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Há ganhos de eficiência em fusões de companhias aéreas? Uma análise na produtividade da indústria de transporte aéreo brasileira.

Are alleged efficiency gains in airline mergers for real? A research on the productivity of the Brazilian airline industry.

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Resumo: Cientes dos potenciais efeitos de concentração em operações de fusões e aquisições, companhias aéreas advogam ganhos de eficiência para defender este tipo de combinação de negócio. Na última década, o mercado brasileiro de transporte aéreo testemunhou duas grandes operações desta natureza, oferecendo uma oportunidade para expandir a literatura nesta área do conhecimento, fortemente concentrada no estudo de mercados já maduros. Empregando o cálculo de Produtividade Total dos Fatores e análise qualitativa este trabalho revela que a fusão entre Azul e Trip trouxe ganhos restritos de produtividade e que a aquisição da Webjet pela Gol não ofereceu ganhos de produtividade.

Palavras-chave: Produtividade na indústria de transporte aéreo, produtividade total dos fatores, fusões e aquisições na indústria de transporte aéreo.
Classificação JEL: L93.

Abstract: Aware of the potential concentration effects of Merger and Acquisitions operations in the market, Airlines advocate efficiency gains to justify these business combinations. Most of the literature in this area focus on mature, well-developed markets, but on the last decade two significant operations were witnessed in the Brazilian market. The methodology used in this study is comprised by a qualitative analysis complimented by an efficiency calculation, regarding the input-output relationship, using Total Factor Productivity calculations. Results show that efficiency gains on Azul-Trip merger were focused on overhead and administrative expenses and that the acquisition of Webjet by Gol provided no efficiency gains.

Keywords: Productivity in the airline industry, Total factor productivity, Mergers and acquisitions in the airline industry.
JEL Classification: L93.

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1. Introduction

The industrial organization of the commercial aviation market is nothing but dynamic. Substantial changes in the industry have been forcing the airlines to reduce their relevance as a source of national pride and sovereignty, a role held until the last decades of the last century (Raguraman, 1997). Since then, the rise of global alliances (such as Star Alliance, Oneworld and Skyteam), and of transnational mergers and acquisitions, associated with fierce competition, reduced government subsidies and, more recently, the consolidation of players with market-challenging strategies and different level of services deeply changed the industrial organization of the business. As a response to the ever-changing characteristics of the airline industry, mergers and acquisitions have been taking place since the 1920 decade. Concurrently, antitrust authorities have been facing the challenge of balancing effects of horizontal mergers that may be favorable not only to the consumers but also to the firms, because of dichotomies that are present in business combinations across almost all industries: in one hand, mergers and acquisitions may favor market concentration and coordination among existing players, but in the other hand these operations may allow companies to operate more efficiently, allowing also for new entrants.

These efficiency claims that may come along with business combinations is one of the most common arguments presented by merging parties to antitrust authorities. If during the examination process any competition concern is raised, the antitrust agency may impose the so-called remedies or may even disapprove the whole operation. However, once the merger is complete, few can be done if the arguments in which the combination was based (such as efficiency gains) do not hold.

This article intends to test a scientific approach to this problem: while the subject of the effects of mergers in the airline industry, as well as the subject of airline productivity have been extensively researched, few investigations were conducted in the literature to test the extent of efficiency gains of airline mergers and acquisitions. Therefore, the purpose of this study is to provide further knowledge of the effects of business combinations in the productivity of recently merged airlines and compare these effects to their peers, non-merged airlines. The acquisition of Webjet by Gol and the merger between Azul and Trip were analyzed as to whether they had an impact on the efficiency of the main players of the Brazilian domestic market. In other words, the research intends to answer the following questions: did the purchase of Webjet by Gol and the merger between Azul and Trip brought any efficiency gains to the combined airlines? If yes, was it due to an improvement on the use of input or were there any other reasons? And how did the competition respond to the mergers and its effects?

To address these questions, efficiency was measured using TFP (Total Factor Productivity) calculation. The productivity was assessed as a relation of product (RPK and RTK) generation to input utilization, applying two different index numbers for TFP calculation (the Tornqvist index and the multilateral productivity index). The use of two different index numbers is intentional: while the Tornqvist index, a non-transitive index, is

used for productivity comparisons within each entity, the transitive multilateral productivity index allows for comparisons among different entities. As far as the literature review shows, no previous works used both transitive and non-transitive index numbers for TFP calculations. Besides the contributions proposed on the methodology side, this study also works as specific case studies: while the acquisition of Webjet by Gol was studied by Fregnani et al. (2019), by using the Cobb-Douglas function (and therefore using only capital and labor as inputs), there is no current studies, to the best of the authors´ knowledge, analyzing effects of the Azul-Trip merger.

An additional contribution lays on the fact that, to a large extent, previous research on both topics (effects or airline combinations and airline efficiency and productivity) focused in mature, well-developed markets. There is a vast literature on these topics for the North American, European and, more recently, Asian markets. A few reasons may justify this, such as academic interest and scientific relevance, availability of data, among others. However, the different characteristics of developing markets, when compared to well stablished markets, advocate for further studies of those topics in less documented countries, which face different aspects of regulation, competition, access to infrastructure, taxation, input prices and exposure to currency rates.

Our results point to positive, albeit small, impacts on the combined, post-merger carriers. Also, the road taken to reach these efficiency improvements was different: while the marginal gains brought to Gol by the acquisition of Webjet came through resizing (cutting capacity and workforce), the slightly larger gains brought to Azul by the merger with Trip came through a more rational use of nonoperational expenses, and through the use of a very efficient network. Furthermore, the gains in efficiency were matched by the competitors of Gol and Azul, namely Tam and Avianca Brazil: the whole Brazilian industry experienced productivity gains in the period, meaning that the efficiency growth was not solely due to business combinations.

The strategy of each business combination studied on this article was also analyzed in a qualitative investigation for each operation. This analysis was based on the use of the productive structure of the absorbed airline and on the impacts of the operation in terms of network.

