standard errors of the second-stage regression to account for the presence of the IMR variable among the regressors. Special attention was given to the stratification of the data, i.e., the separation of data by individuals (routes) and the independent resampling of the values associated with each one of them. Furthermore, we opted for the more conservative procedure of resampling with replacement the *observations* of the original panel (referred to as "pairs bootstrap"), which does not rely on the correct specification of the linear regression model nor assumes independence of the residuals with respect to the regressors.

5. Estimation results

5.1. Route selection model

Table 4 presents the estimation results of the route selection model. Column (8) is our preferred specification. Column (9), related with an alternative specification, is included to facilitate the comparison between the route selection model and the airfare models and to provide a better understanding of the evolution of Varig's network design strategies in the quarters surrounding its bankruptcy and acquisition events. We observe that, in Column (8), the time trends suggest similar rates of route discontinuation concerning the periods associated with the bankruptcy protection (TREND_BKT) and the post-acquisition period (TREND_POST_ACQ), with coefficients -0.0381 and -0.0351, respectively. The period before the bankruptcy filing

(TREND_PRE_BKT), moreover, hints at a slightly more pronounced effect (-0.0507), indicating that the bankruptcy protection may have hampered this preexisting trend. We, therefore, have strong evidence of survival network design strategies (SNDS) by the distressed airline both before and beyond its bankruptcy filing. These observations can also be inferred from the specification in Column (9), which provides a closer look at the time evolution of Varig's route presence. Firstly, it is possible to note a reduction in the propensity related to the company's presence in the two quarters before its bankruptcy filing with respect to the base case (which in this model is the period from January 2002 to August 2004), with the company showing signs of expansion of its flight network in the quarter associated with the bankruptcy filing in itself, given the less negative coefficient of this quarter with respect to previous ones. The suspension of debt collection and the illegality of the arrest of leased equipment resulting from the bankruptcy protection (in force after June 17, 2005) helps to explain these results. The sharp reduction in the probability of the company's presence, associated with the second and third quarters of 2006 (3QRT_BEF_ACQ and 2QRT_BEF_ACQ, respectively), moreover, can be justified by the arrest of the company's aircraft on July 21, 2006, as noted in Section 3.

Columns (1) to (7) present a set of robustness checks for Column (8). We point out the high correlation among ln GDP_GRAV, ln POP_GRAV, and ln TR_DEN, as illustrated in Columns (1) to (3), with one variable losing its statistical significance by the inclusion of the other.[10] Such correlations are similarly noticeable in Table 1. In general, ln TR_DEN was the only variable among the three to retain its statistical significance across specifications. This variable, together with ln FUEL_COST, FL_EFF_ASK, M_SHARE, FREQ_CGH, and the TREND variables, appear to have the highest explanatory power in our model. As such, the results of these checks indicate that our empirical analysis of Varig's presence is not substantially affected by perturbations. Additionally, the IMR terms produced by these specifications did not provide significant changes in the coefficients of the second stage models.

[10] To inspect the possible impact of multicollinearity stemming from the high correlation among the variables of GDP, population, and traffic density, we also ran the same specifications employing GDP per capita instead of GDP or population. Results of these specifications, nevertheless, were qualitatively similar to the ones presented in Table 4, with all regressor showing the same statistical significance, the same sign and similar magnitudes. The only exception to this was the loss of statistical significance of the dummy variable *BKT_FILLING_QRT* in the specification in Column (9).

