# Multi-Airport Systems in Brazil: A Study of the Evolution of Supply and Demand on the São Paulo and Rio de Janeiro Systems

## Embry-Riddle Aeronautical University

### Aviation Management Program – Class of 2020

EMBRY-RIDDLE
Aeronautical University
CENTRAL & SOUTH AMERICA

# MULTI-AIRPORT SYSTEMS IN BRAZIL: A STUDY OF THE EVOLUTION OF SUPPLY AND DEMAND ON THE SÃO PAULO AND RIO DE JANEIRO SYSTEMS

by

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A Capstone Project Submitted to Embry-Riddle Aeronautical University in Partial Fulfillment of the Requirements for the Aviation Management Certificate Program

Embry-Riddle Aeronautical University
Sao Paulo, Brazil
November 2020

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This Capstone Project was prepared and approved under the direction of the Group's Capstone Project Chair, Dr. Leila Halawi
It was submitted to Embry-Riddle Aeronautical University in partial fulfillment of the requirements for the Aviation Management Certificate Program

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November 2020

Acknowledgments

This project would not have been possible without the support of many people. We would like to thank our advisor, Dr. Leila Halawi, for her guidance, patience, encouragement, and committed assistance during our capstone experience.

We are very thankful for *Serviço Social do Transporte e Serviço Nacional de Aprendizagem do Transporte* (SEST SENAT), *Instituto de Transporte e Logística* (I.T.L.), and *Associação Brasileira das Empresas Aéreas* (ABEAR) for funding, supporting, and providing the facilities for this incredible course. We want to extend our sincere appreciation to our colleagues, professors, and employees of Embry-Riddle Aeronautical University (ERAU). These people made this journey very distinctive for us, sharing their knowledge, skills, time, and experiences.

We extend our deepest gratitude to our companies, co-workers, leaders, and teams for the opportunity to embrace this expedition and for the support provided during the last fifteen months, and for our classmates that shared unique moments and experiences with us.

We also owe a big ""thank you"" to all our families, partners, and friends for their everlasting love and support while enduring this process with us. Your endless encouragement brought us energy when we needed it most.

Abstract

Group: Bruno de Paula Balan, Maria Cláudia Cunha, Renan Cipriano da Cunha

Title: Multi-Airport Systems in Brazil: A Study of the Evolution of Supply and Demand on the São Paulo and Rio de Janeiro Systems

Institution: Embry-Riddle Aeronautical University

Year: 2020

Multiple factors affect a passenger's choice for the airport of origin and destination. However, many studies related to price formation or demand behavior leave one interesting factor behind, the existence of more than one airport in the same region, giving more than one option to the passenger. Two important multi-airport systems in Brazil were the object of this study: São Paulo (Congonhas and Guarulhos) and Rio de Janeiro (Santos Dumont and Galeão), the largest demand generating centers in the country, as well as two of the most important distribution centers of flights from South America. Using public databases presenting the evolution of supply and demand from 2013 - 2018, the evolution of flights and the sales by airlines in the same period, we estimated a linear model using panel data on a multiple linear regression with fixed effects. One of the results obtained is that healthy competition between airlines generates a positive effect on prices for consumers, the industry, and tourism, vital for the country.

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## Chapter I

## Introduction

Multiple factors affect a passenger's choice for the airport of origin and destination. These factors vary from personal interest, convenience, location, public transportation, access time to a destination, income, age, previous experience, whether it is a business trip or leisure, the existence of direct service or connection, infrastructure, marketing campaigns, to incentives. Also, prices are some of the factors that influence a passenger when purchasing a ticket.

One of the most exciting factors that could affect passengers' choice is more than one airport in the same region. Despite its relevance, it is always left out in studies by economists related to price formation or demand behavior, for example, as seen in Harvey (1987) and Dresner et al., 1996.

Borenstein (1989) investigated the impact of greater competition in the formation of airline ticket prices. The competition metrics, as share, the Herfindal-Hirschman Index (HHI)[1], and other market concentration indicators, only contemplated competition at the route-market level (Borenstein, 1989). However, throughout the 2000s, Loo (2008) and Ishii et al. (2009) considered nearby airports as competition factors and, therefore, price formation.

However, it is essential to mention that price formation is relevant for measuring a given market's competition and prices. It also impacts traffic flow patterns, ground-holding standby operation, traffic control, cargo flow competition, aircraft rerouting, rescheduling, airport investments, and competition aircraft rerouting rescheduling, airport investments,

[1] The Herfindahl-Hirschman Index (HHI) is an indicator of the level of competition in the industry, based on each organization market share. This index shows the concentration of the market and level of competition.

and competition, aircraft rerouting rescheduling, airport investments, expansion plans, and infrastructure.

**Project Definition**

This study evaluates some of the leading indicators associated with performance in cities with more than one airport. These indicators can influence passengers' choice and the offer - contributing to several stakeholders in the entire air process (authorities, airports, and airline companies).

The strong growth of the aviation sector over the last few decades is directly related to the development of the economy and the times of peace and globalization that we are witnessing. However, this growth is uneven across regions. While several areas still suffer from the lack of air service and the regional aviation frontier has not yet been overcome, several cities have more than one airport in their region, like New York with three primary airports: John F. Kennedy (JFK), La Guardia (LGA), and Newark (EWR).

More than one airport in the same region contributes to the socio-economic development of the catchment area (Fiuza and Pioner, 2009). This situation creates more significant business opportunities, better infrastructure for the region, generates fewer constraints for the growth of airports (Bonnefoy et al., 2008). It also diversifies the number of passengers’ options and allows companies' better organization, favoring the air system's competition and stability.

Like London, Tokyo, Paris, and New York, metropolitan regions have a complex airport system, allowing passengers and airlines greater freedom of choice. According to De Luca (2012), there are 59 Multi-Airport Regions (MAR) globally, with 25 in Europe, 19 in North America, eight in the Asia-Pacific region, four in South America, and three in the Middle-East, as shown in Table 1.

Table 1

*Cities with more than one airport worldwide*

| World Region | Metropolitan Region | Country | Number of Primary Airports | Number of Secondary Airports |
|---|---|---|---|---|
| Asia – Pacific | Osaka | Japan | 2 | 1 |
| | Tokyo | Japan | 2 | 0 |
| | Hong Kong | China | 2 | 0 |
| | Shanghai | China | 2 | 0 |
| | Taipei | China | 2 | 0 |
| | Seoul | South Korea | 2 | 0 |
| | Bangkok | Thailand | 2 | 0 |
| | Melbourne | Australia | 1 | 1 |
| Europe | London | United Kingdom | 2 | 3 |
| | Manchester | United Kingdom | 1 | 3 |
| | Glasgow | United Kingdom | 2 | 1 |
| | Belfast | United Kingdom | 2 | 0 |
| | Dusseldorf | Germany | 2 | 2 |
| | Berlin | Germany | 2 | 1 |
| | Frankfurt | Germany | 1 | 1 |
| | Hamburg | Germany | 1 | 1 |
| | Stuttgart | Germany | 1 | 1 |
| | Paris | France | 2 | 1 |
| | Milan | Italy | 2 | 1 |
| | Pisa | Italy | 2 | 0 |
| | Bologna | Italy | 1 | 1 |
| | Rome | Italy | 1 | 1 |
| | Venice | Italy | 1 | 1 |
| | Amsterdam | Netherlands | 1 | 2 |
| | Moscow | Russia | 2 | 1 |
| | Barcelona | Spain | 1 | 2 |
| | Vienna | Austria | 1 | 1 |
| | Brussels | Belgium | 1 | 1 |
| | Copenhagen | Denmark | 1 | 1 |
| | Oslo | Norway | 1 | 1 |
| | Stockholm | Sweden | 1 | 2 |
| | Gothenburg | Sweden | 1 | 1 |
| | Istanbul | Turkey | 1 | 1 |

*Table 1: Continued*

| | | | | |
|---|---|---|---|---|
| North America | Los Angeles | United States | 1 | 4 |
| | New York | United States | 3 | 1 |
| | Washington | United States | 3 | 0 |
| | San Francisco | United States | 2 | 1 |
| | Boston | United States | 1 | 2 |
| | Tampa | United States | 1 | 2 |
| | Miami | United States | 2 | 0 |
| | Norfolk | United States | 2 | 0 |
| | Chicago | United States | 1 | 1 |
| | Cleveland | United States | 1 | 1 |
| | Dallas | United States | 1 | 1 |
| | Detroit | United States | 1 | 1 |
| | Houston | United States | 1 | 1 |
| | Orlando | United States | 1 | 1 |
| | Philadelphia | United States | 1 | 1 |
| | San Diego | United States | 1 | 1 |
| | Toronto | Canada | 1 | 1 |
| | Vancouver | Canada | 1 | 1 |
| | Mexico | Mexico | 1 | 1 |
| South America | São Paulo | Brazil | 2 | 1 |
| | Belo Horizonte | Brazil | 2 | 0 |
| | Rio de Janeiro | Brazil | 2 | 0 |
| | Buenos Aires | Argentina | 2 | 0 |
| Middle East | Tehran | Iran | 1 | 1 |
| | Tel Aviv | Israel | 1 | 1 |
| | Dubai | UAE | 1 | 1 |

*Note.* Adapted from "Evolution and Development of Multi-Airport Systems: a Worldwide Perspective" by Phillipe A. Bonnefoy Author, Richard de Neufville Author, and R. John Hansman Author, 2010, Journal of Transportation Engineering, p.3.

## Project Goals and Scope

Brazil comprises three metropolitan areas considered multi-airport regions: São Paulo, Rio de Janeiro, and Belo Horizonte, as highlighted in Figure 1. This study will focus on São Paulo and Rio de Janeiro.


*Figure 1*. Brazil airports map from ANAC. Source: Observatório Nacional de Transporte e Logistica, 2019. Highlights made by the authors.

These regions are significant economic and population centers in the country. The greater area of São Paulo comprises 12.3 million and about 44% economically active community, being served by Congonhas Airport (IATA CGH; ICAO SBSP), Governador André Franco Montoro International Airport - Guarulhos (IATA GRU; ICAO SBGR) and Viracopos/Campinas International Airport (IATA VCP; ICAO SBKP). Rio de Janeiro population consist of 6.7 million people and 37.7% of the economically active population, being served by Tom Jobim International Airport – Galeão (IATA GIG; ICAO SBGL) and

Santos Dumont Airport (IATA SDU; ICAO SBRJ) and Belo Horizonte, with 2.5 million people and 58.2% of the economically active population, served by Tancredo Neves International Airport – Confins (IATA CNF; ICAO SBCF) and Carlos Drummond de Andrade Airport – Pampulha (IATA PLU; ICAO SBBH).

