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Labor relations issues such as collective bargaining and strike threat power have recently gained increased attention in the Brazilian air transportation market due to a short-term shortage of qualified workforce, leading stronger pilot unions to demand higher wages and better working conditions. Exacerbated by the notable expansion of the Brazilian economy between 2020 and 2023, where air travel demand surged by 60%, this pressure has driven labor costs to grow more rapidly than other cost categories. This paper examines exogenous flight crew cost shocks, treating these as increases in wage premiums resulting from stronger unionization and higher labor market rents. Using a differentiated duopoly model, we analyze the impact of these wage increases on competition between a major network carrier and a small low-fare carrier, introducing the hypothesis of non-exhausted economies of density. Our findings indicate that smaller airlines are more adversely affected by labor cost shocks, though differentiated wage increase schemes can mitigate these impacts, reducing market concentration and preserving consumer welfare. This study contributes to the literature by incorporating wage premium shocks into existing models and suggesting that labor regulations in Brazil should be liberalized to address the rapid growth in air transportation demand and the resultant workforce shortage.

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1. Introduction

Labor relations issues such as collective bargaining and strike threat power have recently gained increased attention in the Brazilian air transportation market. In an environment marked by a clear short-term shortage of qualified workforce, stronger pilot unions have begun demanding higher wages and better working conditions. This situation has been exacerbated by the notable expansion of the Brazilian economy between 2020 and 2023, where the demand for air travel surged by 60% over three years.

This significant demand pressure contributed to the industry's labor costs growing more rapidly than any other cost categories in recent years. This paper examines exogenous flight crew cost shocks. Shocks in unit labor costs are treated here as increases in wage premiums for a highly specialized workforce, resulting from pilot and cabin crew wage hikes amidst stronger unionization and higher labor market rents. We model the impact of these wage premium increases on product market competition, focusing on the competitive interaction between a major network carrier and a small low-fare carrier. To accomplish this, we consider the differentiated duopoly model of Fu, Lijensen, and Oum (2006) and Oum and Fu (2007). Our contribution lies in relaxing the hypothesis of constant marginal costs, introducing the hypothesis of non-exhausted economies of density.

Two classical models in the literature of differentiated duopoly are Dixit (1979) and Singh and Vives (1984). Applications of this framework to the competition analysis of the airline industry have only been observed in recent years. Most studies are related to the competitive interaction between full-service airlines (FSAs) and low-cost carriers (LCCs), focusing on airport charges or verticalization. For example, Fu, Lijensen, and Oum (2006) study a duopoly model to capture the differential competitive effects of changing airport user charges on FSAs and LCCs. Barbot (2006) develops a vertical differentiation model to analyze the impact of subsidization and lower airport charges in competition between a LCC (Ryanair) and FSAs. Oum and Fu (2007) study the impact of air transportation security user charges on competition between LCCs and network airlines.

The impact of crew costs on downstream airline competition has received little attention in the literature, and our paper aims to fill this gap. Many authors have studied the structure of airline costs, such as Caves, Christensen, and Tretheway (1984) and Batalgi, Griffin, and Rich (1995), who use translogarithmic specifications of airline costs and find no evidence of economies of scale but evidence of economies of density in the airline industry. Brueckner, Dyer, and Spiller (1992), Brueckner and Spiller (1994), and Berry, Carnall, and Spiller (2006) also showed that economies of traffic density are key elements of the cost structure in the airline industry.

Gillen, Oum, and Tretheway (1990) analyzed unit costs of major and smaller Canadian airlines and concluded that as smaller airlines have higher unit costs, they would benefit from significant (unexploited) economies of traffic density in case of traffic expansion. This is the same conclusion of Doganis (2001), who also shows that small airlines may reduce unit costs by gaining from economies of density. Our paper shows that although smaller carriers may obtain lower unit costs from higher traffic density, they face a competitive disadvantage compared to major carriers, which already benefit from their scale of operations in the market.