Table 4 – Estimation results of Varig's route selection model

PRES_VRG	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
DIST	-0.0006***	-0.0006***	-0.0003***	-0.0002*	-0.0002**	-0.0002*	-0.0002*	-0.0002	-0.0002
ln GDP_GRAV	0.3566***		0.0338	0.0708	0.0468	0.0343	0.0041	0.0136	0.0781
ln POP_GRAV		0.3752***		-0.1150	-0.0720	-0.0768	-0.0420	-0.0558	-0.0085
ln TR_DEN (lagged)			0.7600***	0.7340***	0.7370***	0.7509***	0.7462***	0.7497***	0.7022***
ln FUEL_COST	-0.3962***	-0.3607***	-0.2452*	-0.2596**	-0.3340**	-0.2483*	-0.2285*	-0.2293*	-0.4928***
FL_EFF_ASK (lagged)	0.0789***	0.0790***	0.0787***	0.0789***	0.0783***	0.0781***	0.0773***	0.0770***	0.0823***
LF (lagged)	0.1926	0.1702	-0.1052	-0.0895	-0.0762	-0.0969	-0.0762	-0.0500	-0.2010
M_SHARE (lagged)	2.6336***	2.6331***	3.4296***	3.3556***	3.3518***	3.4716***	3.4764***	3.4335***	3.1129***
FREQ_CGH				0.0005**	0.0005**	0.0005**	0.0005**	0.0005**	0.0008***
PRES_GOL				0.1043	0.0703	0.1043	0.1043	0.1280	-0.0495
PRES_VSP				-0.2531**	-0.1557	-0.1227		-0.2250*	-0.4276**
CODESHARE					-0.3586***	-0.1203	-0.1660	-0.1345	-0.6265***
<u>TIME VARIABLES</u>									
TREND	-0.0232***	-0.0208***	-0.0246***	-0.0279***	-0.0301***				
TREND_PRE_BKT						-0.0440***	-0.0465***	-0.0507***	
TREND_POST_BKT						-0.0321***			
TREND_ BKT							-0.0337***	-0.0381***	
TREND_ POST_ACQ							-0.0320***	-0.0351***	
3QRT_BEF_BKT									0.0121
2QRT_BEF_BKT									-0.7188***
1QRT_BEF_BKT									-1.0482***
BKT_FILLING_QRT									-0.4686*
1QRT_AFT_BKT									-0.0428
2QRT_AFT_BKT									-0.5234*
3QRT_AFT_BKT									-1.0591***
3QRT_BEF_ACQ									-2.5553***
2QRT_BEF_ACQ									-2.6801***
1QRT_BEF_ACQ									-1.0388***
ACQ_QRT									-2.4937***
1QRT_AFT_ACQ									-3.1684***
2QRT_AFT_ACQ									-2.6988***
3QRT_AFT_ACQ									-1.9247***
4QRT_AFT_ACQ									-1.7776***
5QRT_AFT_ACQ									-2.2505***
6QRT_AFT_ACQ									-1.5478***
7QRT_AFT_ACQ									-2.3628***
8QRT_AFT_ACQ									-2.7771***
Random Effects	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*
R^2 Maddala	0.45276	0.45232	0.46051	0.46148	0.46241	0.46339	0.46341	0.46369	0.48604
R^2 McFadden (adj.)	0.59756	0.59677	0.61146	0.61201	0.61343	0.61494	0.61498	0.61518	0.65266
R^2 Lave	0.34733	0.37427	0.32557	0.32321	0.32183	0.31971	0.31812	0.31898	0.31125
R^2 McKelvey & Zavoina	0.78091	0.77668	0.80011	0.80271	0.80617	0.80995	0.81183	0.81189	0.83599
Adj. Count R^2	0.79313	0.80312	0.84090	0.83969	0.83286	0.83889	0.84050	0.84050	0.84411
AIC	2613.17	2618.27	2522.90	2519.29	2510.10	2500.31	2500.01	2498.72	2255.38
BIC	2674.16	2679.25	2590.64	2614.13	2611.72	2608.70	2608.40	2613.88	2478.93
Obs.	6,481	6,481	6,466	6,466	6,466	6,466	6,466	6,466	6,466

*Notes: All results produced by the random-effects probit model. p-value representations: ***p<0.01, ** p<0.05, * p<010. The column in grey contains our preferred model.*

5.2. Varig's airfare model

Next, we examine Varig's airfare models. Table 5 presents the results. Two different second-stage regressions are reported. While both specifications include time and route FE, Column (2), our preferred specification, presents, additionally, OD time trends. These are included following Ciliberto & Schenone (2012). They suggest that airlines with operations on routes with decreasing demand are more prone to fall into bankruptcy, with this trend possibly biasing the estimates. Lee (2010), on the other hand, argues that shifts of supply and demand intense enough to force a firm into bankruptcy are more likely to occur at the level of the economy as a whole when compared to shocks associated with specific markets. Based on the above, we opted to report both specifications.