The Brazilian airline sector has undergone several changes over the past few years, being the main one the deregulation experienced amid the 1990s, followed by its tariff liberalization in the early 2000s. Those changes resulted in ending the reference prices defined by the aeronautical authority and allowing price discrimination in a broad way (without lower and upper limits for ticket prices).

The change of legislation entitled the emergence of new Brazilian airlines with different marketing strategies from traditional companies: GOL (founded in 2001), with its low-cost model, and Azul (founded in 2008).

The new regulatory scenario, combined with the changes in the demand that emerged during the 2000s, also led to the definition of new routes, increased competition, a drop in the average value of airfares, and an increase in passengers' number transported.

The growth in demand, measured through the Revenue per Kilometer (RPK) metric, tripled the number of passengers transported (the RPK grew 276% over the period). While the supply growth, obtained through the Available Seats per Kilometer (ASK) metric, although high, was lower - 170%, as shown in Figure 2.

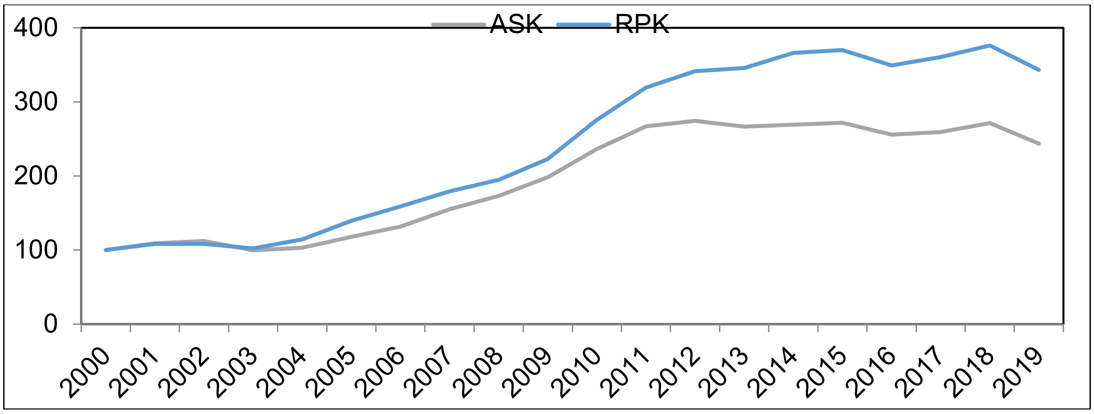


*Figure 2.* Domestic Supply (ASK) and Demand (RPK) Evolution. ANAC

The significant growth in demand increased airlines' efficiency, increasing the load factor (RPK and ASK), which went from 57% in 2002 to 81% in 2018 (Figure 3).

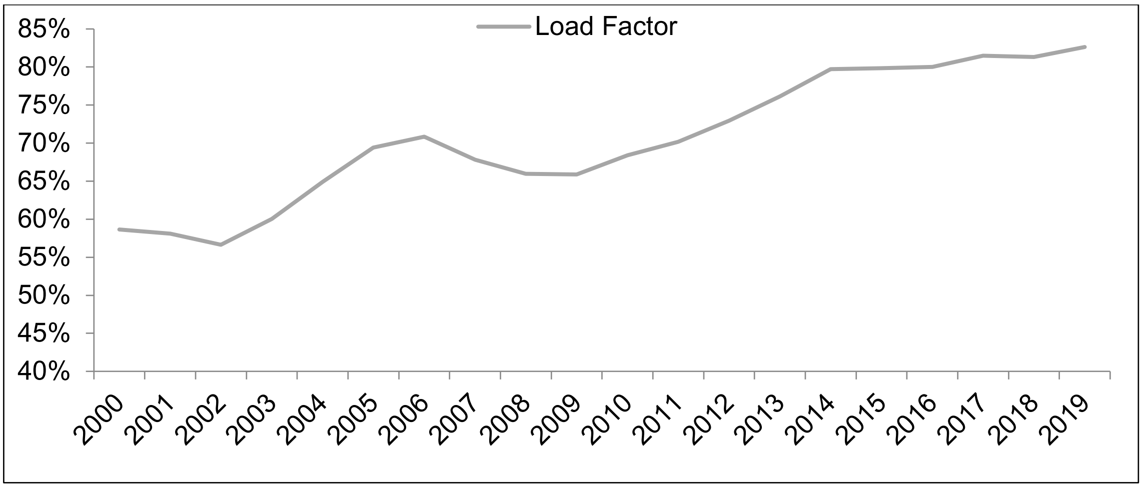


*Figure 3.* Evolution of Load Factor / Occupancy Rate (ANAC)

Regions with more than one airport in Brazil concentrate around 65% (2019) of all demand and supply in the Brazilian airline sector. This percentage has grown over the last few years, especially after 2012.

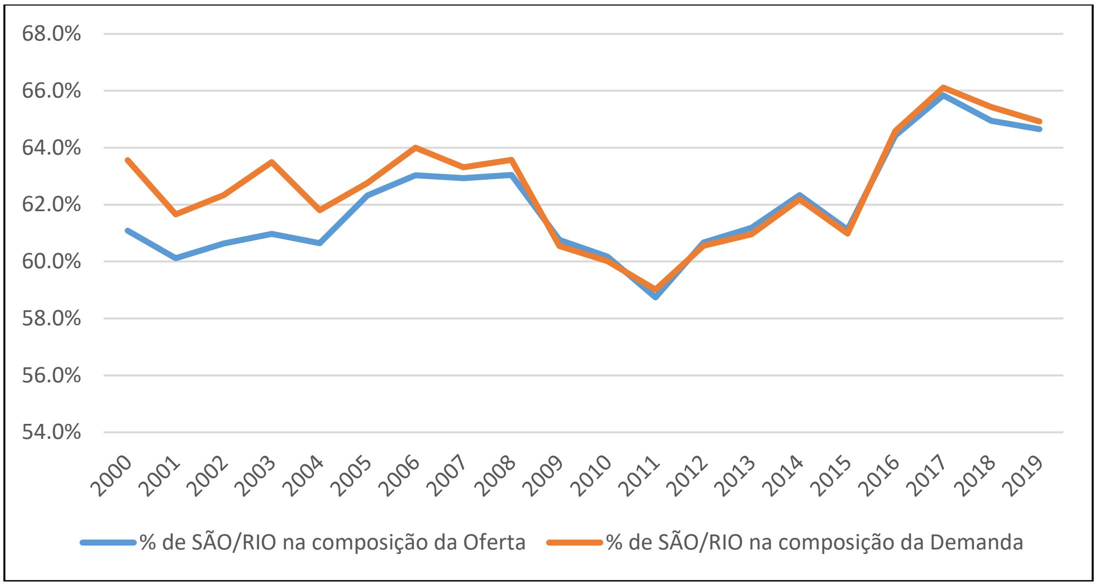


*Figure 4.* Evolution of ASK Index (2000 = 100) - Domestic - Brazil

As shown in Figure 4, the share of the regions of São Paulo and Rio de Janeiro in the overall composition of domestic supply and demand in Brazil has increased considerably since 2012, from 60% to approximately 65% in 2019. Figure 4 presents how concentrated the market is in the composition of the Brazilian ASK.

The competition and supply factors will be addressed in Chapter IV. We will explain the main factors that impact the airlines' supply strategy and the choice to operate at more than one airport in a given region, also showing the evolution of the leading operational indicators (ASK, RPK, cargo, number of flights, and regularity), and how it impacts the network definition in airlines.

Chapter V will present the main factors that impact the airports' demand, studying overlapping markets, average Fare, competition in the ticket fare composition, and linking to studies of applied economy.

In chapter VI, we will present the conclusion of the studies performed.

**Definitions of Terms**

| | |
|---|---|
| ASK | Measures the total flight passengers' capacity when multiplying the total number of available seats and the total distance traveled. |
| HHI | An index of the concentration of the market and level of competition |
| MAS | Metropolitan areas served by more than two important airports (MAR or MAC) |
| RPK | Calculated based on a multiplication of the number of revenue passengers and the total distance traveled. |
| Stage Length | Average distance flown per aircraft departure |

**List of Acronyms**

| | |
|---|---|
| ASK | Available Seats per Kilometer |
| BRL | Brazilian Real (currency) |
| CGH | São Paulo Congonhas Airport |
| GIG | Rio de Janeiro International Airport – Galeão |
| GRU | São Paulo International Airport – Guarulhos |
| HHI | Herfindahl-Hirschman Index |
| MAC | Multi-Airport Cities |
| MAR | Multiple Airport Regions |
| MAS | Multi-Airport Systems |
| RIO | Rio de Janeiro |
| RPK | Revenue per Kilometer |
| SAO | São Paulo |
| SDU | Rio de Janeiro Santos Dumont Airport |

# Chapter II

## Review of the Relevant Literature

### Concept of Multiple Airport Regions

The concept of Multiple Airport Regions (MAR), Multi-Airport Systems (MAS) or Multi-Airport Cities (MAC) is found in literature as a group of two or more major commercial airports in a metropolitan area (Nayak, 2012); a major commercial airport visited by at least two million passengers per year (Wandelt et al., 2017), without regard to ownership or political control over individual airports (Richard, 2004 and Hu et al., 2008). The same definition is found in Perdana and Moxon (2014): airports that, regardless of ownership or political influence, compete in a metropolitan region to serve air traffic.

The additional definition indicates that the MAS is a group of airports serving airline traffic in a metropolitan area. The airport is Part of a MAS if it is close to an existing major/primary airport or if local authorities officially designate it (Richard, 1995),

The definition can be summarized as two or more airports that focus on civil, commercial traffic, serving urban areas, presenting an increase in passengers' numbers through the system (Attaalla, 2019).

Two specific mechanisms are responsible for a single-airport system become multi-airport: an existing airport emerges as a secondary airport of the region and the construction of a new airport, where passenger and aircraft traffic is partially or transferred in its totality, as mentioned by Bonnefoy et al. (2008).

Many cities are served by more than one airport, usually to avoid congestion. In other cities, the multi-airport system may be built to meet specific uses, such as dividing international and domestic flights (Attaalla, 2019).

**Key Factors that Influence Passengers and Airlines Choices in Multi-Airport Systems**

Several studies before the 2000s have already analyzed the factors of passenger choice in a region with more than one airport, as Harvey (1987), Doganis et al. (1987), de Neufville (1995), Cohas et al. (1995), and Windle and Dresner (1995).