The literature on union power and wage determination in the airline industry is scarce and mostly confined to the US airline industry. For example, Card (1996) showed that the wage premiums of the regulatory period in the US airline industry were relatively moderate, comparable to premiums in other sectors. In a recent study, Hirsch (2007) finds that unions now have considerable strike threat power but notes that the financial health of carriers typically constrains the exercise of union bargaining power. The author concludes that there is sufficient evidence of positive wage premiums for pilots stemming from considerable bargaining power at major carriers, but not at regional carriers, which approximate opportunity costs. Lee and Rupp (2007) investigate the effects of pay rate and benefit reductions of the early 2000s and test the hypothesis that pay cuts lead to lower effort by employees using on-time flight performance as proxies for unobservable pilot effort. The authors find limited support for the investigated hypothesis. Finally, Benmelech, Bergman, and Enriquez (2001) analyze how airlines renegotiate wages, using their financial position to extract labor concessions. They conclude that airlines with poor financial health have a higher ability to renegotiate and reduce labor costs of employees with underfunded pension plans.

Unlike these studies, which focus on wage concessions due to firms' financial fragility, our focus is on modeling the reality of a booming airline market where qualified labor is scarce, and unions have enhanced bargaining power to secure wage increases rather than wage concessions.

The model of differentiated duopoly is developed to pinpoint product-market effects of wage increases in the airline industry. We propose an application to the case of the most important Brazilian route—the São Paulo-Rio de Janeiro air shuttle. We estimate econometric models of airline demand and costs. The estimated demand and cost parameters are then employed to simulate the effects of labor cost shocks—i.e., increases in wage premiums—on airline competition. By applying the estimated parameters, we numerically simulate the comparative statics of labor cost shocks. We consider two different scenarios of economies of density and price elasticities to perform a sensitivity analysis regarding the impacts of cost shocks. We find that even though the cost-price pass-through of smaller airlines is higher than that of major airlines, their profitability is always more impacted by wage premium shocks. Additionally, higher concentration levels prevail in the market after a cost shock in all simulated scenarios. Results are amplified by both higher economies of density and higher airline demand price elasticity. We propose a differential wage increase scheme based on wage concessions to avoid higher market concentration and consumer welfare losses.

This paper is organized in the following way. In Section 2, we present the structure of costs in the Brazilian airline industry, with a focus on the recent evolution of labor costs. Section 3 presents the theoretical model, the available data and the estimation results of the empirical models of demand and costs. In Section 4 we present the results of comparativestatic simulations aimming at identifying the impacts of wage premium shocks. And finally, we have the concluding section.

2. The structure of airline costs in Brazil

As the domestic air transportation in Brazil is a fast-growing industry, there has been an ever increasing demand for airline pilots, flight attendants and mechanics in the past few years. According to the National Agency for Civil Aviation (ANAC), labor workforce directly related to flight operations was around 18 thousand workers in 2010, against 11 thoushand in 2002, a 63% increase in less than 10 years. Recently, unions enhaced considerably their bargaining power in this sector. For example, in December 2010, labor unions almost went on strike some days before Christmas - one of the most popular holidays in Brazil - after failed negotiations over a wage hike. On the occasion, negotiations between airlines and workers reached a bargaining impasse as carriers reportedly offered a 6-percent rise while workers demanded a 13-percent increase in wages

Brazilian flight crew regulations are provided by Federal Law Number 7,183 of April 5, 1984. This law regulates safety, operating and flight rules for crew members, including work assignements and work limits with respect to, among others, the number of consecutive hours between assignments and rests. The Brazilian regulatory framework of airline labor relations is considered by many analysts as rather strict and outdated in comparison to other jurisdictions in South America, like Chile and Uruguay. These countries allows a greater flexibility to the airline in terms of working hours. Moreover, the Brazilian law explicitly forbids recruitment of foreign pilots. In India, for example, carriers are allowed to hire expatriate pilots, which have recently become a majority workforce in many airlines. China is another emergent market that started to allow foreign crew recrutiment. In Brazil, on the contrary, not only airlines are not allowed to hire foreing pilots but also for many years several qualified pilots have left the country in search for better salary conditions in expanding airlines abroad. Nowadays, as air transportation in the country has grown fast, the result is a clear shortage of pilots, with relevant consequences to the power of unions and wage premiums.

Airline costs typically represent the expenditures of carriers with highly-specialized production inputs and services. Most important airline costs items that compose the largest share of the total cost of an airline are: fuel, crew, maintenance and overhaul of aircraft, and airport fees. Doganis (2006) finds that fuel costs along labor costs with account for about 50% of U.S. airline's total costs and therefore may be considered the two most important cost categories. According to the Brazilian regulator, the annual average full cost of a pilot was US$ 167 thousand in 2010 against US$ 110 thousand in 2002[2]. This represents an increase of more than 50%. In 2002, the flight crew total workforce within the country was 10 thousand, against 18 thousand in 2010. On the other hand, the total costs associated with flight crew increased by 275% in the same period[3].