Concerning the models' results, the estimated coefficients of the control variables, such as ln FUEL_COST, ln MAX_HHI_AIRP, ln REV_PAX, M_SHARE, CODESHARE, and PRES_GOL, have all shown the expected signs, with most of these undergoing only minor variations in the specifications in Columns (1) and (2). The most evident effects of the removal of the time trends were the gain in statistical significance for ln REV_PAX and DISTRESS_VRG. In the case of DISTRESS_VRG—which is weighted by Varig's market shares—noticeable time trends for both the company's market shares and its Z"- score were verified, providing a plausible explanation for the loss of its statistical significance in models accounting for these trends. Furthermore, the negative sign for this variable implies that lower fares were practiced in routes having a higher degree of exposure to the company's distress.

What is more, the IMR coefficient did not present statistical significance in any of the specifications. This result provides evidence that the bankrupt airline was not able to put into practice a survival pricing scheme coherent with its network adjustments—in other words, the observed SNDS was not followed by an equivalent strategy in prices. We believe that the lack of a consistent market survival strategy by the bankrupt airline may be possibly due to its legacy as a formerly regulated firm with severe governance problems.

Regarding the changes implied by the time dummy variables with respect to the base case of January 2002, for the KEPT routes, these suggest higher airfares being charged by Varig between nine and three months before its bankruptcy filing, with the period comprising the quarter directly before the event (1QRT_BEF_BKT) only reflecting statistically significant reductions with respect to the base case in the model in Column (2). These results are in contrast with the group ABND, where a decrease can be noted in the quarter before the filing in both specifications. Concerning the airfares in the quarter associated with the filling, results point to no statistically significant difference in values with respect to the base case. On the other hand, statistically significant results of sharp airfare reductions associated with 3QRT_AFT_BKT in both specifications are an indication that the company tried its best to drive demand before the arrest of its leased aircraft, to take place in the next quarter.

Together with the results obtained by the specification associated with Column (9) of the route selection model presented in Table 4, airfare increases and subsequent reductions appear to have followed an expansion and subsequent contraction of the company's network. An interpretation for these variations, as discussed in Lee (2010), would be that a contraction of the bankrupt carrier's network and the associated reductions in airfares were a result of the company having less freedom to charge price premiums due to the provision of extensive networks. From this perspective, observed oscillations seem to be a direct result of the attractiveness of Varig's network. Moreover, since reductions were more substantial in routes that would ultimately be exited (the ABND group), particularly in the quarter preceding the filing (1QRT_BEF_BKT), these findings suggest that the company also tried to drive demand in these routes during this period, although eventually preferring to abandon these markets altogether rather than reducing prices further. During the third and fourth quarters of 2006 (3QRT_BEF_ACQ and 2QRT_BEF_ACQ), however, Varig no longer reported its airfares, a period characterized by the operation of a minimal number of routes— thus, making it challenging to infer who (Varig or its rivals) initiated the sharper reductions that occurred in the following quarters. We shall, however, return to this matter in Subsection 5.3.