Literature indicates that passengers chose airports in a multi-airport system based on a series of the level of services features, as

- reasons for the trip (whether leisure or business);
- easy access to an airport, with passengers preferring closer airports and shorter access times (effects were found in Harvey (1987), Pels et al. (2003), Hes and Polak (2005), Ishii et al. (2009). In general, despite impacting both leisure and business passengers, accessibility is a crucial factor, especially for business passengers;
- predictability of travel (airports in regions with volatile traffic are less preferred than airports that are accessed through public transportation on rails and/or a lesser variation in access time)
- frequency and schedule of air services: the more diverse the frequency of a given airport and the better the times (the hours of greater demand are closer), the greater the interest in using that airport (Loo, 2008; Ishii et al., 2009)
- regularity and punctuality of operations;
- airfares and the presence of a low-cost carrier, especially for leisure passengers (Hess and Polak, 2005, Dresner et al., 1996);
- type of service (whether direct or connecting flights): the existence of a direct service increases the likelihood that a passenger will choose that airport compared to an airport that only offers a service with a connection to the desired destination, as seen at Souza (2010);

- loyalty programs (and the presence of a specific airline at a given airport): primarily for business or frequent passengers, the fact of a particular airline at an airport is a factor of choice for the airport to be chosen;
- airport access and infrastructure (Gjerdåker et al., 2008; Dobruszkes et al., 2011), which reduces access time to the airport and can affect passengers' choice - especially in the presence of means of faster and cheaper transport;
- cost of access to a given airport: especially for leisure passengers, the cost of transportation from a given airport is considered at the time of your choice;
- borders between countries (Paliska et al., 2016)

It is essential to highlight that the cited studies focus on passenger choice factors, leaving aside, for example, which factors directly impact the airlines' selection and financial strategies.

Regarding airlines and airport authorities' choice, one of the factors explored in the literature is the size (and degree of homogeneity) of a given airport's catchment area, as seen in Lieshout (201, p.27). The catchment area is defined as the airport's service area that attracts passengers. Its size depends on the factors that drive the passengers'' passengers' choice of the airport (accessibility, fares, and frequency of flights) compared with other airports in the area. This area's size will also impact the airport market share and the primary or secondary airport classification.

The degree of heterogeneity (demand, income, and destination profiles sought) of a given region affects the catchment area, adding uncertainty and oscillation in time and space (Lieshout, 2012).

Despite the existence of more than one airport in a region, they do not necessarily substitute - this was the result of Brueckner et al.'s (2014) study when concluding that not all airports in the same region are replaceable and will impact the performance of the other airport. In this article, the authors highlight three significant factors to explain the degree of substitutability: the existence of a shuttle service between airports and the city center, the mix of services between airports (if, for example, an airport is focused on low-cost carriers or if both are carrier airport; which can affect, among other factors, the airlines' network and pricing strategy) and the type of Market served and nature of the trip (long or short-haul, regional or international).

**Multi-Airport Systems Worldwide**

Figure 5 presents multi-airport systems globally, totaling 59 MAS, based on ICAO's database (2008).

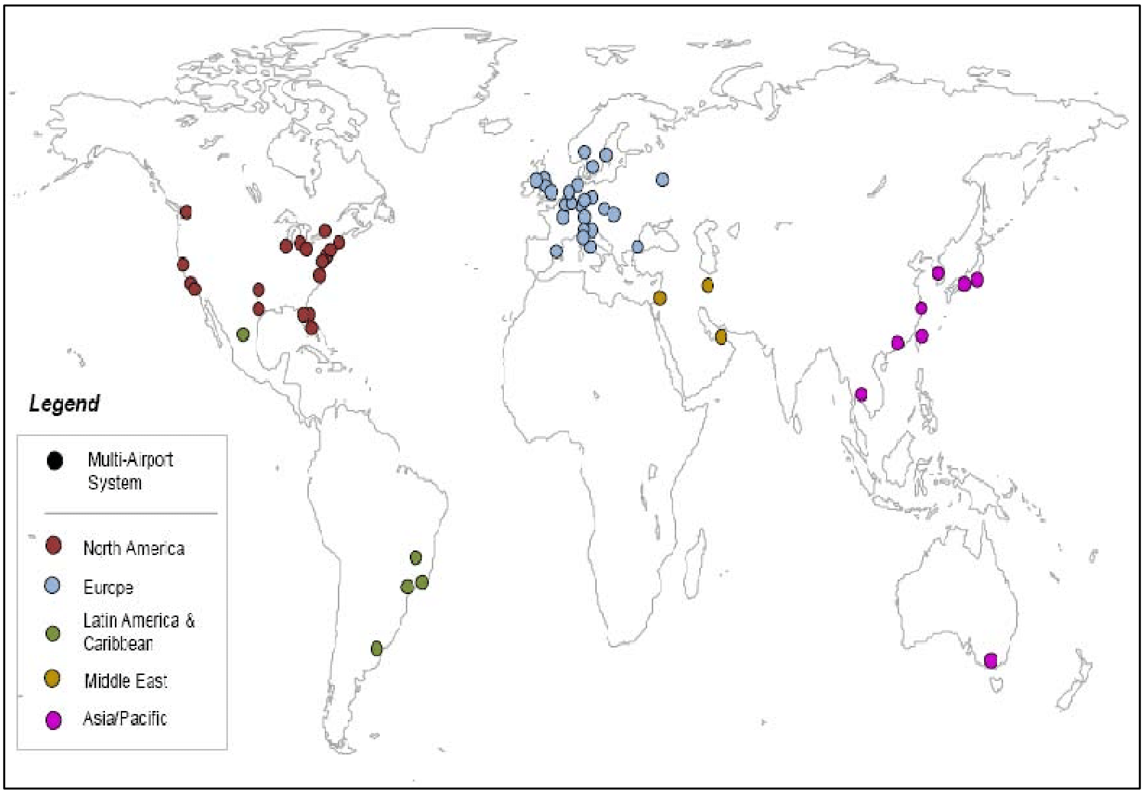


*Figure 5.* Multi-Airport Systems Worldwide, Hu et al. (2008)

The North-American Market usually emerges as one of the leading centers for these studies, not only due to the presence of several regions with more than one airport in the United States, but also due to the diversity of these regions, competition, and availability of data, as mentioned by Attaalla (2019) and Abreu et al. (2017). Some examples of studies performed in this Market are Basar and Bhat (2004), Pels et al. (2003), Hess and Polak (2005), and Ishii et al. (2009).

Other relevant MAS studies are performed in England. Specifically, the Greater London area, as seen at Pels et al. (2009) and Hess and Polak (2006), with six operational airports, which, according to Chandrakanth (2015), are the busiest airport globally, both in aircraft and passenger volume.

Many other MAS were studied, as Japan (Usami et al., 2017), Hong Kong (Loo, 2008), Taiwan (Yang et al., 2014), and South Korea (Jung and Yoo, 2016).

**Multi-Airport System in Brazil**

Airports are distributed uniformly throughout Brazilian territory as all major cities have at least one airport. However, there are only a few airports with regularly scheduled flights and a combination of regular routes along the coast of the country, where most of the population is concentrated (ANAC, 2016).

Table 2

*Airport Network in Brazil, per state.*

| State | Airports | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | **Federal** | **State** | **Municipal** | **Concession** | **Private** | **FAB (Air Force)** | **Brazilian Army** | **Total** |
| Acre | 2 | 0 | 9 | 0 | 0 | 0 | 0 | **11** |
| Alagoas | 1 | 0 | 4 | 0 | 0 | 0 | 0 | **5** |
| Amapá | 1 | 0 | 4 | 0 | 0 | 0 | 0 | **5** |
| Amazonas | 3 | 3 | 6 | 0 | 0 | 0 | 0 | **12** |
| Bahia | 2 | 0 | 1 | 5 | 0 | 0 | 0 | **8** |
| Ceará | 1 | 0 | 24 | 1 | 0 | 0 | 0 | **26** |
| DF (Capital) | 0 | 0 | 0 | 1 | 0 | 0 | 0 | **1** |
| Espirito Santo | 1 | 0 | 6 | 0 | 0 | 0 | 0 | **7** |
| Goiás | 1 | 0 | 25 | 0 | 0 | 0 | 0 | **26** |
| Maranhão | 4 | 0 | 30 | 0 | 0 | 0 | 0 | **34** |
| Mato Grosso | 1 | 0 | 40 | 0 | 0 | 0 | 0 | **41** |
| Mato Grosso do Sul | 3 | 0 | 20 | 0 | 0 | 0 | 0 | **23** |
| Minas Gerais | 7 | 0 | 36 | 4 | 0 | 0 | 0 | **47** |
| Pará | 6 | 0 | 22 | 0 | 0 | 0 | 0 | **28** |
| Paraíba | 2 | 0 | 13 | 0 | 0 | 0 | 0 | **15** |
| Paraná | 4 | 0 | 39 | 0 | 4 | 0 | 0 | **47** |
| Pernambuco | 3 | 0 | 10 | 0 | 0 | 0 | 0 | **13** |
| Piauí | 2 | 0 | 8 | 0 | 0 | 0 | 0 | **10** |
| Rio de Janeiro | 4 | 0 | 10 | 2 | 2 | 3 | 0 | **21** |
| Rio Grande do Norte | 0 | 0 | 7 | 0 | 1 | 0 | 0 | **8** |
| Rio Grande do Sul | 4 | 0 | 65 | 0 | 0 | 0 | 0 | **69** |
| Rondônia | 1 | 3 | 5 | 0 | 0 | 0 | 0 | **9** |
| Roraima | 2 | 0 | 7 | 0 | 0 | 0 | 0 | **9** |
| Santa Catarina | 3 | 0 | 17 | 4 | 1 | 0 | 0 | **25** |
| São Paulo | 3 | 21 | 30 | 8 | 10 | 3 | 1 | **76** |
| Sergipe | 2 | 0 | 2 | 0 | 0 | 0 | 0 | **4** |
| Tocantins | 2 | 0 | 15 | 0 | 0 | 0 | 0 | **17** |
| **Total** | **65** | **27** | **455** | **25** | **18** | **6** | **1** | **597** |

*Note.* Adapted from Dias and Lopes, 2019 apud Infraero, 2019.

As observed by Dias and Lopes (2019), São Paulo has the more significant airport network in the country and the highest number of passengers transported. Together with Rio de Janeiro, both cities are considered the most important in entering and exiting the country by air, since they concentrate most on Brazil's international flights (Brito, 2017).