Figure 1 shows the evolution of the main cost items in proportion to the total cost of Brazilian airlines. Consistent with the international experience, fuel costs in Brazil represent the largest share of total costs.

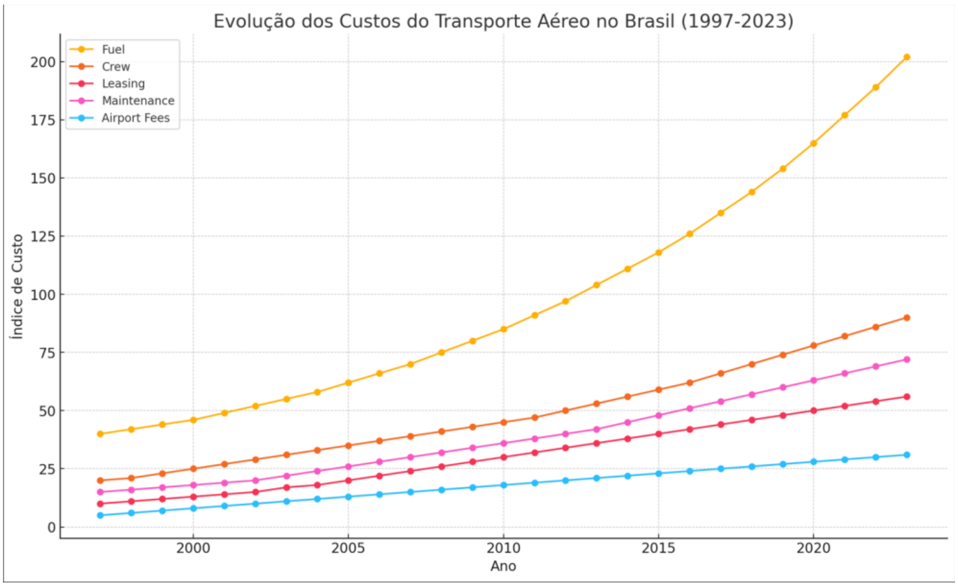

Figure 1: Evolution of main airline cost figures, 1997 - 2023 (Source: ANAC).

[2] These figures include benefits and taxes. Statistical Yearbook of the National Agency for Civil Aviation, 2000-2010, with own calculations.
[3] Approximatelly US$ 570 million in 2002 against US$ 1,568 million in 2010. Source: Statistical Yearbook of the National Agency for Civil Aviation, 2000-2010, with own calculations.

3. Modelling airline competition with economies of density and wage premiums shocks

3.1. The theoretical model of duopoly competition

We developed a differentiated duopoly model based on the framework of Dixit (1979) and Singh and Vives (1984). More precisely, we build upon the airline duopoly model of Fu, Lijsen and Oum (2006) and Oum and Fu (2007). Assume price competition with Bertrand-Nash equilibrium in which a duopoly is composed by a major airline (firm 1) and a small low fare airline (firm 2). These two firms face the following respective demand functions:

$$\begin{aligned} q_1 &= \alpha_1 - \beta_1 p_1 + \gamma_1 p_2 \\ q_2 &= \alpha_2 - \beta_2 p_2 + \gamma_2 p_1 \end{aligned} \tag{1}$$

where q_1, q_2, p_1 and p_2 are the quantities and the price set by firm 1 and firm 2, respectively. α_1, α_2, β_1, β_2, γ_1 and γ_2 are demand parameters. With this demand system, the profits of firms are:

$$\begin{aligned} \pi_1 &= TR_1 - TC_{1=} \, p_1 q_1 - TC(q_1) \\ \pi_2 &= TR_2 - TC_{2=} \, p_2 q_2 - TC(q_2) \end{aligned} \tag{2}$$

The total cost function may be written as (3), where FC_1 and $FC_2$are fixed costs, c_1 and c_2 are cost parameters, and φ is a measure of the density economy:

$$\begin{aligned} TC_1(q_1) &= FC_1 + c_1 q_1 - \varphi q_1^2 \\ TC_2(q_2) &= FC_2 + c_2 q_2 - \varphi q_2^2 \end{aligned} \tag{3}$$