1.1. A brief recap of the current state of the Brazilian airline industry

The Brazilian airline industry was responsible for 2.17% of the global passenger traffic of 2018 (IATA, 2019), and in 2018 Brazilian airlines grossed about BRL 43.1 billion in revenues, directly employing about 50 thousand people (ANAC, 2019). According to ABEAR, the national´s airline association, the value delivered to the national product in the same year was more than BRL 100 billion. But not only the current state of the airline industry in Brazil is important: due to the continental dimensions of its land (the fifth largest nation in area), its huge population of approximately 210 million inhabitants (UN, 2018), which corresponds to 2.8% of the world´s population, and the developing integration to

global markets, the airline industry still has the potential to drive the future development of the country, as it already does in many other nations.

As in other countries, the Brazilian airline industry was influenced by different stages of government intervention along its history. In 2005, with the decentralization of civil aviation management from military powers and following the creation of the Brazilian civil aviation authority, ANAC, most of the relevant economic regulations were lifted: no more pricing determination or supply limitation would be imposed. Ever since, most of the government regulation remains on the technical side (although there´s been some restriction on access to infrastructure, or, more specifically, to airport slots on a few profitable, busy airports).

Since 2005, the landscape of the Brazilian airline industry changed significantly from what it was in the turning of the century. Back then, the domestic market trunk routes were dominated by Transbrasil, Vasp and Varig, which ceased operations in 2001, 2005 and 2007, respectively. The regional markets were served by its subsidiaries or small, regional airlines. In the early of the decade of 2000, Tam (now called Latam Airlines Brasil) was an incumbent. As of 2018 it was, by far, the largest Brazilian carrier (considering both domestic and international markets), with more than 60 billion RPKs carried on that year.

Along with the rise of Tam, the same period witnessed the creation and growth of Gol. The airline started flying in 2001 and brought to the company the concept of low cost, low fare flying. Favored by the bankruptcies of Transbrasil and Vasp, and the deteriorating performance of Varig (bought by Gol in 2007) Gol expanded its operations within Brazil and neighboring countries, being the large domestic operator in the country in 2018 and the largest Brazilian airline in international traffic within South America.

Roughly in the same period, the other airlines that are important for this study started regional operations, expanding their network in the following years, just to become relevant players by 2010. Trip started its operations in 1998, flying 30-seat turboprops. Oceanair, which later became Avianca Brasil, started flying in 2002, flying routes boosted by the oil and gas industry. Webjet started flying in 2005, adopting a low-cost structure similar to Gol´s, and promoted competition by adopting real low fares. Azul started flying by the end of 2008, mixing hub and spoke and point to point services on city pairs that were, until then, not served by other airlines.

Between 2004 and 2010 the Brazilian domestic product grew by 24% (in real terms), favored by a strong reduction in the interest rates and by a strong growth in consumption (IPEADATA, 2018). These factors, along with public policies of economic stimulation and a favorable exchange rate, led to an annual growth on the demand for air transport services, between 2004 and 2010 of 11% (ANAC, 2019). RPK raised from 26 billion to 65 billion, and carried passengers grew from 30 million to 65 million. More interestingly, even with such a strong demand, average nominal prices of airline tickets fell from R$ 565 to R$ 296.

Growth rates in the following decade reduced significantly. In 2016, for instance, the Brazilian airline industry faced one of its hardest years, with a 5.7% reduction in RPK and 8.2% reduction in RTK, following a decay of 3.5% on the Brazilian domestic product in 2015 and 2016. This rationalization process, which followed the cutback in the demand

and a reduction on cargo transportation, witnessed a reduction of 6% in ASK and 5% in ATK between 2015 and 2016, as an industry strategy to face the crisis. This strategy allowed for a better load factor, which rose from 70.2% in 2011 to 81.5% in 2017. The horizontal mergers studied in this paper were part of this rationalization process.

The acquisition of Webjet by Gol was announced in August of 2011 and was approved by ANAC in October of that year. In the year preceding the announcement, Webjet network´s grew from 96 city pairs to 113 city pairs, reducing its overlap with Gol´s network and gaining market share. The approval of CADE, the Brazilian antitrust authority, happened in October of the following year, with Gol announcing the end of Webjet´s operations virtually in the following day. On that month, Webjet´s market share was 4.16% (4.7 million passengers in 2012) and Gol´s was 30.16% (30.7 million passengers in 2012). In 2013, the number of passengers carried by Gol was of 32,5 million (roughly 2.5 million less than the two airlines combined in the previous year). 18 aircraft were returned to lessors and the number of combined employees reduced from 21.4 thousand (end of 2012) to 16.1 thousand (end of 2013).

The merger between Azul and Trip was announced in May of 2012 and concluded in May of 2014, with the merger of the operations´ certificates. The market shares were, then, 12.74% for Azul and of 6.7% for Trip and the resulting market share was of 21.35%. In 2013, Azul carried 13.3 million passengers and Trip, 5.3 million passengers. As a result of the merger, in 2014 the combined airline carried 20 million passengers, making Azul the third largest operator by a large margin.

As a summary of the evolution of the Brazilian domestic airline market in the last 16 years, Table 1 exhibits the main indicators for every 5 years since 2003. A growth of about 270% can be noticed, along with an improvement on the load factor of 21%. The average fare currently corresponds to 46% of that from 2003, even though the market remains highly concentrated, roughly in the same levels of 2003.

Table 1: Evolution and Key Indicators of the Brazilian Domestic Air Travel Market

Year	Load Factor	RPK 000	Average Fare	Average Stage	Seats 000	Departures	HHI
2018	81,3%	95.900	381,92	1.180	38.090	815.862	2,8
2013	76,1%	88.200	445,88	1.065	52.028	946.681	3,1
2008	66,0%	49.700	768,19	908	14.250	657.196	3,9
2003	60,0%	26.000	823,64	699	13.352	538.649	2,5

Source: ANAC Consulta Interativa.

2. Literature Review

The literature survey presents the two core topics covered by this article: airline efficiency and productivity gains brought by airline mergers and acquisitions. There is an extensive literature on both subjects, therefore this review does not intend to cover all previous work and their considerable findings but allows for a good understanding of common aspects of current knowledge, allowing also the identification of trending topics in this area of research.