Table 3

*Busiest Airports in Brazil (2019)*

| Ranking Position | Airport | IATA / ICAO | Multi-Airport System | Passengers (2019) |
|---|---|---|---|---|
| 1 | Guarulhos | GRU / SBGR | São Paulo | 42.248.207 |
| 2 | Congonhas | CGH / SBSP | São Paulo | 22.281.896 |
| 4 | Galeão | GIG / SBGL | Rio de Janeiro | 13.518.783 |
| 5 | Confins | CNF / SBCF | Belo Horizonte | 10.734.359 |
| 6 | Viracopos | VCP / SBKP | São Paulo | 10.199.171 |
| 7 | Santos Dumont | SDU / SBRJ | Rio de Janeiro | 8.933.777 |

*Note.* The table elaborated by the authors, using statistical data extracted from ANAC (2019).
*The city in position 3 (Brasilia) was excluded because it is not relevant for the Multi-Airport System study.

**The Main Multi-Airport Systems of Brazil: Rio de Janeiro and São Paulo**

The air travel between Rio de Janeiro and São Paulo (40-45 minutes flight) was set in the early days of Brazilian commercial aviation. The high frequency only intensified after the Second World War, as the aircraft supply became larger and cheaper (Abreu et al., 2017). It was not only until 1959 that the shuttle network model was implemented between SDU and CGH airports. This air connection is currently among the world's four busiest connections, with 40 thousand annual flights.

In the first year of operation of the shuttle flights, 388,000 passengers were transported, while in 2019, 26.5 thousand passengers were transported daily (INFRAERO, 2019). According to ANAC (2018), the average ticket fare in 2018 was BRL 262.31.

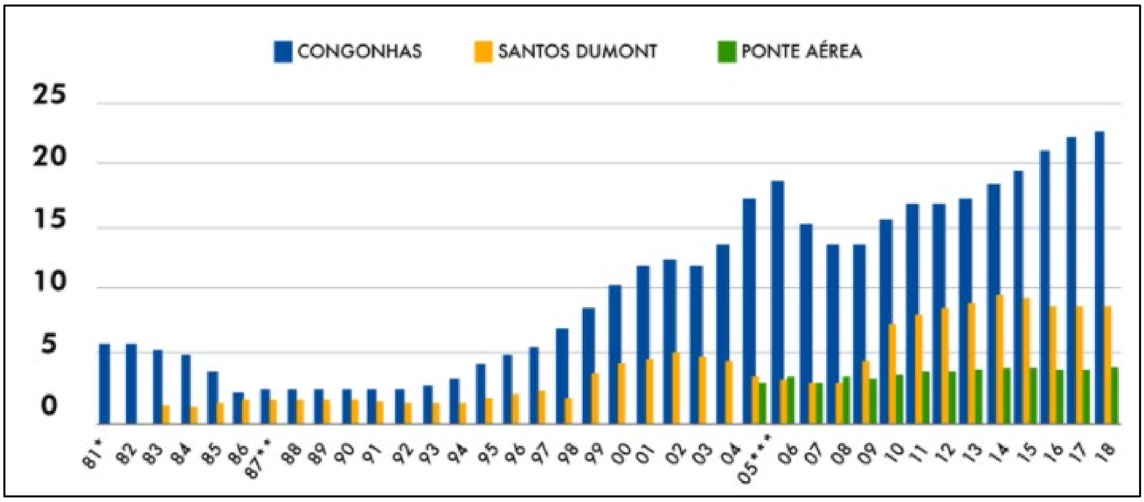

*Figure 6.* Passenger Traffic between Rio de Janeiro and São Paulo (in million). INFRAERO (2019).
**Ponte Aérea* is the Portuguese translation for Shuttle-Flight.

In 2018, the Brazilian National Civil Aviation Secretariat (S.A.C./Minfra) had studied the profile of the shuttle-flights passenger, described as, mainly, business travelers: 56% are male, and 44% female; 40,5% are between 31 and 45 years old, and 50,6% of the passengers are traveling for work/studies (INFRAERO, 2019).

**Rio de Janeiro Muti-Airport System**

***Santos Dumont Airport.*** Santos Dumont Airport (SDU), founded in 1936 and currently administrated by INFRAERO, was the first airport to offer commercial/civil flights in Brazil exclusively. It is one of the busiest airports in the country due to two main factors: the shuttle-flights between Rio - São Paulo and being strategically located in the city center, close to headquarters of large companies, financial institutions, and the port area, providing easy access to passengers, especially for those traveling on business. The shuttle-flights represent 40% of the flights (ANAC, 2019), and its traffic comprises about 4 million passengers annually, about half of the total passenger capacity of the airport (9,9 million) (INFRAERO, 2019).

***Galeão International Airport.*** Tom Jobim International Airport – Galeão (GIG), founded in 1952, is the second busiest airport in Brazil in international traffic, managed by the RIOGALEAO concessionary. It is located in Rio de Janeiro, about 20 kilometers from the city center, has the largest airport site in total area, and the most massive commercial runway in the country, making it the most crucial gateway for Rio de Janeiro (RIOGALEAO, 2020).

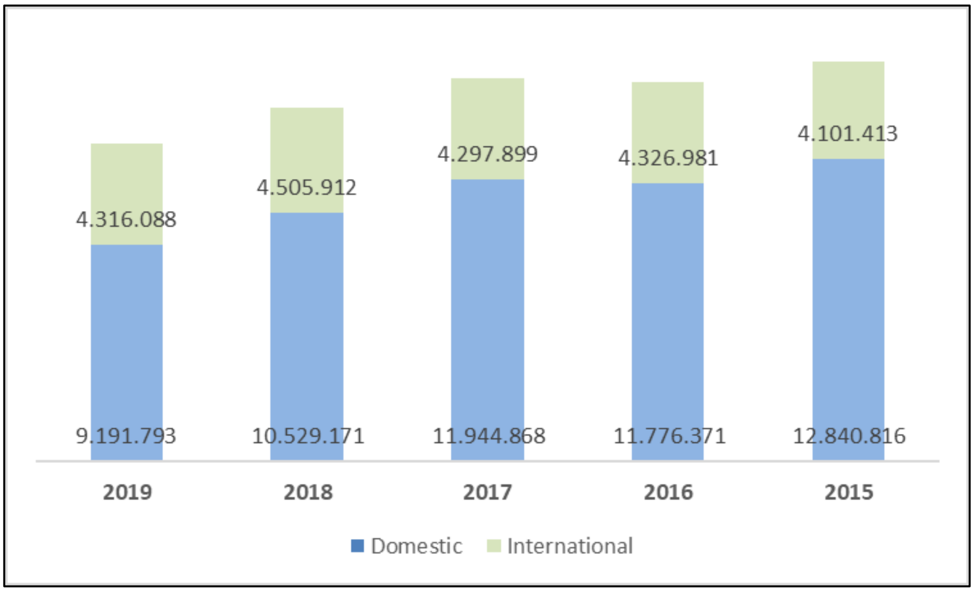


*Figure 7.* Passengers Traffic in Galeão. Adapted using data extracted from RIOGALEAO, 2020.

**São Paulo Multi-Airport System**

The MAS of São Paulo was already studied by Moreno and Müller (2003, 2004), who also considered the two airports in São Paulo Metropolitan Region (CGH and GRU).

***Congonhas Airport***. Congonhas Airport (CGH) was founded in 1936, is managed by INFRAERO, and is located 8,7 kilometers from the city center. It has the most significant traffic of executives in the country, with passengers annual capacity of 17,1 million (INFRAERO, 2019), due to its proximity to São Paulo's financial center, shuttle-flights with Rio de Janeiro, and essential connections to Brasília (BSB), Belo Horizonte (CNF), Porto Alegre (POA) and Curitiba (CWB).

The airlines' excellent competition for slots in CGH is explained by the high demand for air transportation to Brazil's main destinations. The higher the demand, the fares also tend to be higher, turning the operation very profitable for companies.

***Guarulhos International Airport***. One of the main hubs in Latin America, Guarulhos International Airport (GRU), founded in 1985, is managed by GRU Airport concessionary comprised of three passengers connected terminals and one cargo terminal 24 hours/day.

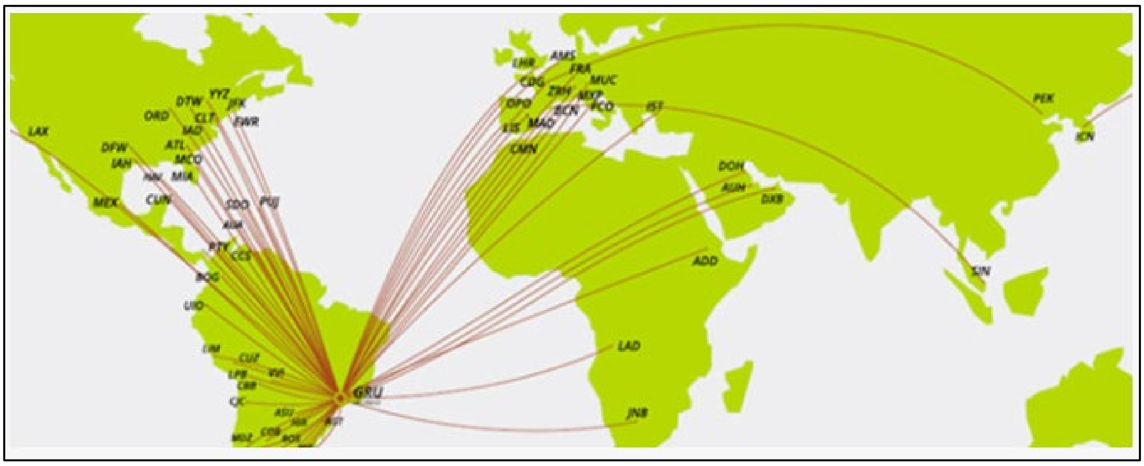


*Figure 8.* Guarulhos - Main Hub in Latin America for International Flights. GRUAirport (2020).

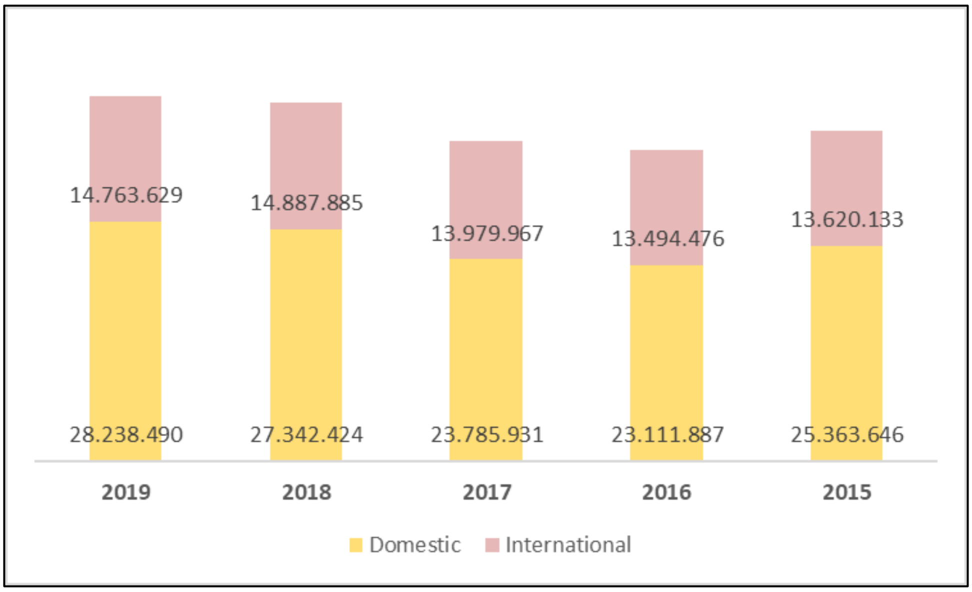


*Figure 9.* Passengers Traffic in Guarulhos. Adapted from GRU Airport, (2020).