The marginal cost is therefore equal to:

$$\begin{aligned} MC_1 &= \frac{\partial TC_1}{\partial q_1} = \ c_1 - 2\varphi q_1 \\ MC_2 &= \frac{\partial TC_2}{\partial q_2} = \ c_2 - 2\varphi q_2 \end{aligned} \tag{4}$$

Assuming that both firms maximize profits by setting output quantities, such as in (2), then the first-order conditions are the following:

$$\begin{aligned} \pi_1' &= \frac{\partial \pi_1[p_1, q_1(p_1,p_2)]}{\partial p_1} = q_1 + p_1 \frac{\partial q_1(p_1,p_2)}{\partial p_1} - c_1 \frac{\partial q_1(p_1,p_2)}{\partial p_1} + 2\varphi \frac{\partial q_1(p_1,p_2)}{\partial p_1} = 0 \\ \pi_2' &= \frac{\partial \pi_2[p_2, q_2(p_1,p_2)]}{\partial p_2} = q_2 + p_2 \frac{\partial q_2(p_1,p_2)}{\partial p_2} - c_1 \frac{\partial q_2(p_1,p_2)}{\partial p_2} + 2\varphi \frac{\partial q_2(p_1,p_2)}{\partial p_2} = 0 \end{aligned} \tag{5}$$

Substituting the demand system (1) in (5):

$$\begin{aligned} \pi_1' &= (\alpha_1 - \beta_1 p_1 + \gamma_1 p_2) + p_1(-\beta_1) + c_1(-\beta_1) + \ \varphi(-2\beta_1) = 0 \\ \pi_2' &= (\alpha_2 - \beta_2 p_2 + \gamma_2 p_1) + p_2(-\beta_2) + c_2(-\beta_2) + \ \varphi(-2\beta_2) = 0 \end{aligned} \tag{6}$$

With (6), we obtain the reaction functions of (7):

$$\begin{aligned} p_1 &= \frac{\alpha_1 + \gamma_1 p_2 - \beta_1 c_1 - 2\beta_1 \varphi}{2\beta_1} \\ p_2 &= \frac{\alpha_2 + \gamma_2 p_1 - \beta_2 c_2 - 2\beta_2 \varphi}{2\beta_2} \end{aligned} \tag{7}$$

By solving the system of simultaneous equations represented by the reaction functions (7), we obtain the vector of equilibrium prices $p^* = \{p_1^*, p_2^*\}$ for firm 1 and firm 2:

$$p_1^* = \frac{8\alpha_1\beta_1\beta_2^2 + 4\alpha_2\beta_1\beta_2\gamma_1 - 4\beta_1\beta_2^2\gamma_1 c_2 - 8\varphi\beta_1\beta_2^2\gamma_1 - 8\beta_1^2\beta_2^2 c_1 - 16\varphi\beta_1^2\beta_2^2}{16\beta_1^2\beta_2^2 - 4\beta_1\beta_2\gamma_1\gamma_2}$$

$$p_2^* = \frac{8\alpha_2\beta_2\beta_1^2 + 4\alpha_1\beta_1\beta_2\gamma_2 - 4\beta_1\beta_1^2\gamma_2 c_1 - 8\varphi\beta_1^2\beta_2\gamma_2 - 8\beta_1^2\beta_2^2 c_2 - 16\varphi\beta_1^2\beta_2^2}{16\beta_1^2\beta_2^2 - 4\beta_1\beta_2\gamma_1\gamma_2} \quad (8)$$

With the equilibrium prices of (8), it is possible to investigate the comparative-statics of wage premium shocks. By differentiating price with respect to marginal costs, we have:

$$\frac{\partial p_1^*}{\partial c_1} = \frac{-8\beta_1^2\beta_2^2}{16\beta_1^2\beta_2^2 - 4\beta_1\beta_2\gamma_1\gamma_2} \quad (9)$$
$$\frac{\partial p_2^*}{\partial c_2} = \frac{-8\beta_1^2\beta_2^2}{16\beta_1^2\beta_2^2 - 4\beta_1\beta_2\gamma_1\gamma_2}$$

which is our measure of the price-cost pass through of both firms in the market. With this measure, it is possible to simulate the competitive impacts of a change in cost figures c_1 and c_2. With respect to changes in our density economies measure (φ), we have that the static-compatative of the Bertrand-Nash equilibrium is:

$$\frac{\partial p_1^*}{\partial \varphi} = \frac{-8\beta_1\beta_2^2\gamma_1 - 16\beta_1^2\beta_2^2}{16\beta_1^2\beta_2^2 - 4\beta_1\beta_2\gamma_1\gamma_2} \quad (10)$$
$$\frac{\partial p_2^*}{\partial \varphi} = \frac{-8\beta_2\beta_1^2\gamma_2 - 16\beta_1^2\beta_2^2}{16\beta_1^2\beta_2^2 - 4\beta_1\beta_2\gamma_1\gamma_2}$$