Table 5 – Estimation results of Varig's airfare model

ln YIELD_VRG	(1)		(2)	
ln REV_PAX (instr.)	-0.7977***		-0.2119	
ln FUEL_COST	0.1186***		0.0423**	
ln MAX_HHI_AIRP (instr.)	1.0160***		0.9868***	
M_SHARE_VRG (lagged)	0.3957**		0.2080**	
PRES_GOL	-0.1352***		-0.1725***	
PRES_VSP	-0.0059		-0.0299	
CODESHARE	0.0233		0.0260	
DISTRESS_VRG (instr.)	-0.1793***		-0.0821*	
HAZARD	-0.0773		-0.1418	
<u>ROUTE GROUP</u>	KEPT	ABND	KEPT	ABND
3QRT_BEF_BKT	0.2387***	0.1411**	0.2119***	0.1776***
2QRT_BEF_BKT	0.1616***	-0.0337	0.1887***	0.0726
1QRT_BEF_BKT	-0.0841	-0.2941**	-0.1268*	-0.1964**
BKT_FILLING_QRT	-0.0424	-0.0825	-0.1439*	-0.0168
1QRT_AFT_BKT	0.2085**	0.0263	0.1038	0.1016
2QRT_AFT_BKT	-0.0317	-0.1558	0.0160	0.0341
3QRT_AFT_BKT	-0.4241***	-0.5569***	-0.4068***	-0.3755***
3QRT_BEF_ACQ				
2QRT_BEF_ACQ				
1QRT_BEF_ACQ	-0.6168***		-0.6174***	
ACQ_QRT	-0.6622***		-0.8144***	
1QRT_AFT_ACQ	-0.4542**		-0.3234**	
2QRT_AFT_ACQ	-0.4010**		-0.4754***	
3QRT_AFT_ACQ	-0.7906***		-0.7689***	
4QRT_AFT_ACQ	0.2094		0.0584	
5QRT_AFT_ACQ	-0.0631		-0.1427	
6QRT_AFT_ACQ	-0.3239**		-0.4461***	
7QRT_AFT_ACQ	-0.3030*		-0.4964***	
8QRT_AFT_ACQ				
Time fixed effects	*yes*		*yes*	
Route fixed effects	*yes*		*yes*	
OD time trends	*no*		*yes*	
R^2 (adj.)	0.8519		0.8688	
RMSE	0.1477		0.1390	
KP Statistic	43.948		43.146	
KP p-value	0.0001		0.0001	
Weak CD Statistic	9.1249		9.3574	
Weak KP Statistic	10.408		10.677	
J Statistic	0.1273		0.0442	
J p-value	0.7212		0.8334	
Obs.	3,153		3,153	

*Notes: Results produced by the two-step feasible efficient generalized method of moments estimator (2SFEGMM); statistics robust to heteroscedasticity; first-stage results produced with the probit model of Table 4, Column (8); standard errors of the estimated coefficients were bootstrapped with a panel bootstrap procedure to account for the two-stage nature of the Heckman correction; fixed effects and time trends omitted; OLS, RMSE and F statistics reported for the equivalent OLS estimation; p-value representations: ***p<0.01, ** p<0.05, * p<010. The column in grey contains our preferred model.*

We end this section by noting that a worsening reputation following the bankruptcy event has also been cited as a possible cause for airfare reductions. As argued in Busse (2002) and discussed in Ciliberto & Schenone (2012), companies under bankruptcy have incentives to charge lower fares since their potential passengers need to be persuaded to do business with a company that may cease to exist. For Varig's case, however, the non-stop media coverage of its deteriorated financial situation—which had been going on for some time—would mean that its bankruptcy filing most likely wouldn't come as a surprise to its passengers. Besides, given Varig's "national pride" status as Brazil's flag carrier, it was generally assumed that the Brazilian government would eventually propose a bailout plan for the company, what could be said to have influenced passengers to downplay the bankruptcy filing event.

5.3. Rivals' airfare model

Similarly to Varig's case, we present two different second-stage regressions for the rivals' airfare model, with and without OD time trends. These correspond to Column (2) and Column (1) of Table 6, respectively. Column (2) is our preferred specification. The estimated coefficients of the control variables have shown the expected signs, with most of these undergoing only minor variations in Columns (1) and (2), with the exceptions of ln MAX_HHI_AIRP, which lost its statistical significance with the inclusion of the time trends in Column (2). A similar remark is also made concerning the IMR term. However, even having the time trends removed, the results presented in Column (1) suggest that IMR had only limited influence on the rivals' airfares.

Moving on to DISTRESS_RIVALS, the models suggest that it did not have a significant impact on the airfares charged by these companies. Similar conclusions can be drawn about the effects of DISTRESS_VRG, which, although presenting statistical significance in Column (2), did not show robustness throughout specifications. It is noteworthy mentioning, nevertheless, that the result in Column (2) indicates that rivals charged lower fares in routes that were more exposed to Varig's financial distress, a piece of evidence that hints at predatory pricing.