2.1. Airline Efficiency

On the topic of airline efficiency, there is a significant number of recently published articles, indicating an existing gap on the matter. Heshmati and Kim (2018) state that there are several methods of measuring airline efficiency. Several articles adopt more than one technique consecutively. Studies that consider some form of production possibility frontier account for a great number of approaches that tackle the issue, specially adopting data envelopment analysis and its variations. To name a few, this methodology has been employed by Wanke and Barros (2016), on their research on Latin American airlines, Duygun et al. (2016), studying European airlines, Zoltaszek and Pisarek (2016), also studying efficiency of European airlines and Mallikarjun (2015), on research of North American airlines of different business segments. Most recently, Kuljalin et al. (2019) used DEA along with a second stage analysis that employed a productivity index. Index numbers were also used by Yan et al. (2019), Chen et al. (2018), See and Rashid (2016), and Barros and Couto (2013). A more specific index number, through TFP calculation, which was also the methodology employed in this research, was used by Wang et al. (2014) and in the influential work of Oum et al. (2005). Other forms of productivity evaluation were also used in other substantial work, such as Cobb-Douglas function (Fregnani et al., 2019), cost function (Bitzan and Peoples, 2016) and Network analysis functions (Li and Cui, 2018; Li et al., 2016). Barros et al. (2013) made use of Beck´s theorem along with the B-Convex model to evaluate the efficiency of US Airlines.

All these papers share some common characteristics: the estimation of cost functions relies on input prices, which are rarely available for research purposes. For that reason, production functions are preferred to cost functions. Most studies focus on the US and European markets, with a recent trend on studying Asian (Chinese, especially) markets. There is still a huge gap on case studies of developing markets, especially in Latin American markets. On the methodology side, as mentioned above, most papers rely on DEA and other forms of production possibility frontiers. The findings of these preceding works have proven to be broad: airline efficiency is driven by several factors, such as competition levels, business models, exposure to foreign currency, network characteristics, among others.

2.2. Effects of Airline Mergers

On the topic of airline mergers and its effects, most of existing works focus on simulating merger effects, exploring market concentration issues, and performing post-merger analysis of real case mergers. Most of these previous works focus on well-established markets, US and Europe in special and China more recently. Again, very few papers explore emerging mergers. Also, most post-merger analysis has a strong focus on effects of mergers over tariffs: airline efficiency and service levels are more recent subjects. The number of recent articles on the airline industry consolidation and its effects is even higher than of airline efficiency. It is important to emphasize that airline mergers are still a matter of interest in contemporaneous research.

Several studies use the Difference-in-Differences estimator and its possible variations to measure horizontal merger effects. This technique was used by Yan et al. (2019), on a study of mergers effects on efficiency of Chinese airlines, Doi and Ohashi (2019), in a study of the Japanese market, Douglas and Tan (2017), which is the most recent study on post-merger profitability of airlines around the globe, Fageda and Perdiguero (2014), which focus post-merger tariffs on the Spanish market and Dobson and Piga (2013) study on European mergers involving full service carriers and LCC. The same methodology was used in several studies of the US market, such as Carlton et al. (2019) about effects on competition, Vaze et al. (2017) about passenger welfare, Shen (2017) about tariffs, Prince and Simon (2017) about level of service, which was also the object of study of Steven et al. (2016).

Along with the Difference-in-Differences estimator, other forms of econometric modelling were used to study airline mergers: Chen and Gayle (2019) studied service levels after modelling the demand for air transport services, Oliveira and Oliveira (2018) modelled the Brazilian market concentration, while Gudmundsson et al. (2017) developed three different cost-function for global post-merger analysis. Huschelrath and Muller (2014) and Zhang (2015) used fixed effects modelling for analysis respectively on productivity and pricing and in low performing airlines profitability. Another relevant work that used econometric modelling is the groundbreaking work of Kim and Singal (1993), which studied post-merger effects on pricing.

To name a few studies that used other approaches, Borenstein (1990) used market concentration and its impacts on tariffs to analyzing the effects of the US airline industry consolidation of the 1980s. Market concentration was also the object of study of Guterres and Muller (2003), one of the few studies on the Brazilian market. Schosser and Wittmer (2015) performed a qualitative study, as did Németh e Niemeier (2012) on their study on European and American mergers, while Mudde and Sopariwala (2014), employed variance analysis.

Besides these different methodological approaches, along with the different markets studied, all the cited previous works also differ on the number of samples and, more significant, on its findings. No studies were equal, and this diversity led to results that were not only different, but dichotomic at times, due to the nature of the methodologic approach,

to the constraints applied to the database and to the size of the sample. The heterogeneity on the results of previous studies on both subjects, airline efficiency and merger effects, are noticeable. This heterogeneity exists regardless of studied markets, timing, methods and even conclusions about the same case studies. However, a few common grounds on the results of these previous studies may be found.

To name a few, Bitzan and Peoples (2016) mention that network characteristics affect legacies and regional carriers on a different way when compared to low-cost carriers. Studies by Wanke and Barros (2016), Barros and Wanke (2015) and Oum et al. (2005) show that for airlines with business models that differ from low cost, the adoption of a proper fleet, instead of a single fleet, is a better productivity driver. On the merger-efficiency side, recent studies, such as Yan et al. (2019) and Doi and Ohashi (2019), show that merged airlines are experiencing productivity growth due to efficiency of scale, and reduced costs.

2.3. A synthesis on the state of the literature

There is no question that the literature on the topics of airline efficiency and effects of airline mergers is vast and great knowledge has been built over the years. However, as the recency of other papers highlights, there is still scientific appeal on additional research on the subject, because many are the knowledge gaps to overcome. For instance, few of the existing studies approach the antitrust aspect of airline mergers by comparing pre-merger alleged gains versus post-merger materialized gains.