We use both (9) and (10) in our application to the Brazilian airline industry below, in order to assess the impacts of changes in the cost structure of airlines in the market.

3.2. Application to a Brazilian Airline market

ian airline market We apply the above theoretical framework to the case of the airport pair Congonhas airport (CGH) - Santos Dumont airport (SDU), which links Rio de Janeiro and São Paulo, in the Southeast of Brazil. This route is the densest flow within the country. The data used to estimate the parameters were provided by the National Agency for Civil Aviation (ANAC). The database structure consist of panel data of five airlines across months. The sample period is January 1997 to September 2001, monthly. The airlines are Varig (RG), Rio Sul (SL), TAM (TA), Vasp (VP) and Transbrasil (TB). The market is considered as directional, so that the data set include information of both SDU-CGH and CGH-SDU. Total sample size was 572 observations.

Some codeshare agreements were observed within the sample period. The most prominent of them were RG-SL and VP-TB. TA kept independent operations througout the sample, but engaged in codesharing with RG in 2003. As TA and RG-SL had similar characteristics in the market (more than 25% market share each) and ultimately formed an alliance, we grouped them as a single carrier – "major carrier" group. VP and TB had each less than 15% of the market and therefore were grouped to form the "small low fare carrier" group. In fact, the average fare of

VP-TB was roughly a third lower than the average fares of RG-SL-TA.[4] We do not classify these airlines as LCCs (Low Cost Carriers) because they did not follow the LCC business model, but were actually the only low fare alternatives in the market. The first LCC in Latin America, Gol Airlines, only entered the market in 2002. We therefore employ the simplification of grouping similar carriers to estimate the demand and costs equations. As these carriers were actually partners, we believe our simplification does not change results significantly.

Given the panel data structure of our sample (airlines-months), we therefore employ a fixed effects estimator for both the demand and the costs equations. Also, in the estimation of demand and cost parameters we used White's robust correction to control for heteroscedasticity and autocorrelation of third order.

3.2.1. **Demand function**

We use the following variables in our demand framework: q_j(dependent variable) is the number of passengers daily each way of Airline j, p_j is the average price of airline j, p_j is the average price of rival group of airline j. As we have two groups of airlines, we use dummies for airline classification: major is a dummy indicative of the group of major airlines (RG, SL, TA), and small is a dummy indicative of the group of small airlines (VP, TB). gdp is gross domestic product, a demand shifter for business-related trips and a proxy for income Evolution.

We employ the above variables in a single econometric framework of demand. In order to estimate different price and gdp sensitivities for each airline group, we make use of slope shifters, ie. interactions with the airline group dummies. Therefore we have: $p_j \times major$ is an interaction of p_j and major, $p_{-j} \times major$ is an interaction of p_{-j} and major, $p_j \times small$ is an interaction of p_j and small, $p_{-j} \times small$ is na interaction of p_{-j} and small, $gdp \times major$ is an interaction of gdp and major and $gdp \times small$ is aninteraction of gdp and small. Table 1 presents the estimation results, consistente with demand system (1):

Table 1 - Estimation Results[5]

	dep. Var.: q_j
$p_j \times major$	-4.266***
	[1.088]
$p_{-j} \times major$	3.369***
	[1.040]
$gdp \times major$	9.388**
	[4.664]
$p_j \times small$	-8.948***
	[0.754]
$p_{-j} \times small$	4.906***
	[1.105]
$gdp \times small$	0.356
	[4.476]
Adj. R^2	**0.934**

[4] 4USD 160 against USD 110 (Source: ANAC, 2000, with own calculation

[5] l 5Heteroskedasticity and autocorrelation-robust standard errors in brackets. Superscripts *, ** and ***denote, respectively, significance at the 10%, 5%, and 1% levels. Estimated effects of airline-period, Airline-codesharing periods, month, quarter and airline-specific trends not reported.