Table 6 – Estimation results of the rivals' airfare model

ln YIELD_RIVALS	(1)		(2)	
ln REV_PAX (instr.)	-0.8838***		-0.5119***	
ln FUEL_COST	0.0670***		0.0673***	
ln MAX_HHI_AIRP (instr.)	0.4893**		0.3219	
PRES_GOL	-0.2847***		-0.3741***	
PRES_VSP	0.0792***		0.0643**	
CODESHARE	-0.0255		-0.0244	
DISTRESS_VRG (instr.)	-0.0089		-0.0936**	
DISTRESS_RIVALS (instr.)	0.0176		0.0060	
HAZARD	0.0177**		0.0098	
<u>ROUTE GROUP</u>	KEPT	ABND	KEPT	ABND
3QRT_BEF_BKT	0.0784	0.1019*	0.1188*	0.1215*
2QRT_BEF_BKT	0.0569	-0.0132	0.0661	0.0127
1QRT_BEF_BKT	-0.4249***	-0.3307***	-0.5797***	-0.4772***
BKT_FILLING_QRT	-0.2745**	-0.1868	-0.4638***	-0.3189***
1QRT_AFT_BKT	0.0186	0.0299	-0.1843	-0.1467
2QRT_AFT_BKT	-0.1510	-0.2010	-0.3517**	-0.3770***
3QRT_AFT_BKT	-0.1916	-0.1746	-0.5176***	-0.4861***
3QRT_BEF_ACQ	-0.2286	-0.2227	-0.4881***	-0.4838***
2QRT_BEF_ACQ	-0.3068	-0.3265*	-0.6003***	-0.6072***
1QRT_BEF_ACQ	-0.6571***	-0.5540***	-0.8902***	-0.7698***
ACQ_QRT	-0.6415***	-0.4679***	-0.9876***	-0.8133***
1QRT_AFT_ACQ	-0.4230**	-0.2517*	-0.6380***	-0.4712***
2QRT_AFT_ACQ	-0.2326	-0.0685	-0.5738***	-0.4112**
3QRT_AFT_ACQ	-0.3570***	-0.3591***	-0.5988***	-0.5942***
4QRT_AFT_ACQ	0.2463**	0.2590**	-0.1313	-0.1178
5QRT_AFT_ACQ	-0.0410	-0.0102	-0.3614**	-0.3182*
6QRT_AFT_ACQ	-0.0964	0.0572	-0.4006***	-0.2654*
7QRT_AFT_ACQ	-0.2656***	-0.1977**	-0.5488***	-0.4688***
8QRT_AFT_ACQ	-0.3521***	-0.2987***	-0.7064***	-0.6570***
Time fixed effects	*yes*		*yes*	
Route fixed effects	*yes*		*yes*	
OD time trends	*no*		*yes*	
R^2 (adj.)	0.8074		0.8163	
RMSE	0.2081		0.2032	
KP Statistic	58.892		57.705	
KP p-value	0.0001		0.0001	
Weak CD Statistic	12.464		11.403	
Weak KP Statistic	12.172		11.758	
J Statistic	0.0008		0.0969	
J p-value	0.9773		0.7556	
Obs.	6,284		6,387	

*Notes: Results produced by the two-step feasible efficient generalized method of moments estimator (2SFEGMM); statistics robust to heteroscedasticity; first-stage results produced with the probit model of Table 4, Column (8); standard errors of the estimated coefficients were bootstrapped with a panel bootstrap procedure to account for the two-stage nature of the Heckman correction; fixed effects and time trends omitted; OLS, RMSE and F statistics reported for the equivalent OLS estimation; p-value representations: ***p<0.01, ** p<0.05, * p<010. The column in grey contains our preferred model.*

Regarding the time dummy variables, these suggest airfares similar to the base case of January 2002 being charged between 9 and 3 months before the bankruptcy filing in deflated values, as the statistical significance of the associated coefficients is relatively modest. Sizeable reductions, however, are observed in the quarter preceding the filing, with statistically significant results in both specifications, and with stronger effects in Varig's KEPT routes.

As for the quarter of the bankruptcy filing itself, both specifications suggest statistically significant increases in relation to the quarter preceding the filing for the KEPT routes, although airfares remained below the base case value. These results signalize that any predation that may have occurred from the part of the rivals was mainly associated with the quarter preceding the filing and not with the quarter related to it, thus suggesting that the airfare reductions observed, if anything, may have contributed to Varig to decide to seek legal protection.