The present article is an attempt to cover a part of those gaps: while covering the less documented Brazilian airline market, the paper addresses the singularities of the airline industry in developing markets. The paper also follows the trend of more recent works that shifted the object of study from covering the effects of mergers and acquisitions over ticket prices to airline efficiency and level of service. Finally, this research intends to test a follow up methodology from a productivity standpoint: if firms justify their business combination decisions on the grounds of likely efficiency gains, it is important to establish a consistent method that evaluates whether these proposed gains ever materialized.

3. Methodology and Data

To achieve the objectives of the study outlined in section 1, the methodology adopted in this article is comprised by the calculation of the Total Factor Productivity (TFP) with the use of two index numbers. This section is then divided in two subsections, in which the first explains each of the steps of the methodology, followed by the presentation the databases of the study.

3.1 Measuring productivity: an input-output view

As presented by Coelli et al. (2005), there are several methods to measure productivity. Some of them make the use of the productivity ratio, balancing the use of input per units of outputs produced. Among these techniques that use the productivity ratio as a measure of efficiency, the Total Factor Productivity, TFP, has been the method of choice on studies about productivity of different economies, industries and firms (Windle, 1991). The TFP concept has been widely employed on previous literature because it allows for factors such as technology changes and organizational changes to be computed as drivers of efficiency of a given entity. In other words, the TFP explains in productivity that may not be explained only by an input-output standpoint. There are different paths for the TFP calculation: for instance, the production frontier may be used or not, and the calculation may also be parametric or not.

On this study the TFP is used to calculate the TFP for the airlines included in this study, via the application of index numbers. Index numbers are real numbers used to evaluate, in a uniform manner, how a set of related variables, valued by quantity and price, vary during a given time frame. For a brief background on index numbers, we refer to V_{st}, equation (1), which is the change of value of the inputs from period *s* to period *t*.

$$V_{st} = \sum_{n=1}^{N} p_{nt}\, q_{nt} \Big/ \sum_{n=1}^{N} p_{ns} q_{ns} \tag{1}$$

Considering the number of inputs equal to 1 (N = 1) the calculation of the changes in quantity and prices would be straightforward, as shown in equation (2), given that the ratios p_t / p_s and q_t / q_s measure the relative quantities in prices and quantities.

$$V_{st} = p_t q_t / p_s q_s = p_t / p_s \; X \; q_t / q_s \tag{2}$$

However, most production functions use more than one input, leading to an aggregation problem (Coelli et al., 2005), due to the infinite combinations of changes in input prices and quantities. One of the index numbers that addresses the aggregation problem is the Tornqvist index, which can be decomposed in price indexes, and quantity indexes. The Tornqvist index, which has been previously used in airline productivity studies by Yan et al. (2019) and by See and Rashid (2016), is defined by the geometric average of the relative price or quantity values, weighted by the average value of periods *s* and *t*. When used for price indexes, the index is calculated by equation (3), while equation (4) shows the index in its logarithmic format, representing the average change in the log of prices. When used for quantity indexes, the index is calculated by equation (5), while equation (6) shows the index in its logarithmic format, representing the average change in the log of quantities.

$$P_{st}^{T} = \prod_{n=1}^{N} \left(\frac{p_{nt}}{p_{ns}}\right)^{\frac{\omega_{ns}+\omega_{nt}}{2}} \quad (3)$$

$$\ln P_{st}^{T} = \sum_{n=1}^{N} \left(\frac{\omega_{ms} + \omega_{mt}}{2}\right) \times (\ln p_{nt} - \ln p_{ns}) \quad (4)$$

$$Q_{st}^{T} = \prod_{n=1}^{N} \left(\frac{q_{nt}}{q_{ns}}\right)^{\frac{\omega_{ns}+\omega_{nt}}{2}} \quad (5)$$

$$\ln Q_{st}^{T} = \sum_{n=1}^{N} \left(\frac{\omega_{ms} + \omega_{mt}}{2}\right) \times (\ln q_{nt} - \ln q_{ns}) \quad (6)$$

A proper index number must comply with a few mathematic properties, thoroughly explained in Coelli et al. (2005). The Tornqvist index complies with most of these properties but lacks the one called transitivity (Eichhorn and Voller, 1990). The transitive property (sometimes called circularity) states that, given time periods *s*, *r* and *t*, when comparing the productivity between two periods, or two entities, the result must be the same as when inserting an intermediate comparison. In a mathematic notation, $P_{st} = P_{sr} \times P_{rt}$. This is relevant because only transitive index numbers can be used for TFP comparisons among different entities in different periods of time. Therefore, in this study, the Tornqvist index is used only for TFP comparisons in the same entity (airline). There are mathematical treatments to provide the Tornqvist index with the circularity, such as the ones applied by Selvanathan and Rao (1992) and Fujikawa et al. (1995). However, the use of the logarithmic form of the Tornqvist index, equation (6), first employed by Caves et al. (1982) to create the translog multilateral index, is the most cited contribution in the literature. Equation (7) rewrites the transitive property, in which I is any (input, output or the whole TFP) index of entity *k* compared to entity *l*, for any *m* base:

$$I_{kl} = {}^{I_{km}}/_{I_{lm}}, \text{ or: } \ln\ I_{kl} = \ln\ I_{km} - \ln\ I_{lm} \quad (7)$$

From equations (4) and (6), the proportional change in production between entities *k* and *l* can now be compared. δ^{kl} represents this proportional change, while *R* represents the changes in revenues and Y_i represents the physical change of produced outputs.

$$\ln\ \delta_{kl} = \frac{1}{2}\sum (R_{ki} + R_{li}) * \ln\left(\frac{Y_{ki}}{Y_{li}}\right) \quad (8)$$

However, the use of this index for a further third entity would not comply with the transitive property described in equation (7), as explained in Coelli et al. (2005) and Eichhorn and Voller (1990). To allow for the comparison of more than two entities, the geometric mean of bilateral comparisons must be used. This geometric mean is defined as the average value of the natural logarithm of the index numbers of each entity. This is the multilateral output index, shown in equation (9):

$$\ln \delta^{*}_{kl} = \ln \delta_k - \ln \ \delta_l = \frac{1}{2} * \left[\sum \left(R_i^k + \bar{R}_i \right) * ln \left({Y_i^k}/{\tilde{Y}_i} \right) - \sum \left(R_i^l + \bar{R}_i \right) * ln \left({Y_i^l}/{\tilde{Y}_i} \right) \right] \quad (9)$$