## The relation between Supply, Demand, Network Definition, and the Price Formation

A subject widely studied by economists regarding price formation is the relationship between market structures and their impact on prices. Due to its price discrimination dynamics and competitive dynamics, the air market is one of the world's most studied.

One of the main factors in price composition - and exhaustively explored by academic literature - is the impact of greater market concentration on prices. The relationship found in all studies always points to an inverse relationship between competitiveness and prices: the higher the level of competition, the lower the level of average prices practiced; the more concentrated, the higher the average price level (Borestein, 1989; Bilotkach & Lakew, 2014; Gerardi & Shapiro, 2009; Cunha, 2020).

However, those studies do not contemplate the impact of changing supply in a substitute airport B, for example, for a metropolitan region in the pricing composition of airport A.

***Airline Network Models.*** According to the manufacturer Boeing and Istanbul Technical University, airline networks can have different structures (Figure 10): point to point, hub operation, and network operation, which comprises multiple hubs.

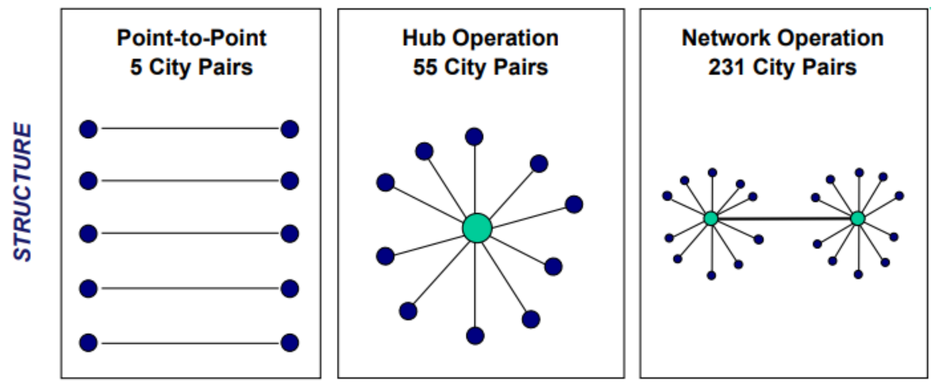


*Figure 10.* Network Planning Structures. Boeing, Istanbul Technical University (2016)

To define the best network strategy, the airlines will have to undergo different Market, fleet, and market segment analysis to evaluate the best schedule combination and network structure for their customer (Figure 11), considering:

- Market Analysis: long-term strategic planning forecasting, which will orient airline capacity, evaluating future demand, market trends, macroeconomic fluctuation, and competition movements, to assess what industry opportunities exist for the company.
- Long Term Schedule Planning: evaluates market segments it will focus on to optimize flight timing, route schedule, market seasonality, airport/authority regulations to ensure correct capacity allocation to maximize revenue.
- Fleet Evaluation: determine the best fleet mix considering the type of network structure the airline will operate, what customer and market characteristics the airline will target, and what type of routes it will fly.

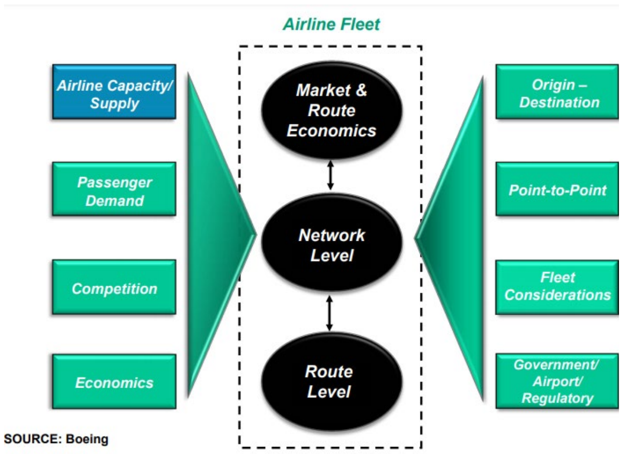


*Figure 11*. Network and Fleet Planning Evaluation. Source: Boeing, Istanbul Technical University (2016)

Airlines can use different network structure models to meet the diverse needs of the markets they operate. All regular passenger operations worldwide converge into one of the three construction models: Hub and Spoke, Point-to-Point and Shuttle, Network Operation (Cook and Goodwin, 2008; Boeing 2016).

***Hub and Spoke.*** "It requires flights from different airports (spokes) to land at the hub simultaneously. Aircraft are on the ground simultaneously" (Doganis, 2012).

This model is mainly used by traditional airlines (legacy carriers) that have one or more destinations as a large distribution center for flights (hubs) spread across a region and serve from them different destinations (spokes) and generate connectivity between cities of different sizes and geographic regions (Figure 12).

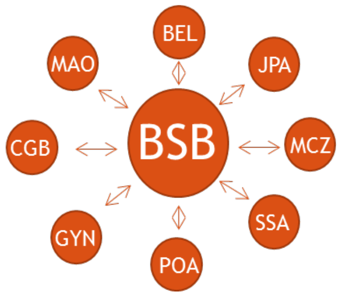


*Figure 12.* Represents the opportunity to connect multiple spokes using BSB as a hub. Authors (2020)

Results achieved from the hub and spoke model are summarized in:

- Serve more origin and destination routes through a single hub base. In this way, the company can meet various customers' needs to travel in the shortest possible time between several different cities, generating greater access to multiple revenues. In this model, the results of the network as a whole and the individual contribution of flights to the network are easily tracked since the maintenance of a loss-making flight can be important to contribute to the maintenance of supply to other profitable destinations;
- Risk reduction of launching new services, as from the moment a new destination is connected to a city that acts as a hub, the new plethora of itineraries can be built to improve revenue;

- Expand the attractiveness of schedules for destinations already served, generating a more competitive product, as it is common for larger and established hubs to have more daily flights on several routes, making it more attractive to some customer segments (Figure 13);
- Generate economies of scale since a hub's fixed costs, such as overhead, facilities, equipment, infrastructure, gates, handling, and maintenance, can be prorated in various daily operations.

| Airline | Flight # | Origin | Departure Time | Destination | Arrival Time | Equipment |
|---|---|---|---|---|---|---|
| DL | 1633 | ATL | 0650 | MCO | 0816 | 757 |
| DL | 2672 | ATL | 0750 | MCO | 0921 | 757 |
| DL | 2483 | ATL | 0850 | MCO | 1019 | 757 |
| DL | 2425 | ATL | 0950 | MCO | 1130 | 757 |
| DL | 2420 | ATL | 1055 | MCO | 1225 | 757 |
| DL | 2400 | ATL | 1155 | MCO | 1325 | 757 |
| DL | 2918 | ATL | 1255 | MCO | 1423 | 757 |
| DL | 2274 | ATL | 1355 | MCO | 1527 | 757 |
| DL | 2360 | ATL | 1455 | MCO | 1625 | 757 |
| DL | 2324 | ATL | 1555 | MCO | 1722 | 757 |
| DL | 2422 | ATL | 1655 | MCO | 1825 | 757 |
| DL | 2335 | ATL | 1800 | MCO | 1934 | 757 |
| DL | 2436 | ATL | 1900 | MCO | 2030 | 757 |
| DL | 2490 | ATL | 2030 | MCO | 2204 | 757 |
| DL | 2588 | ATL | 2130 | MCO | 2301 | 757 |
| DL | 2533 | ATL | 2230 | MCO | 0002 | 757 |

*Figure 13.* Delta Air Lines competitive flight schedule from Atlanta (ATL) to Orlando (MCO) for August 5th,2021, showing hourly departures pattern. Authors using Cirium database (OCT20)

However, generating a volume of operations in a hub presents excellent challenges as operational constraints, difficulty in expansion, and future investments:

- As each new route added in a hub and spoke model to a new destination, a greater need for investment in aircraft allocation needs a dedicated aircraft to take advantage of the bank of connections' connectivity. Using the route map shown in Figure 12 as an example, a linear programming simulation was performed. The group found that to make two daily flights in all those markets generating connections between them, eight aircraft would be needed. Each would make four landings and four takeoffs, totaling a system with 32 daily departures.

- Less utilization of the fleet, as it is common for aircraft in hubs and spokes systems to have long ground time to ensure the completeness of all customer connection routes and their luggage, demanding, even more, ground time, consequently reducing the number of hours available for flight;
- The concentration of flights in a time frame, such as longer check-in queues and safety inspection channels, lack of sufficient positions for aircraft parking, congestion in air traffic control and runway systems, taxiways, and apron, in addition to the lack of slots to serve all operators in some of the most critical time banks (Figure 14);


*Figure 14.* Intense air traffic demand on United Arab Emirates airspace due to the simultaneous arrivals and departure waves due to its global hub status. FlightRadar (2019)

***Point to Point and Shuttle.*** "The simplicity of the point-to-point architecture that connects each origin and destination through a nonstop flight" (Embry-Riddle, 2008).

This model is most used by low-cost (LCC) and ultra-low-cost (ULCC) airlines. Its main characteristic is the s system's simplicity aiming at direct flights between different cities, avoiding connections and complex structures (Figure 15).