Results indicate that the demand of major airlines are much less sensitive to price than the demand of smaller airlines. In a situation of overall price increase of one unity, the major airline loses 4.27 passengers and gains 3.37 passengers from rival small airline. The small airline loses 8.95 passengers and gains 4.91 passengers from rival major airline. With respect to the sensitivity of demand to changes in the gross domestic product (GDP), we find that economic growth has a statistically significant impact only on the demand of the major airline.

With respect to parameters α_1 and α_2, we had the following steps in order to identify their values from the estimation results of demand. These figures are associated with the value that dependent variable assumes when all independent variables are zero. The Steps were:

1. remove the mean of all independent variables of the demand of major and small airlines;
2. multiply each independent variable of demand by the average obtained in the previous operation to both firms; and
3. add up all the independent variables multiplied by their average of demand of major and small airlines, separately. With this steps, we obtained $\hat{\alpha}_1 = 2.248$ and $\hat{\alpha}_2 = 721$, all statistically significant at 1% level.

3.2.2. Cost function

Consistent with the cost side model of (3), we estimate a quadratic total cost function. In other to accomplish that, we employ the same panel data described before. Again, we use a fixed effects estimator. Again, all data was provided by the National Agency for Civil Aviation (ANAC).

We use the following variables in the regression model: tc_j(the dependent variable), is the total cost of Airline j; $q_j \times major$ is an interaction of q_j and $major$. $q_j \times small$ is an interaction of q_j and $small$. And finally, q_j^2 is a quadratic term. The estimated coefficient of this variable provides an assessment of the economies of density in the market - ie, the parameter φ of (3). Estimation results of the costs side are presented below:

Table 2 - Estimation Results[6]

	dep. Var.: tc_j
$q_j \times major$	113.669***
	[12.598]
$q_j \times small$	108.713***
	[10.785]
q_j^2	-0.0216***
	[0.006]
Adj. R^2	**0.802**

We find a statistically significant measure of economies of density, $\hat{\varphi}$In fact, the estimated coefficient of was equal to -0,0216, meaning that marginal costs clearly decreases with traffic.

3.2.3. Simulations of wage premium shocks

[6] Heteroskedasticity and autocorrelation-robust standard errors in brackets. Superscripts *, **, and *** denote, respectively, significance at the 10%, 5%, and 1% levels. Estimated effects of airline-period, Airline-codesharing periods, month, quarter and airline-specific trends not reported.

Here we study the comparative-statics of a wage premium shock in the competition between major and small airlines in the presence of weak, estimated (base case), and strong economies of density. We simulate a wage hike of 10%. The wage hike is transmitted to costs according to the share of wages in total airline costs. The price-cost pass through rates are dictated according to the Bertrand-Nash model developed ealier. Results are presented in Table 3. In these simulations $\%\Delta_p$ is the price variation, $\%\Delta_q$ is the traffic variation, and $\%\Delta_\pi$ is the profit variation, all measured in percent change. We simulate three cases of economies of density: "base case" (ie, estimated φ), "weak economies of density" $\left(\frac{\varphi}{2}\right)$ and "strong economies of density" $(\varphi \times 2)$.

Table 3 - Wage premium shock simulations - 10% wage hike[7]

Economies of density		$\%\Delta_p$	$\%\Delta_q$	$\%\Delta_\pi$
"weak"	Major	0.22	-0.05	-0.09
	Small	0.47	-0.44	-0.88
"base case"	Major	0.24	-0.04	-0.08
	Small	0.54	-0.46	-0.93
"strong"	Major	0.29	-0.02	-0.04
	Small	0.80	-0.53	-1.05

As expected, Table 3 shows that the wage hike produces reductions in the proÖts of both airlines. For the major airline, however, profit losses are negligible, being lower than 0.10% in all scenarios of economies of density. It is clear that even the cost-price pass through of smaller airlines being higher than major airlines - in fact, more than twice in all cases -, their profitability is considerably more impacted in all scenarios. Also, as a result of the higher decrease in quantities of the small airline, we have that higher concentration levels prevail in the market after the cost shock. Another point that can be observed in Table 3 is that in the presence of weak economies of density the small airline is less affected. In this situation, the major carrier is less benefited from having a larger portion of the traffic in the market. We also perform some simulations of cost shocks in case of higher elasticity of demand. In these simulations, we double all price sensitivies of demand, ie we consider $2 \times \beta_i$ and $2 \times \gamma_i$, instead of β_i and γ_i, $i = \{1,2\}$. Table 4 presents the results.