$\bar{R}$ is the arithmetic mean and $\tilde{Y}$ is the geometric mean. The main difference between the bilateral and multilateral indexes is the replacement of the arithmetic mean for two entities for the geometric mean of several entities. As equation (9) refers to the multilateral output index, the multilateral input index is introduced in equation (10), in which the proportional change of input usage of entities *k* and *l* is given by ρl e ρk, W represents the changes in costs and X represents the changes in the usage of inputs. As in equation (9), in equation (10) the arithmetic mean and the geometric mean are represented respectively $\bar{W}$ and $\tilde{X}$.

$$\ln \rho^{*}_{kl} = \ln \rho_k - \ln \ \rho_l = \frac{1}{2} * \left[\sum (W_n^k + \bar{W}_n) * ln \left({X_i^k}/{\tilde{X}_i} \right) - \sum (W_n^l + \bar{W}_n) * ln \left({X_n^l}/{\tilde{X}_n} \right) \right] \quad (10)$$

Therefore, as applied by Caves et al. (1982), the TFP index, when calculated with the use of the multilateral productivity index, will result in equation (11) from the division of (10) per (9).

$$\ln \rho^{*}_{kl} \div \ln \delta^{*}_{kl} \quad (11)$$

The TFP calculation with the use of the Tornqvist index and with the use of the multilateral procedure index are similar (Diewert, 1978), with the difference that the second allows for productivity comparisons among different entities in different periods of time. For that reason, in this article the TFP calculation will use the Tornqvist index for efficiency comparisons among the same airlines, namely Gol and Webjet and Azul and Trip before and after the horizontal mergers, and will use the multilateral index procedure for all the airlines in the sample.

3.2. Database description

The database is comprised of a set of inputs, which are the most used in airline productivity studies, and two outputs, which are standardized output metrics for the

airline industry, namely RPK and RTK. Two were the criteria for an airline to be included in the database: the first was the intentional limitation of analyzing only domestic mergers and compare with non-merged domestic airlines. This intentional limitation intends to allow comparisons between carriers that operate in the same competition, regulation, taxation, manpower and infrastructure scenarios. The second criteria refer to the scale of operation, and the minimum cap for an airline to be included in the database was at least a 1% market share in 2009.

Even with the criteria applied to include an airline in the database, there are still significant differences of scope of operations of the airlines included in the database, ranging from a predominant regional network, such as Trip´s, to a network that includes long haul flying, such as Tam´s. The adoption of index numbers intends to avoid all the efficiency biases that different scope of operations may produce. To address the same issue, the study of productivity for all airlines, even those of which had significant international operations during the whole database (namely Gol and especially Tam), was constrained to its domestic operations. With that in mind, some of the data disclosed by ANAC and by the airlines, especially regarding the inputs, are measured by its use in total (domestic and international) operations. To address this issue and provide a better estimate for the input usage in the domestic operations, each input index number considered the proportion of domestic ASK over total ASK. As an example: data disclosed by ANAC or by the airlines on fuel consumption did not specify the percentage of fuel used in domestic or international operations. To produce the index numbers used in this study, the percentage of domestic ASK was applied over the total fuel consumption, resulting in fuel consumption used in domestic operations, which by its turn was used in the input index number.

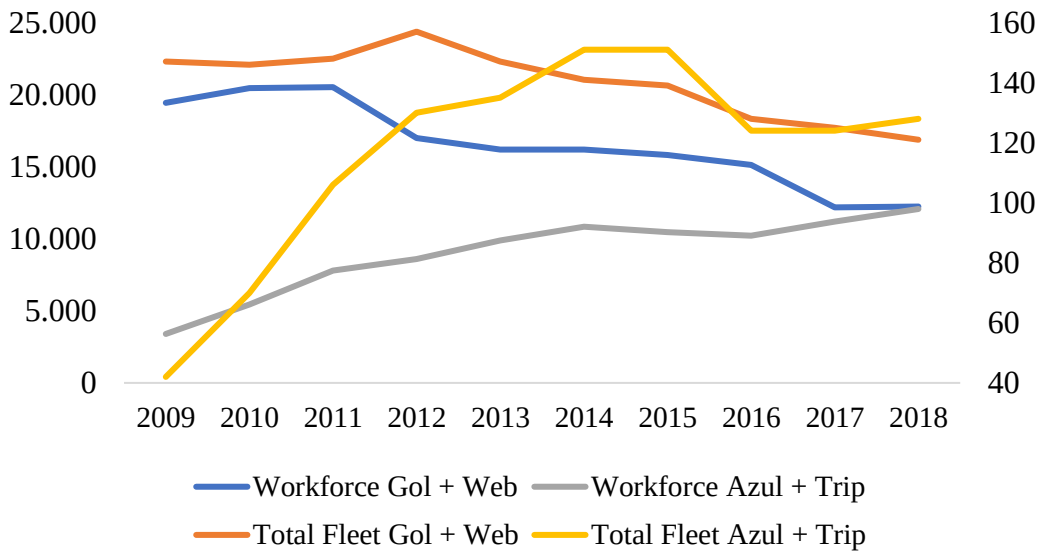
Recent studies on productivity have used the acronym KLEMS to name each input considered as a driver of productivity and efficiency on a given economy, industry or firm. These initials stand for Capital, Labor, Energy, Materials and Services. This study also uses the KLEMS inputs as drivers of productivity, and those will be the inputs used in TFP calculation. On the output side, the study uses RPK and RTK as production numbers. To transform the physical quantities of the inputs into an index number, the input use was measured by its physical quantity and priced by the reported expense value weighted by the total expenses. The physical measure of each input was as follows: capital corresponds to total of seats available in the airline´s aircraft at the year-end; labor corresponds to the number of employees at the year-end; and energy corresponds to the total fuel consumption at the year-end. Materials and services were not measured by its physical quantity due to the nature of these inputs, so these inputs were measured with the use of a weighted average price index as proposed by Caves et al. (1982).