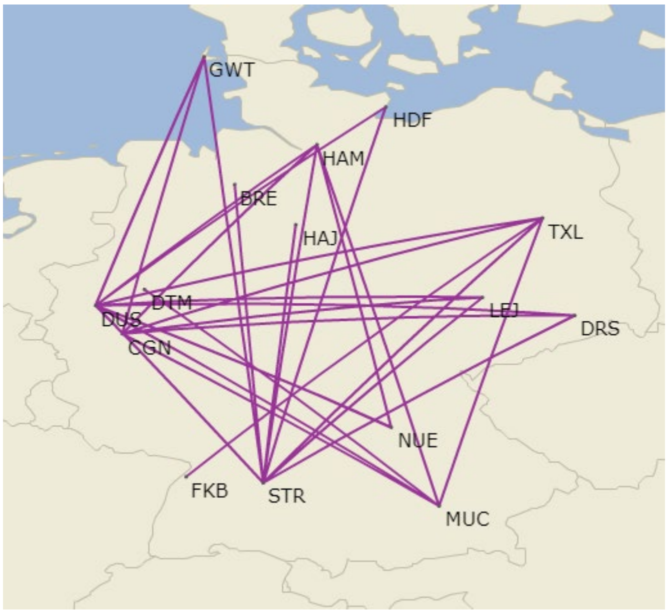


*Figure 15.* Represents opportunity to fly non- stop with German low-cost carrier Eurowings from multiple cities in Germany without using a connecting hub. Authors using Cirium database from August 2019 (2020)

Geographically, it is common to find in regions of high demographic density, with greater income distribution and wide geographical distances, is commonly applied by companies in the United States and Europe and regions in Asia. The simplicity of these companies' fleet is essential to maintain low cost and a higher operating margin. The main advantages of this model are:

- Shorter total travel time, as companies prioritize direct flights from point A to point B without the need for intermediate connections, guaranteeing a more competitive product for customers who want to travel between these locations;
- Lower dilution of the average Fare, since there are no connections in this network model, the total revenue that the customer pays is allocated on that single non-stop itinerary, avoiding pro-apportioning of revenue between different flights;

- Lower unit cost, which can mean lower prices and greater travel incentives in the Market with direct flights;
- Since the aircraft's schedule, greater efficiency in the use of the aircraft does not need to wait for connectivity from other flights at airports during congested hours. This ensures a more competitive turn-around time for this network model. Using the route map shown in Figure 15as an example, the group did a linear programming simulation and found that to be able to make one daily flight in all those non-stop markets, only two aircraft would be needed. Each would make seven landings and seven takeoffs, totaling one system with 26 daily departures.

The main disadvantage of this network construction model is associated with the inherent risk of operating in markets without a feed of any other place, which generates pressure for individual routes. Besides that, there may not be enough demand and income distribution in developing countries to guarantee this air network model's success.

"Most LCC's try to combine low fares with high frequencies, which are attractive to the corporate market" (Doganis, 2005).

Shuttle markets can be a variation that occurs within the two network construction models presented above. In this model, companies allocate resources to operate dense markets with many daily frequencies, connecting banks or local customers.

It mainly serves the high demand for corporate customers traveling between two cities, usually in the same country, but there are shuttle cases between different nations. Among the main advantages of the shuttle model, the high frequency of flights in shuttle markets is the most important one since it guarantees the company a competitive position with corporate customers, which are less price-sensitive and willing to pay higher fares on short notice due to the nature of the business trip. Among the main points of attention, it is important to highlight:

- The price level tends to be lower during off-peak hours since the corporate public is characterized by trips in the morning and the late afternoon, which can generate overcapacity and financial pressure on off-peak times (Figure 16)
- Corporate customers demand investments in more sophisticated and technological products, such as VIP lounges, seats with more space, onboard Wi-Fi connection, and responsive apps.

| Airline | Origin | Departure Time | Destination | Arrival Time | Available Fare (AUD) | Origin | Departure Time | Destination | Arrival Time | Available Fare (AUD) |
|---|---|---|---|---|---|---|---|---|---|---|
| Qantas | MEL | 0600 | SYD | 0725 | 148 | SYD | 0600 | MEL | 0735 | 148 |
| Qantas | MEL | 0615 | SYD | 0740 | 148 | SYD | 0615 | MEL | 0750 | 148 |
| Qantas | MEL | 0630 | SYD | 0755 | 148 | SYD | 0630 | MEL | 0805 | 148 |
| Qantas | MEL | 0645 | SYD | 0810 | 148 | SYD | 0645 | MEL | 0820 | 148 |
| Qantas | MEL | 0700 | SYD | 0825 | 199 | SYD | 0700 | MEL | 0835 | 199 |
| Qantas | MEL | 0715 | SYD | 0840 | 199 | SYD | 0715 | MEL | 0850 | 199 |
| Qantas | MEL | 0730 | SYD | 0855 | 199 | SYD | 0730 | MEL | 0905 | 199 |
| Qantas | MEL | 0745 | SYD | 0910 | 199 | SYD | 0800 | MEL | 0935 | 199 |
| Qantas | MEL | 0800 | SYD | 0925 | 199 | SYD | 0830 | MEL | 1005 | 199 |
| Qantas | MEL | 0830 | SYD | 0955 | 199 | SYD | 0845 | MEL | 1020 | 199 |
| Qantas | MEL | 0900 | SYD | 1025 | 199 | SYD | 0900 | MEL | 1035 | 199 |
| Qantas | MEL | 0930 | SYD | 1055 | 199 | SYD | 0930 | MEL | 1105 | 148 |
| Qantas | MEL | 1000 | SYD | 1125 | 148 | SYD | 1000 | MEL | 1135 | 148 |
| Qantas | MEL | 1030 | SYD | 1155 | 148 | SYD | 1030 | MEL | 1205 | 199 |
| Qantas | MEL | 1100 | SYD | 1225 | 199 | SYD | 1100 | MEL | 1235 | 199 |
| Qantas | MEL | 1130 | SYD | 1255 | 148 | SYD | 1130 | MEL | 1305 | 199 |
| Qantas | MEL | 1200 | SYD | 1325 | 199 | SYD | 1200 | MEL | 1335 | 148 |
| Qantas | MEL | 1300 | SYD | 1425 | 148 | SYD | 1300 | MEL | 1435 | 199 |
| Qantas | MEL | 1400 | SYD | 1525 | 148 | SYD | 1330 | MEL | 1505 | 199 |
| Qantas | MEL | 1430 | SYD | 1555 | 148 | SYD | 1400 | MEL | 1535 | 199 |
| Qantas | MEL | 1500 | SYD | 1625 | 260 | SYD | 1430 | MEL | 1605 | 199 |
| Qantas | MEL | 1530 | SYD | 1655 | 199 | SYD | 1500 | MEL | 1635 | 199 |
| Qantas | MEL | 1545 | SYD | 1710 | 199 | SYD | 1530 | MEL | 1705 | 199 |
| Qantas | MEL | 1600 | SYD | 1725 | 260 | SYD | 1600 | MEL | 1735 | 260 |
| Qantas | MEL | 1615 | SYD | 1740 | 148 | SYD | 1615 | MEL | 1750 | 199 |
| Qantas | MEL | 1630 | SYD | 1755 | 148 | SYD | 1630 | MEL | 1805 | 199 |
| Qantas | MEL | 1645 | SYD | 1810 | 148 | SYD | 1645 | MEL | 1820 | 199 |
| Qantas | MEL | 1700 | SYD | 1825 | 328 | SYD | 1700 | MEL | 1835 | 328 |
| Qantas | MEL | 1715 | SYD | 1840 | 260 | SYD | 1715 | MEL | 1850 | 328 |
| Qantas | MEL | 1730 | SYD | 1855 | 328 | SYD | 1730 | MEL | 1905 | 328 |
| Qantas | MEL | 1745 | SYD | 1910 | 260 | SYD | 1745 | MEL | 1920 | 328 |
| Qantas | MEL | 1800 | SYD | 1925 | 328 | SYD | 1800 | MEL | 1935 | 328 |
| Qantas | MEL | 1815 | SYD | 1940 | 199 | SYD | 1815 | MEL | 1950 | 199 |
| Qantas | MEL | 1830 | SYD | 1955 | 199 | SYD | 1830 | MEL | 2005 | 260 |
| Qantas | MEL | 1845 | SYD | 2010 | 199 | SYD | 1845 | MEL | 2020 | 199 |
| Qantas | MEL | 1900 | SYD | 2025 | 199 | SYD | 1900 | MEL | 2035 | 199 |
| Qantas | MEL | 1915 | SYD | 2040 | 199 | SYD | 1915 | MEL | 2050 | 199 |
| Qantas | MEL | 1930 | SYD | 2055 | 148 | SYD | 1930 | MEL | 2105 | 148 |
| Qantas | MEL | 1945 | SYD | 2110 | 148 | SYD | 1945 | MEL | 2120 | 148 |
| Qantas | MEL | 2000 | SYD | 2125 | 148 | SYD | 2000 | MEL | 2135 | 148 |
| Qantas | MEL | 2030 | SYD | 2155 | 148 | SYD | 2030 | MEL | 2205 | 148 |
| Qantas | MEL | 2100 | SYD | 2225 | 148 | SYD | 2205 | MEL | 2340 | 148 |

*Figure 16.* Australian Qantas Airways schedule of flights on its shuttle from Melbourne (MEL) to Sydney (SYD) for August 5th, 2021 showing the lowest available prices in Australian Dollar (AUD) and time of day departure. Authors using Cirium database and Qantas Airways website (2020)

***Network Operation.*** The rationale for building network operations is the same as shown above for hubs, offer multiple origins and destinations choices. This model's uniqueness is that companies choose to serve different regions of the same country with hubs in privileged geographic locations to be present in all regions and have national relevance. The flights that link these hubs are called trunks routes and are responsible for transporting the company's customers across its portfolio of destinations, connecting regions, and cities with no demand to support cross-country services sustainably other countries.

The example below (Figure 17) shows the American Airlines model in two of its main hubs. Still, companies in different countries can use the same logic within a joint-venture partnership model, or that belong to the same holding company such as Iberia, British Airways and Aer Lingus (parts of IAG holdings) that seek complementary connectivity through their hubs in Madrid, London, and Dublin, respectively.

*Figure 16.* Example of Network Operation to North America of American Airlines in August 2019 at Phoenix, AZ (PHX) represented by blue lines and Charlotte, NC (CLT) represented by red lines, displaying how they can serve complement markets from different hubs across the country. The authors using Cirium database (2020)

The relationship between market structures, network definition, and price formation was studied by Borestein and Rose (1994), who estimated the impact of market concentration relating supply variables like frequency of flight between airports, airline market share and HHI of each location; and demand, finding that a higher level of market concentration would result in less price dispersion.

However, in 2009, Gerardi and Shapiro updated the 'study's methodology and conclusions: a lower level of competition increases price dispersion.

Cunha (2020) concluded that the 2009 results are similar to the Brazilian scenario, where ” the increase in the level of market concentration gives companies greater power to discriminate prices, segmenting them more than in a scenario increased competition.”