Table 4 - Wage premium shocks simulations - 10% wage hike, high price-elasticity[8]

Economies of density		$\%\Delta_p$	$\%\Delta_q$	$\%\Delta_\pi$
"weak"	Major	0.31	-0.07	-0.13
	Small	0.61	-0.84	-1.66
"base case"	Major	0.35	-0.05	-0.09
	Small	0.75	-0.92	-1.84
"strong"	Major	0.48	0.03	0.07
	Small	1.34	-1.27	-2.53

[7] Scenarios of economies of density: "base case" (ie, estimated φ), "weak economies of density" $\left(\frac{\varphi}{2}\right)$ "strong economies of density" $(\varphi \times 2)$.

[8] We denote "high price elasticity" when considering $2 \times \beta_i$ and $2 \times \gamma_i, i = \{1,2\}$, instead of β_i and γ_i. Scenarios of economies of density: "base case" (ie, estimated φ), "weak economies of density" $\left(\frac{\varphi}{2}\right)$ and "Strong economies of density" $(\varphi \times 2)$.

The analysis with higher elasticity of demand of Table 4 shows that the losses in profits and quantities of the small airline due to the wage hike are amplified. For example, with higher price-elasticity of demand, the small airline would lose 1.84% of profits in the base case. This is almost double the results of the case of Table 3, when estimated economies of density were applied. On the other hand, results for the major airline are not significantly impacted. We therefore have that the impacts in the concentration levels are magnified.

The analysis of Tables 3 and 4 shows that both economies of density and price-elasticity of demand impact market results. In sum, results of small airline losses in demand and profits are amplified by both stronger economies of density and higher price-elasticity of demand. The major airline is either always less impacted or even benefited from the wage hike, although the magnitude of this effect is small. This situation is illustrated in figure 4, where we plot an index of economies of density (setting the base case equal to 100) against the percent change in total profit of both carriers. In order to produce this graph, we simulated many intermediate cases of economies of density for two situations of price-elasticity of demand: *situation A* (estimated price-elasticity) and *situation B* (higher price-elasticity). The higher the economies of density the lower the profit variation of the small Airline (π_2^A) and the higher the profit variation of the major Airline (π_1^A). Results are ampliÖed in situation B, as the slopes of both curves increase as is decreasing in the index of economies of density.