Shown in appendix A, table 4 presents the compilation of the database used for the TFP Calculation. Some of the discussions presented in the results section are also based in the following data. As equation (11) require lengthy calculations demanding the use of computational tools, the software TFPIP™, developed for different types of TFP calculations, was employed.

3.3. Quantitative Analysis

As stated in the introductory section, the tiny productivity gains obtained by Gol upon acquiring Webjet were mainly due to the downsizing of the combined airline, through cutting workforce, returning older aircraft to lessors and cutting capacity and infrastructure use. In the other hand, the Azul-Trip merger resulted in a larger airline, which had their productive structures combined, rationalizing administrative and selling expenses.

Graph 1: Timeline of fleet and workforce size



Source: Prepared by the Authors based on ANAC, 2019.

Graph 1 above presents the timeline of the Productive Capacity of each combined airline, showing a constant growth in Azul´s business until the end of the time series, except for the years 2015 and 2016 (during which the Brazilian economy experienced a 7% reduction in its domestic product). The combined airline´s headcount grew from roughly 3.400 employees in 2008 to about 12.100 in 2018, and its fleet size grew from 42 to 128. In Gol´s case, after purchasing Webjet, the airline started a significant rationalization process, bringing its employees down from a peak of 20.500 in 2010 to 12.200 in 2017 and 2018, with a significant cut of 3.500 employees in 2012 from 2011 alone. By returning Webjet´s older aircraft and some of its own older aircraft to lessors, Gol reduced its fleet size from a peak of 157 in 2012 to 121 in 2018.

Table 2: Route Overlap on Total Network, in %, per Combined Airline

	2009	2010	2011	2012	2013
% overlap Gol	6,1%	5,5%	4,6%	5,7%	
% overlap Webjet	35,2%	35,5%	22,0%	24,8%	
% overlap Azul	8,2%	4,1%	4,7%	5,3%	5,7%
% overlap Trip	0,7%	0,8%	1,7%	3,0%	5,3%

Source: The Authors, prepared witth ANAC Data.

Other relevant data to be brought to the qualitative analysis is presented in table 2 above, showing the average percentage of route overlapping in each airline network, compared to each combined airline. For instance, in 2009 and 2010 Webjet was directly competing with Gol in 35% of its routes, these same routes representing about 6% of Gol´s network. This competition decreased by a third, to about 23% in 2011 and 2012, during the combination process of their business. Before its incorporation by the former competitor, Trip competed in about 1% of its routes with Azul, and these routes represented a range of 8,2% to 4,7% of Azul´s network. Business of both airlines grew on the overlapping routes during the combination process of their business. Table 3 below shows the number of city pairs operated by each combined airline, adjusted for the route overlap. Data evidences that after starting its business combination with Webjet, Gol started to reduce the number of operated routes within its network, reaching in 2013 the same levels of 2009. Azul´s merger with Trip allowed the combined entity to double its network, in terms of number of city pairs.

Table 3: Number of City-Pairs, adjsted for route overlap

	2009	2010	2011	2012	2013
Gol + Webjet	510	545	614	555	514
Azul + Trip	367	484	679	754	716

Source: The Authors, prepared witth ANAC Data.

4. Results and Discussion

This section has three subsections: the first presents the qualitative results of non-transitive TFP calculations for Gol, Webjet and their combined results, and Azul, Trip and their combined results, and the results of the transitive TFP calculation, allowing for comparisons with competing, non-merged airlines, Tam and Avianca. The second subsection exhibits a qualitative analysis of the mergers and the last subsection draws conclusions based on the two previous analysis.

4.1. Quantitative Analysis

The main goal of this article is to evaluate the impact of the acquisition of Webjet by Gol, and the merger of Azul and Trip, on the productivity of the domestic operations and to compare their productivity with the competing, non-merged airlines. To answer the questions proposed in the introduction, two different TFP calculations were conducted. Non-transitive TFP (constrained to airlines that unified their operations), with the use of the Tornqvist index, to compare intra-entity results along the database, and transitive TFP, with the use of multilateral procedure index, that allows for comparisons among different entities.

Table 4 shows the efficiency of Gol and Webjet (until the purchase in 2012) and of Azul and Trip as separate entities (until the merger in 2013) and as a combined entity after the merger (the data of the combined airlines before the merger represent the sum of inputs and outputs). As stated in equation 11, the TFP will show better results as higher as the output index is and as low as the input index is.

Most of the TFP improvement was due to the output index improvement, which, by itself, is due to the expansion of the market. Between 2009 and 2013, Trip more than tripled its RPK while Azul multiplied its production by five on the same period. Regarding Gol and Webjet, between 2009 and 2010, both companies experienced a certain level of productivity gain, but Webjet had a better performance, mainly because of the growth in RPK (64%, while Gol had a 21% increase). In the following year Webjet experienced higher input usage, leading to a decrease in the TFP, due to a growth of 4% in the workforce (but with 35% higher personnel costs), and due to a growth of 15% on seat capacity (but with 43% higher capital costs).

From the database used for the calculations (shown in Appendix A), a few considerations may be outlined for the TFP behavior during the pre-merger period: the growth in Azul´s input quantity index may be justified by the startup characteristic of the airline in the early years of the database. The airline´s sales effort, which in the database is the services input, was 3% higher than Trip´s in the 5 years that preceded the merger (17% to 14%). Azul´s cost of capital (incurred expenses per offered seat) was also higher than Trip´s on the same period (11% compared to 8,7%), due to the use, by Trip of cheaper, used ATR aircraft when compared to Azul´s new Embraer aircraft. Fuel use also represented higher costs for Azul (39% compared to Trip´s 31%).

Taken as a single entity, the TFP of Azul and Trip combined rose by 87,5%. The immediate effects of the merger regarding the efficient use of inputs were dichotomic: on the 3 first years following the merger, the TFP worsened by, respectively, 2%, 6% and 1%. On the other hand, it showed a strong resilience during the Brazilian economic recession, growing 7% on the TFP in 2016, bringing efficiency levels to those of pre-merger.