**Summary**

Airlines are businesses of high complexity, intense need for capital, and historically low margins than other segments and industries. As one of the drivers of a company's business plan, it is necessary to define its network structure based on supply and demand. Depending on the company's network construction model, it will reap benefits and costs related to revenue, costs and directly impact its demand, investments, and the need for product adjustments.

Based on the concepts identified in the literature, it is safe to conclude that MAS is a metropolitan or urban area served by two or more commercial airports experiencing constant increases in passengers' numbers.

In those systems, an airport is considered significant (or primary) when having a capacity of more than 500,000 passengers and attending more than 20% of the total passenger traffic of the respective multi-airport region that is inserted.

The competition analysis in this system represents a topic widely discussed in the literature due to its importance for airport and airline planning. Most studies use some simpler models, encompassing only one the choice of the airport itself. In contrast, others try to represent reality more faithfully, including other dimensions in the problem (the 'passengers' choice of the modal of access to the airport and the airline, for example). Despite this, most of the conclusions obtained converge that the flight frequency, the access time, and the Fare are the most important passenger attributes.

For passengers on work trips, the cost and easy access to airports, combined with flexibility in the date and time of flights, are very important. For passengers on leisure trips, ticket fares are the most relevant factor for choosing the origin airport. The relationship between demand and supply is directly related to the price formation and difference; therefore, preferences between airports in the same area.

## Chapter III

## Methodology

Although aviation is one of the most studied sectors globally, there are few analyses of the Brazilian scenario. Part of this was due to the difficulty of accessing data. However, this has become easier over the past few years: ANAC has started to share multiple information about Brazil's civil aviation sector, allowing the carrying out of several studies for the Brazilian Market.

For this study, three databases will be used for its analysis, being two of them obtained through ANAC's website:

- "*Demanda e Oferta*" (translated as "Demand and Supply"), ANAC's official databases, which presents the evolution of supply and demand that were flown in a specific period and the evolution of important KPIs (number of seats, number of passengers, ASK, and RPK).
- Cirium database, which contains the evolution of flights and airline services by the Market;
- "*Microdados de Tarifas Aéreas*" (translated as "Airfare Microdata"), database by ANAC available online, which includes sales made by airlines in a given period (year and month).

The two most used in this study are the Cirium databases, which allow us to evaluate the evolution of the non-stop services to the airports being assessed and cities, and the "Microdados" one, which contains the evolution of demand and average sold Fare of the analyzed markets.

This ANAC database has the following format and shows us the sales made by a given airline for a given pair of airports (origin and destination) in a given month and the number of seats sold at a given fare. A preview is shown in Figure 18.

| YEAR | MONTH | ICAO AIRLINE | ICAO ORIGIN | ICAO DESTINATION | SOLD FARE | NUMBER OF SEATS SOLD |
|---|---|---|---|---|---|---|
| 2019 | 5 | GLO | SBSP | SBRJ | 67,05 | 5 |
| 2019 | 5 | GLO | SBSP | SBRJ | 69,9 | 6 |
| 2019 | 5 | GLO | SBSP | SBRJ | 78,9 | 1 |
| 2019 | 5 | GLO | SBSP | SBRJ | 79,9 | 1 |
| 2019 | 5 | GLO | SBSP | SBRJ | 84,9 | 1 |
| 2019 | 5 | GLO | SBSP | SBRJ | 89,9 | 115 |
| 2019 | 5 | GLO | SBSP | SBRJ | 92,89 | 2 |
| 2019 | 5 | GLO | SBSP | SBRJ | 92,9 | 2.187 |

*Figure 17.* Sample of “Microdados de Tarifas Aéreas” from ANAC (Cunha, 2020, p. 15)

As shown in Figure 18, in May 2019, 115 seats were sold from GOL to fly on SBSP (CGH) to SBRJ (SDU) at R$ 89,90.

It is important to note that his database contains only fares sold without discounts, private fares, or frequent flyer programs. Its coverage ranges from 40% to 50% of all seats sold in the Brazilian domestic market.

The analysis period includes the period between January 2013 and December 2018 because, during this period, there wasn’t any merger or acquisition involving the major airline companies in the country.

After all the data between 2013 and 2018 was stacked, all percentiles of sold seats for each Market allowed us to evaluate the evolution of different price ranges. The final database is an unbalanced panel, with sales information, the average sold Fare, percentiles of fares considering the seats sold on Market and time level.  To evaluate the impact of changes in the competition scenario, we added supply information, such as the number of seats available, the competition level identified by the Herfindahl-Hirschman Index, and the complementary market's competition level.

A linear model will be estimated using panel data on a multiple linear regression with fixed effects to evaluate the impact of changes in the competitive scenario on the average price level.

The panel data with a fixed effect approach is the estimation strategy in Gerardi & Sharpiro (2009). The authors evaluate the impact of the competition level in the average Fare (and its distribution e discrimination) between markets.

A panel has two dimensions: the cross-sectional one, like any other linear regression, and the time-series dimension, allowing analysis of an effect over time. In our case, it can describe competition impact over time and across multiple markets.

A panel data model, combined with fixed effects variables, allows a better bias control, controlling the omitted variable bias when a significant independent variable is omitted.

A fixed-effect variable is a group dummy that controls the differences between groups. When using a dummy variable for a specific market to explain its average Fare, it is possible to control its market's characteristics with this variable. The fixed effect condensates observable and unobservable independent variables in only one variable.

# Chapter IV

## The study of the supply

In this topic, the group addresses the characteristics of the network model of the four airports with a view of the Market and characteristics of accessibility, which are the subject of this study, to highlight the particularity of each airport from the point of view of both the passenger and the airline

**Network Construction Models in Brazil**

In Brazil, specifically in São Paulo and Rio de Janeiro, it is possible to notice different network strategies between airports. At the airports of Guarulhos (GRU) and Galeão (GIG), the use of the hub and spoke models, respectively, is more clearly presented, as characterized by some peak movement of arrivals and departures along with of some hours of the day (figures 18 and 19). This means that the airlines use these airports' structure to connect customers throughout their network and with partners' airlines.

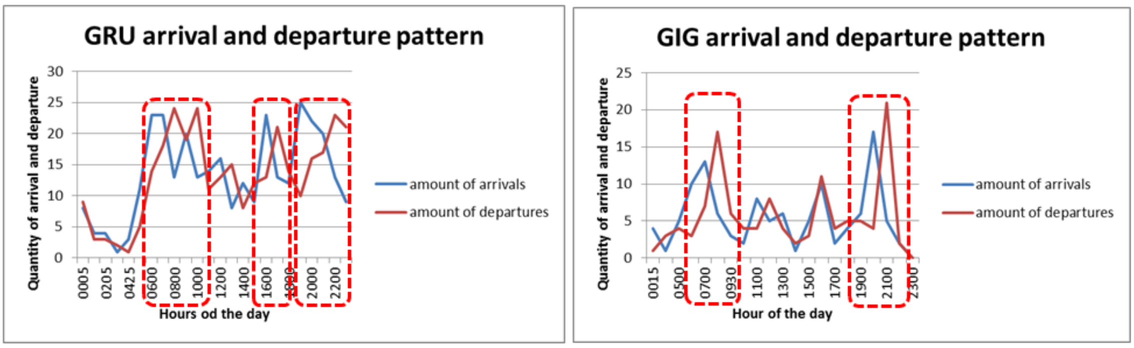


*Figure 18.* An example of arrivals and departure patterns at GRU and GIG of the three largest airlines at these airports shows strong capacity allocation trends in a hub and spoke model. Authors using Cirium database from September 2018 (2020)

On the other hand, at the major airports CGH and SDU, a point-to-point or shuttle structure is detected, mainly serving travelers' local demand to that city, characterized by the more uniform distribution of flight arrivals and departures throughout the day (Figure 20). Connection opportunities exist, as many flights at these airports can generate competitive routes for customers who want to connect from point A to point C via B, but are not intentional as the main goal is to attract local flyers.

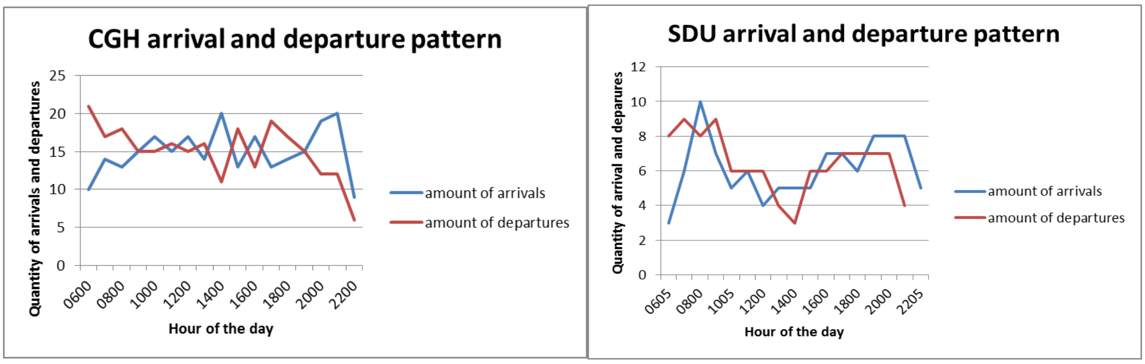


*Figure 19.* Example of arrivals and departures patterns at CGH and SDU, showing capacity allocation distributed more evenly throughout the day with no spoke in arrival and departures waves. Authors using Cirium database from September 2018 (2020)

In Brazil, the international airports in São Paulo and Rio de Janeiro are used as large centers for connections at the national and global level, while the airports located more centrally in these large metropolises have point-to-point and shuttle model networks.

**Evolution of supply in São Paulo and Rio de Janeiro**

Over the last decade, there have been important milestones that allowed for diversification and increased offer of destinations and flights in the cities of São Paulo and Rio de Janeiro.

As of April 2009, a restriction that limited the SDU airport to operations only on the CGH-SDU-CGH shuttle and flights to regional destinations with turboprop aircraft was lifted and allowed that, within the airport limitations of capacity per hour, restriction of runway length and respecting the airport's operating curfew, flights to all other regions of the country be operated with narrow-body aircraft such as Boeing 737 and Airbus A319, which generated an increase in overlap markets between GIG and SDU. This led to an increase in the number of destinations by companies that already operated at the airport

(TAM, GOL, Oceanair) and attracted the service of new companies operating jets to major national destinations, such as Webjet, Azul, and Trip.

This movement greatly benefited the accessibility of new destinations to the central airport in Rio de Janeiro. In the following years, it generated the stagnation of domestic services at GIG airport, culminating in the withdrawal of some long-haul routes operated by Brazilian flag-carrier airlines since local traffic gives preference to the SDU airport. The flow of customers connecting to other domestic destinations and abroad at GIG was insufficient to support this investment. In other words, the hub and spoke model at GIG lost forces due to the increased capacity at SDU (Figure 22).