Similarly, looking at the results of Column (2) in particular, marked price reductions in the quarter associated with the arrest of Varig's aircraft (3QRT_BEF_ACQ) and in the three following quarters could be said to support the occurrence of predation as well. Still, it should be noted that the evidence presented here is somewhat vestigial. Despite that, we highlight the statistical significance of the coefficients of 1QRT_BEF_ACQ and ACQ_QRT, which are consistent through specifications, and will be further analyzed in Subsection 5.4, dedicated to the discussion of the acquisition event and the comparison of its results on models of Subsections 5.2 and 5.3.

We conclude this section by noting the differences found for rivals' airfares concerning the two route groups. The coefficients of 1QRT_BEF_BKT, in both specifications of Columns (1) and (2), suggest that more substantial reductions were made in KEPT routes. Likewise, the coefficients of BKT_FILING_QRT suggest that fares, although higher than in the quarter preceding the bankruptcy, remained at a lower level when compared with the base case for Varig's KEPT routes in both specifications. In contrast, no significant differences were found for the ABDN routes, particularly in Column (1). Both specifications also imply more robust reductions in KEPT routes when compared to ABDN ones, an observation that can also be extended for the quarters 1QRT_BEF_ACQ and ACQ_QRT, preceding and concurrent with the acquisition event. These results would imply that rivals reduced airfares during that period mainly in routes that Varig gave preference to keep its operations. Such observation prompted us to conduct further analysis of Varig's route selection model, including the rivals' average yield lagged by one period. Results of these models indicate that Varig, in its turn, preferred routes where its competitors charged higher prices.[11] These two observations combined hint at rivals having more room to perform deeper airfares cuts precisely on routes that Varig preferred to maintain as part of its network. Moreover, given Varig's preferences, it would be less reasonable to assume that it was the one to begin the price reductions—although we point out that we do not have enough evidence to dismiss this claim entirely. As such, overall, our results present suggestive evidence supporting the hypothesis that rivals charged lower fares on routes with a higher probability of Varig being present.

As argued in Barla & Koo's (1999), predatory pricing practices could be related to an attempt by one or more competitors to influence the terms of a potential acquisition of the distressed company or to reduce the value of its assets—particularly gates and slots—in case of liquidation. Furthermore, benefits could include the addition of entire strategic hubs to the acquirer's network (Merkert & Morrell, 2012). These remarks are indeed especially suitable for Varig's case, since both of its main competitors during these events, TAM and Gol, had already shown signs of interest in joint efforts with the company.

5.4. Acquisition effects

Concerning the acquisition quarter (ACQ_QRT), both Varig's and its rivals' models indicate some drastic reductions in the quarter preceding the event—indeed the most significant airfare reductions observed in the models.

However, increasing trends for airfares in the two route groups in the quarters following the acquisition are also observed, beginning in the next quarter (1QRT_AFT_ACQ) and reaching peak values in the second quarter of 2008 (4QRT_AFT_ACQ). Coefficients of 4QRT_AFT_ACQ in the rivals' model are mostly associated with prices being comparable to or larger than the base case and with little difference between the two route groups (Columns (2) and (1), respectively). Similar trends are also observed in Varig's model, indicating that the effects of the increased market concentration that followed the acquisition may have prevailed any possible efficiency gains obtained by the acquisition in the short-term. Furthermore, these

[11] These specifications are presented in the Appendix. We note that the effect can only be noticed in specifications having coarser time dummies. Thus, we cannot rule out that this effect is manifested by the lack of proper controls in these models and encourage further enquiry into this subject.

results are in line with the findings of the previous literature, as discussed in Subsection 2.3—i.e., Kim & Singal (1993), Peters (2006), and Hüschelrath & Müller (2014).

After the third quarter of 2008 (5QRT_AFT_ACQ), however, the time dummies indicate progressive airfare decreases until at least the second quarter of 2009, the last months contained in our database. Considering that Azul airlines, at the time an adept of the LCC model, had its establishment in May 2008 with its first flights being offered in December of the same year, our results find support in those presented by Hüschelrath & Müller (2013), which suggest decreasing trends for airfares in the medium- and long-term after mergers. The authors ascribe these decreasing trends to efficiencies resulting from the merger and, particularly fitting for the case in hand, to post-merger entry-inducing effects.