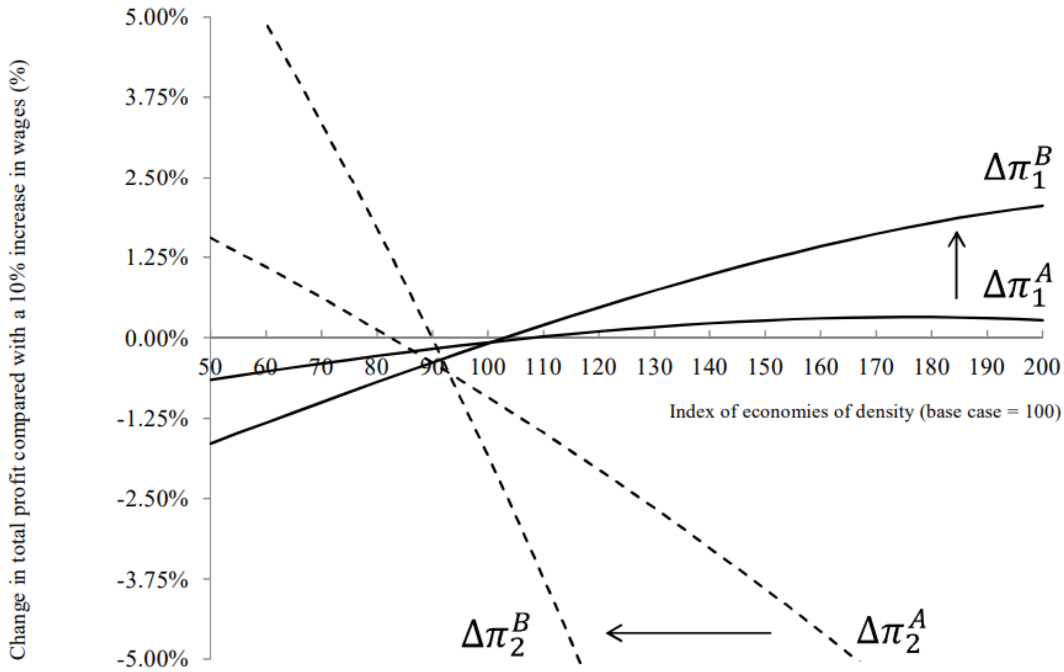

Figure 4: Profits variations according to economies of density

Final results indicated that the small airline is always more affected than the major airline when a linear wage increase is imposed. Looking strictly at the product market e§ects, and aiming at avoiding a higher concentration, one possible proposal is a di§erentiated wage hike, according to the size of airline. With this wage hike di§erential, workers would allow wage concessions to the smaller airline. Table 5 permits observing the effects of this proposal. There, we simulate a situation of differentiated flight crew cost shocks in which the small airline will suffer a 5% wage hike whereas the major airline will have the full, 10% hike, in wages.

Table 5 - Wage premium shocks simulations - Di§erential Wage Increase

Economies of density		$\%\Delta_p$	$\%\Delta_q$	$\%\Delta_\pi$
"weak"	Major	0.18	-0.10	-0.19
	Small	0.27	-0.13	-0.27
"base case"	Major	0.20	-0.10	-0.19
	Small	0.31	-0.14	-0.27
"strong"	Major	0.24	-0.09	-0.19
	Small	0.42	-0.14	-0.28

Table 5 suggests that in the presence of bargaining with differentiated wage concessions - ie, with the workforce of the small carrier having only half of the wage hike of the major carrier -, the small airline is considerably less affected. In this situation, overall prices and concentration have a lower increase in comparison to previous cases. The small carrier still has higher losses due to the increase in the wage premiums, but is significantly less impacted. We believe that our simulation results above points to the same direction of the US market nowadays. Hirsch (2007) shows that the experience of the US market in the postderegulation period reveals positive wage premiums for pilots stemming from considerable union bargaining power at the major carriers, but not at regional carriers. In fact, the author shows that regional carriers wages approximate opportunity costs. Looking at our results, we think there is a trend to the differential wage concessions scheme in which smaller carriers have lower wage premiums than major carriers tends to prevails in Brazil. We therefore conclude that the Brazilian experience may converge to the case of the labor market in the US airline industry. We also believe that, consistent with other emerging airline markets, labor regulations should be liberalized in Brazil.

4. Conclusions

The Brazilian airline industry has been characterized by strong product-market concentration since the mid 2000's. With the Brazilian recent trend of significant increase in labor costs, the study of impact of wage premium shocks on the competitiveness of the industry has become an important issue. In an environment of ever increasing unionization, wage premiums of a highly-qualified workforce tend to increase as a result of labor market rents from union bargaining power. In particular, due to the strong concentration of the market, industry analysts are increasingly worried about the erosion of the benefits from economic deregulation since the late nineties. This is specially relevant in case of cost shocks that tend to be passed through to prices. In this paper we analyzed the effects of exogenous labor cost shocks on prices, demand and total profits. We used a differentiated duopoly model relaxing the hypothesis of absence of economies of density typical of previous studies. With this framework, we model the competitive interaction between major and small airlines. We employ this model to simulate the impacts of a linear wage increase of 10% and of a di§erentiated scheme of workers concessions regarding wage hikes.

This paper's findings suggest that smaller airlines are always more affected by cost shocks than major airlines. On the other hand, if wage hikes are differentiated by airline size, small airlines may be less affected, with a lower increase in market concentration and lower damage to consumer welfare. Final conclusions suggest that lower bargaining power of smaller carriers when negotiating salaries may weaken airline competition in case of overall linear labor cost increases. Schemes of differentiated wage concessions tend to reduce significantly small airline losses.

The present work contributes to the literature by 1. developing existing differentiated duopoly models in order to incorporate wage premium shocks, and 2. evaluating the impacts of wage premiums shocks on major and small airlines taking into account of economies of traffic density. By modelling wage premium increases we consider a situation that has recently become relevant in an emerging country like Brazil due to its rapid growth of air transportation demand and consequent shortage of qualified workforce in the industry. We suggest that, in light with other emerging airline markets, labor regulations should be liberalized in Brazil.

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