From the database used for the calculations, a few considerations may be outlined for the post-merger TFP behavior: the main reason for the reduction in the TFP on the three years that followed the merger was the increase on the costs of capital (costs of

provided seats) by some 51% (with an increase of only 4% on aircraft seats) between 2014 and 2015, due to the depreciation of the Brazilian currency in 2014 (9%), 2015 (41%) and 2016 (5%). The currency depreciation also drove an increase in the materials inputs. The services input, which refers to overhead and selling expenses, averaged 14% and 16% of total expenses for Trip and Azul, respectively. Post-merger, this proportion fell to 12,5% of total expenses, allowing for a successful reduction of the overhead, non-production related expenses.

When analyzing the purchase of Webjet by Gol, a noticeable loss of productivity occurred in both airlines in the two preceding years of the acquisition, 2011 and 2012. The operation granted immediate effects on the efficiency of the combined entity, allowing it two grow in the two following years in 25%. In the first year the efficiency gain was due to better input usage, namely a reduction in more than 20% of the workforce, while in the following year the efficiency gain came from better production (in both passengers and cargo segments). In 2016 the company experienced a new loss in its TFP, due to a substantial, outlier increase in the services input, and to a reduction of about 5% in cargo and passenger demand. In the opposite direction to what happened after Azul and Trip´s merger, Gol experienced a significant growth in the services input in the years that followed the acquisition, meaning an increase in non-operational, overhead expenses.

The non-transitive TFP calculations for the combined entities of Azul and Trip and Gol and Webjet allow for the following conclusions: i) from the non-operational standpoint, the merger was much more successful than the acquisition. Azul and Trip truly experienced synergy gains, which can be seen from the behavior of the services input, which had its index number reduced from 0,81 in the pre-merger period to 0,62 in the post-merger period. In terms of percentual value, the use of this input reduced from 15,5% to 12,6% over the total expenses. After the acquisition of Webjet, the services input index grew from 1,0 to 1,1, and in percentual terms the use of this input grew from 16,1% to 17,5% over the total expenses. ii) regarding the efficient use of operational inputs, the acquisition of Webjet brought immediate TFP gains due to the reasons stated above, while the combined entity of Azul and Trip experienced a productivity loss in the years following the merger, mainly due to the depreciation of the Brazilian currency. However, during the Brazilian economic crisis, Azul seemed to be more resilient, showing better TFP results.

Table 4: non-transitive TFP calculation for Azul+Trip, Gol+Webjet and their combined entities

	Azul			Trip			Azul + Trip		
Year	***output index***	***input index***	**TFP**	***output index***	***input index***	**TFP**	***output index***	***input index***	**TFP**
2009	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00
2010	2,02	1,63	1,24	1,78	1,24	1,43	1,95	1,47	1,33
2011	3,35	2,63	1,27	3,11	1,83	1,70	3,27	2,28	1,44
2012	4,19	3,21	1,31	4,57	2,08	2,20	4,30	2,72	1,58
2013	5,56	4,70	1,18	3,93	1,22	3,23	5,09	3,00	1,70
2014							5,28	3,17	1,66
2015							5,45	3,50	1,56
2016							5,17	3,34	1,55
2017							5,57	3,37	1,66
2018							6,07	3,24	1,88
	Gol			**Webjet**			**Gol + Webjet**		
	output index	***input index***	**TFP**	***output index***	***input index***	**TFP**	***output index***	***input index***	**TFP**
2009	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00	1,00
2010	1,21	1,07	1,13	1,64	1,08	1,51	1,25	1,08	1,16
2011	1,32	1,17	1,13	1,79	1,30	1,38	1,37	1,19	1,15
2012	1,28	1,17	1,09	1,66	1,28	1,30	1,32	1,19	1,11
2013							1,22	1,05	1,17
2014							1,32	0,97	1,36
2015							1,33	1,03	1,29
2016							1,25	1,15	1,09
2017							1,30	0,97	1,34
2018							1,34	1,02	1,31

Source: Calculated by the Authors.

Table 5 presents the transitive TFP results, calculated by the multilateral index procedure, which allows for comparative computations among competing airlines. As mentioned in the methodology section, the four remaining airlines in the Brazilian domestic market are now divided in two groups: those that can be considered dominant in the beginning of the period of analysis, namely Gol and Tam, and those that can be considered incumbents, Azul and Avianca. The objective of the transitive calculation differs from the non-transitive, therefore Gol and Webjet and Azul and Trip were treated, from the beginning, as single entities. Table 3 exhibits the transitive (therefore comparable among entities) TFP evolution for the leading companies on the beginning of the database. For the dominant companies, the TFP values were normalized at Tam, 2009, and both airlines increased their productivity: Tam in 48% and Gol in 35%, reaching similar productivity levels in their domestic operations in 2018. Both companies experienced an efficiency loss during the economic slowdown of 2016 (lower output index). For the incumbent companies, the TFP values were normalized at Avianca, 2009. Avianca´s TFP rose by 304% (TFP index increased from 1 to 4,04) and Azul´s by 144% (TFP index increased from 1,48 to 2,92).

The database used for the calculations shows that, from 2015 to 2016, Tam´s domestic operations experienced an 11% RPK loss, followed by a loss of revenue of 6,5%. That came along a 12% RTK loss, followed by a loss of revenue of 9,5%. The multilateral productivity index corroborates improved TFP levels for Gol, following Webjet´s acquisition. Lower input indexes in 2013 and 2014 were essential for Gol´s TFP gains. Having that said, the better productivity levels reached by Gol were not outstanding, at least when compared to its main competitor: matter of fact, during the whole period of analysis, Tam had better results in both output (1,37 in 2014, compared to Gol´s 1,35 in 2011) and input (0,88 in 2015, compared to Gol´s 0,89 in 2017) indexes, and also on the whole TFP (1,52 in 2015, compared to Gol´s 1,46 in 2014).

Evidence shows that the acquisition of Webjet brought, in fact, almost immediate productivity gains for Gol, especially from the better input usage, in the years that followed the business combination. However, none of these gains came from lower overhead, non-operational expenses. Additionally, especially when compared to a competitor of similar scope, these efficiency gains were, to some extent, modest.