6. Conclusion

This paper investigated the market outcomes of the bankruptcy and subsequent acquisition of a major FSC (Varig) by an LCC (Gol) in Brazil in the late 2000s. We contribute to the literature by addressing two issues that have been previously neglected: firstly, we consider the survival network design strategies (SNDS) of the financially distressed carrier surrounding and during its bankruptcy, and secondly, we examine the effect of endogenous financial distress on both the bankrupt carrier's and its rivals' airfares.

Our estimation results show statistically significant SNDS behavior by the bankrupt airline in the investigated period. However, we did not find evidence of survival pricing stemming from such network design adjustments, as the estimated IMR term was not statistically significant. We believe that the lack of good governance and its past as a long-date regulated firm may be the causes of such incoherent market behavior by the distressed legacy carrier. Still, we believe that further research should be conducted in other case studies to further explore the sensitivity of the IMR variable in the context of survival network design strategies.

While controlling for the bankruptcy event, no robust evidence was found on the impact of a company's distress on its rivals' fares, although we find evidence that it did have a (negative) effect on its own fares. Moreover, while results indicate airfare reductions in the quarter preceding the bankruptcy filing for both the bankrupt carrier and its rivals, no robust result was found for periods directly following this event.

For both Varig's and its rivals' models, we uncover considerable price reductions in the acquisition quarter and the quarter preceding it, which could be an indication of rivals' attempt to influence a potential acquisition of the company or reduce the values of its assets in case of a liquidation, as increasing trends for airfares in quarters directly following the event were also observed. Nevertheless, the results uncover an enduring price fall, suggesting more intense market competitiveness in the long run. We think such a result may stem from either merger-related synergies or merger-related entry-inducing effects—with the latter being seemingly more relevant to the case in hand given the subsequent market entry of LCC Azul in 2008.

By allowing the outcome of Varig's assets being acquired by a rival—instead of the company's liquidation, our results indicate that bankruptcy protection in the airline industry may have a role not only in avoiding the undesired consequences of service discontinuation of carriers but also in sustaining the competition for the bankrupt company's market share at key airports. Therefore, our findings illustrate that, under certain circumstances, aviation authorities may perceive the bankruptcy event as an opportunity to foster the contestability of airline markets by making regulatory efforts toward the bankrupt carrier's airport positions being relocated to non-dominant rivals. The bankruptcy of Varig, a major airline with a significant set of slots and positions at key airports of Brazil, ultimately opened up the opportunity for a newcomer such as Gol to rise through the ranks and fill its place, instead of letting an increasing overall market concentration. Moreover, in the meantime of these events, fiercer price competition came about, possibly increasing social surplus. As such, our results have policy implications that suggest that bankruptcy protection should be an instrument that ultimately supports authorities in sustaining competition while promoting the removal of some of the most relevant barriers of entry in the airline industry, such as access to airport slots and gates.

Our research has important limitations. In particular, the main conclusions are confined to the Brazilian experience, being specific to the events studied in this paper. Further research should be conducted employing the proposed methodology within different contexts to assess the replicability of the results and how well they can be generalized.

We conclude the paper by remarking that, with recent developments of the COVID-19 pandemic, there appears to be a reemergence of discussions concerning airline bankruptcies, consolidations, and network readjustments throughout the world. Airlines are finding themselves now in harsh financial conditions, compelled to streamline their networks to survive. In Brazil, a solution found by bankrupt airline LATAM (former TAM) and Azul was to enter into a codeshare agreement backed up by Brazilian competition agencies—what would have been unthinkable in different times (*Reuters*, June 29, 2020). While some countries have made governmental aid available, support has been limited, particularly in emerging economies. In this regard, we believe that our research may contribute to this debate, as results suggest that government relief could be justified beyond a bailout for particular airlines, as a way of (artificially) securing the number of competitors, at least until new carriers could venture into the market.