For the incumbent airlines, results show that both airlines increased their productivity during the period of analysis. The main reason for the productivity rates was the market expansion, allowed by a growth in RPK, between 2009 and 2018, of 5,1 times for Azul and 7,9 times for Avianca, which experienced better productivity due to lower use of the materials input.

The materials input refers to expenses priced in US dollars, such as maintenance, and navigation and airport charges, among others. Avianca better performance was because Azul has incurred, since 2014, in expensed priced in US dollars, because of its US operations, while Avianca started its international operations only in 2017. As for the effects of the Azul-Trip merger, as calculated the Tornqvist index, there were no extraordinary productivity gains regarding production-related inputs. Most of the

productivity gains obtained by the company were due to overhead synergies, which led to lower services input usage. Having that said, the change in the competition outlook caused by the merger might have contributed to the growth in the output index.

Summing up the results of the transitive TFP calculation for the Brazilian airlines in their domestic operations, all companies experienced efficiency gains. TFP showed an increase of at least 35% (Gol), reaching 304% (Avianca). Tam and Azul experienced gains of 48% and 144%. All four Airlines had their performances improved by market conditions that were, most of the time, favorable. However, these better market conditions were especially favorable to incumbent airlines, as proven by the improvement of the output index of Azul and Avianca.

Table 5: Transitive TFP calculation - dominant airlines and incumbent airlines

Year	output index	input index	TFP	output index	input index	TFP
dominant airlines, normalized at TAM, 2009						
	Tam			**Gol**		
2009	1,00	1,00	1,00	0,99	0,92	1,07
2010	1,16	1,09	1,07	1,23	0,98	1,26
2011	1,26	1,33	0,95	1,35	1,08	1,25
2012	1,36	1,26	1,08	1,30	1,08	1,20
2013	1,35	1,12	1,21	1,20	0,96	1,26
2014	1,38	1,06	1,30	1,30	0,89	1,46
2015	1,34	0,88	1,52	1,31	0,95	1,38
2016	1,19	0,89	1,34	1,24	1,06	1,17
2017	1,16	0,79	1,47	1,28	0,89	1,44
2018	1,18	0,79	1,49	1,32	0,94	1,41
incumbent airlines, normalized at Avianca, 2009						
	Avianca			**Azul**		
2009	1,00	1,00	1,00	2,05	1,38	1,49
2010	1,27	1,04	1,23	4,01	2,02	1,98
2011	1,79	1,47	1,21	6,74	3,12	2,16
2012	3,26	1,65	1,97	8,85	3,71	2,38
2013	4,41	1,99	2,22	10,47	4,10	2,56
2014	5,47	2,14	2,56	10,86	4,34	2,50
2015	6,25	2,33	2,68	11,21	4,68	2,40
2016	7,15	2,22	3,23	10,62	4,39	2,42
2017	8,33	2,40	3,46	11,46	4,43	2,58
2018	8,98	2,22	4,04	12,48	4,27	2,92

Source: Calculated by the Authors.

4.2. Qualitative Analysis

The reduction in capacity and the focusing on a smaller number of city pairs by Gol is an example of how efficiency gains can be interpreted in many ways for entities involved in business combinations, including not only players but industry regulators and competition agencies as well. While Azul combined its productive capacity with Trip´s and reduced non-productive expenses Gol had a focus of obtaining operating rights (slots) eliminating competition and focusing on flying a smaller number of routes in constrained, more profitable airports (Rocha, 2020) such as Guarulhos and Santos Dumont, while virtually eliminating a direct competitor.

While this study limits its scope on not analyzing tariffs on each individual route, it is worth noting that in the period between 2009 and 2012 Webjet´s average ticket prices were 29% lower than Gol´s (R$ 351 and R$ 495, respectively), while Trip´s average ticket prices were 10% higher than Azul´s (R$ 413 and R$ 373, respectively), according to ANAC (2022).

As previously stated, the Brazilian domestic aviation market experienced an increase in market concentration between 2008 and 2018, as a result of market developments, along with the M&A operations studied in this article. In the case of these business combinations, CADE´s antitrust remedies were the same. As Santos-Dumont airport was the only constrained airport that could still sustain operations of an additional airline similar in size to Webjet, Gol had to comply with an 85% compliance of in time performance of its total slots held at the airport (CADE, 2012). Post-merger with Trip, Azul would have to fulfill that same requirement, for the same reason, along with being obligated to end Trip´s codeshare agreement with Tam (CADE, 2013).

4.3. Conclusions

This article had the goal of analyzing the impact of the business combinations between Gol and Webjet and Azul and Trip on the productivity of the domestic operations of these airlines, comparing these impacts on the productivity of other competing companies. The intent was to clarify if business combinations are indeed followed by efficiency gains.

The evidence show that all the Brazilian airlines included in the database had a significant increase on their productivity, regardless of being part of a horizontal merger or not. Most of the productivity gains come from the TFP side, mainly because of market expansion, but also because a rationalization of input usage.

Even with the increased productivity of all players, merged or not, results show that in fact, both the acquisition of Webjet by Gol, and the merger between Azul and Trip brought efficiency gains to the combined airlines. However, the sources of these efficiency improvements were different: while in the case of the purchase of a competitor and the ceasing of its operations, the gains came from reducing available seats and cutting manpower by more than 20%, in the case of the merger of previous competitors the gains

came from reducing non-operating expenses, namely administrative and selling expenses, from better use of inputs and from higher load factors.

The main limitation of this study was the frequency of the disclosure of data required by the model: number of available seats and number of employees were disclosed only once per year. The differences of consolidation criteria and disclosed data between ANAC and the airlines also pose, to some extent, a limitation. One possible way around this constraint is the use of data dedicated to the financial markets, such as investor relations´ reports. These are consistent, comparable, high standardized data, and are usually disclosed every quarter. This option, however, was not available for this study given the fact that, among the six airlines studied, Gol was the sole public company during the whole period.

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<**Erro! A referência da hiperligação não é válida.**>

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