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Appendix

Table A.1 – Estimation results of Varig's route selection model (with rivals' airfares)

PRES_VRG	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
DIST	-0.0005***	-0.0005***	-0.0001	-0.0000	-0.0001	-0.0000	-0.0000	0.0000	-0.0003
ln GDP_GRAV	0.3119***		0.0323	0.0322	0.0001	-0.0165	-0.0471	-0.0403	0.0850
ln POP_GRAV		0.3358***		-0.0727	-0.0219	-0.0271	0.0082	-0.0053	0.0234
ln TR_DEN (lagged)			0.7011***	0.6668***	0.6708***	0.6836***	0.6791***	0.6870***	0.5193***
ln FUEL_COST	-0.4102***	-0.3812***	-0.2978**	-0.3159**	-0.3970***	-0.3049**	-0.2816**	-0.2860**	-0.5259***
FL_EFF_ASK (lagged)	0.0767***	0.0768***	0.0783***	0.0786***	0.0778***	0.0776***	0.0768***	0.0764***	0.0802***
LF (lagged)	0.2089	0.1889	-0.1066	-0.1060	-0.0914	-0.1168	-0.0970	-0.0693	-0.1043
M_SHARE (lagged)	2.9668***	2.9692***	3.5235***	3.4835***	3.4890***	3.6417***	3.6477***	3.6012***	3.2014***
FREQ_CGH				0.0005**	0.0005**	0.0005**	0.0005**	0.0005**	0.0010***
PRES_GOL				0.2858	0.2902	0.3634	0.3673	0.4116	-0.0085
PRES_VSP				-0.2909***	-0.1887*	-0.1534		-0.2730**	-0.3315
CODESHARE					-0.3959***	-0.1266	-0.1796	-0.1451	-0.6120***
ln YIELD_RIVALS (lagged)	0.2504**	0.2603***	0.3283***	0.3586***	0.3948***	0.4281***	0.4243***	0.4471***	0.0615
<u>TIME VARIABLES</u>									
TREND	-0.0207***	-0.0185***	-0.0228***	-0.0262***	-0.0285***				
TREND_PRE_BKT						-0.0444***	-0.0470***	-0.0523***	
TREND_POST_BKT						-0.0307***			
TREND_ BKT							-0.0323***	-0.0377***	
TREND_ POST_ACQ							-0.0304***	-0.0343***	
3QRT_BEF_BKT									0.0569
2QRT_BEF_BKT									-0.6106**
1QRT_BEF_BKT									-0.9113***
BKT_FILLING_QRT									-0.3051
1QRT_AFT_BKT									0.2768
2QRT_AFT_BKT									-0.2405
3QRT_AFT_BKT									-0.8757***
3QRT_BEF_ACQ									-2.3770***
2QRT_BEF_ACQ									-2.4981***
1QRT_BEF_ACQ									-0.8397***
ACQ_QRT									-2.2664***
1QRT_AFT_ACQ									-2.9389***
2QRT_AFT_ACQ									-2.4938***
3QRT_AFT_ACQ									-1.6971***
4QRT_AFT_ACQ									-1.5390***
5QRT_AFT_ACQ									-2.0107***
6QRT_AFT_ACQ									-1.3196***
7QRT_AFT_ACQ									-2.1398***
8QRT_AFT_ACQ									-2.5411***
Random Effects	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*	*yes*
R^2 Maddala	0.45821	0.45793	0.46429	0.46550	0.46665	0.46795	0.46794	0.46833	0.48981
R^2 McFadden (adj.)	0.60514	0.60463	0.61489	0.61590	0.61771	0.61982	0.61980	0.62023	0.65615
R^2 Lave	0.36714	0.35716	0.32013	0.31739	0.31492	0.31251	0.31054	0.31166	0.31080
R^2 McKelvey & Zavoina	0.78292	0.78040	0.79872	0.80211	0.80594	0.81048	0.81260	0.81297	0.83479
Adj. Count R^2	0.80016	0.81030	0.83951	0.83992	0.83870	0.84155	0.84318	0.84033	0.84521
AIC	2563.94	2567.24	2500.65	2494.07	2482.30	2468.58	2468.73	2465.93	2232.74
BIC	2631.64	2634.95	2575.11	2595.61	2590.61	2583.66	2583.80	2587.77	2462.89
Obs.	6,444	6,444	6,432	6,432	6,432	6,432	6,432	6,432	6,432

*Notes: All results produced by the random-effects probit model. p-value representations: ***p<0.01, ** p<0.05, * p<010.*