In recent years, we can see that the number of destinations served non-stop in the city of Rio de Janeiro has remained stable, with a reduction in recent years in the number of destinations served by GIG (Figure 21).

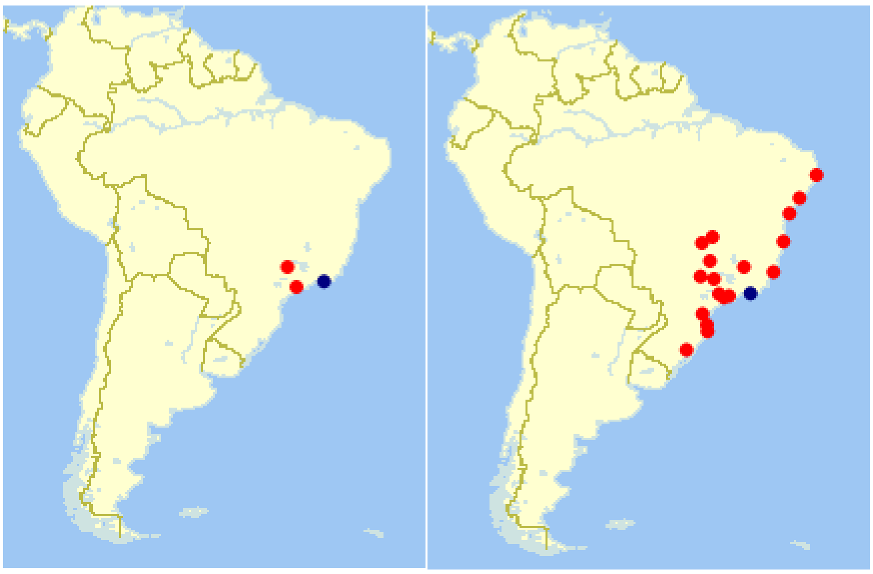

*Figure 20.* New destinations with non-stop services by jet-engine aircraft at SDU after 2009: went from 2 to 18 destinations. Authors using Cirium database (2020)

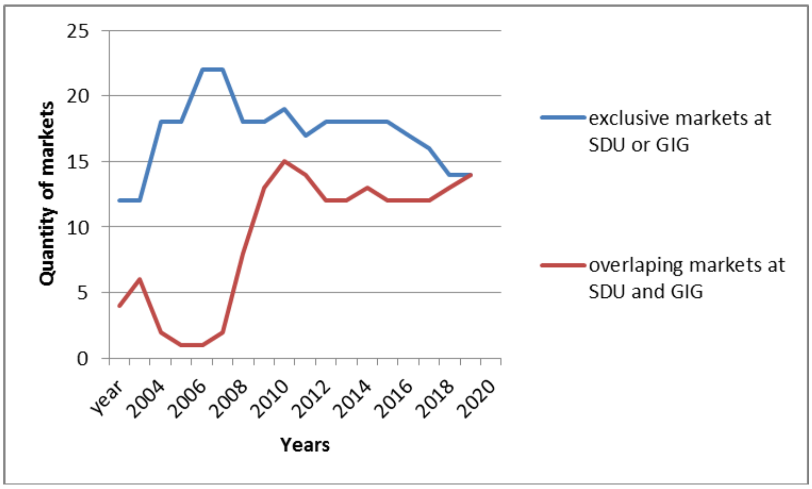

*Figure 21.* The growth of capacity to new destinations in SDU leads to a reduction at GIG. Capacity in Rio is more stable during the last decade. Authors using Cirium database (2020)

In São Paulo, the trend was the opposite of what happened in Rio de Janeiro. The number of markets with direct service to the city increased both for routes operated in the overlap and exclusive markets (Figure 23). The town gained new services to destinations that were previously not operated directly, even with the number of overlapping routes growing. We identified two factors that triggered these events:

- Until 2015, there was a technical limitation of perimeter rule that allowed direct flights from CGH to destinations up to 1500 km, leaving important cities in the country without the possibility of flights to CGH, including at least eight state capitals. With the absence of this restriction, companies immediately adapted their network to offer these services to new destinations for customers who prefer to use CGH airport (Figure 24).
- GRU flights' concentration with an increasingly larger hub and spoke network model has also enabled airlines in São Paulo to expand to new destinations, causing the city to expand its national capillarity by gaining new routes, both domestic and international, over the past few years (Figure 25).

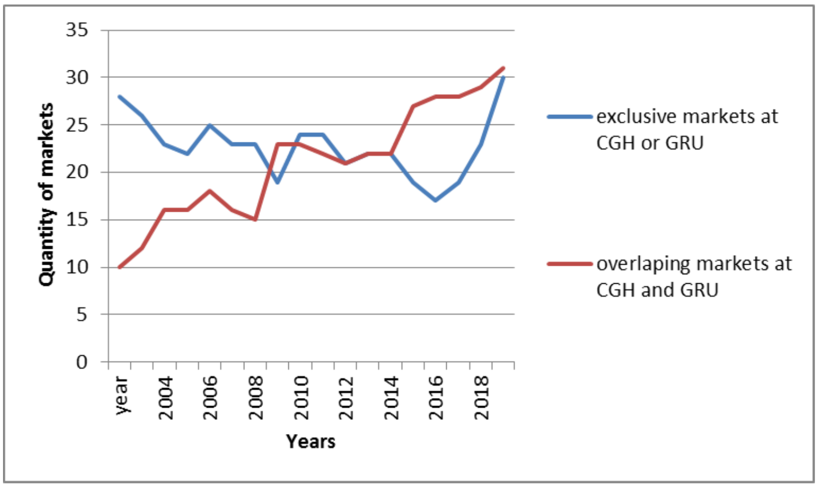


*Figure 22.* Quantity of non-stop destinations from São Paulo improving from both airports. The number of overlapping markets served both from CGH and GRU also grew during the last years. Authors (2020)


*Figure 23.* Map with a 1500km perimeter range from CGH showing capitals only reaching PMW (Palmas) and SSA (Salvador) at most. Outside of this range lie at least 8 important Brazilian capitals that gained non-stop services to CGH immediately after the perimeter rule ceased. Authors (2020)

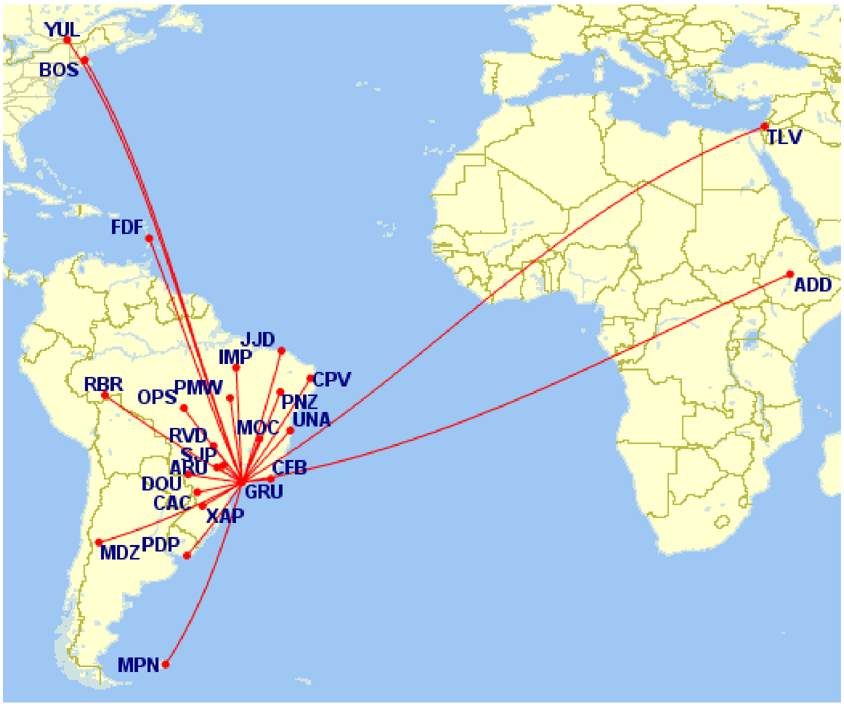

*Figure 24.* Map with new non-stop destinations from GRU that gained service over the last 5 years. Authors using Cirium database (2020)

**São Paulo and Rio de Janeiro airports' characteristics**

At GRU, over 43 million customers were handled to 103 global destinations during 2019. About 65% of the total passengers were on domestic flights, which handled more than 28 million people, being the busiest airport in the country in the number of customers for both domestic and international markets.

Due to the airport's characteristics as a major flight distribution center for the largest national airlines, and São Paulo being the largest aviation market in the country, this airport consolidates itself as the main gateway to Brazil. Its destinations are to international places. It is powered by over 53 domestic cities with more than 370 daily departures. However, GRU's location is a negative factor in the passenger's needs to travel to the main business destinations in the city of São Paulo, given the distance from the airport to these centers.

Even having a direct link with the metropolitan train line, the distance and complex logistics to reach the city's main points make the airport less attractive to a significant portion of the population.

As the second busiest airport in the country in terms of the number of passengers, CGH plays the role of gateway to much of the South, Central, and West of the city of São Paulo, where is located the largest belts population, commerce, offices and wealth. The airport's location also serves the populous south shore, thanks to its more central location in the metropolis. It is closer to expressways to the coast, making it attractive to customers who are destined for these areas. The airport operates on weekdays, with 100% of the commercial operations of scheduled air transport companies. In 2019 it handled 22,261,392 passengers (79% of the number of domestic passengers in GRU) in 243 daily departures. Even serving 15 fewer domestic destinations has the equivalent of 85% of GRU domestic seating capacity.

Despite the central location in São Paulo's city, CGH does not include any integration of modal to mass transportation by rails, an efficient solution to increase its attractiveness to the city's local customers and reduce travel time the city's traffic. After eight years of delay, a line under construction promises integration with the city's metro network scheduled to open in 2022. As it is located between dense residential areas, there is a limitation of operation, and between 11 pm and 6 am, flight operations at the airport are prohibited.

In Rio de Janeiro, GIG is the main access point to the city, mainly for international passengers, with direct connections to 53 destinations, of which 26 are abroad, from where it received more than four million passengers. This airport handled 13,507,881 passengers in 2019, with 68% of customers coming from Brazil to 27 domestic destinations. Of all four airports evaluated, this is the one with the lowest domestic seats per day (15,199).

At GIG, in addition to the greater distance factor to the main points of interest and demand generators in Rio de Janeiro, the airport suffers from a limitation of access options since public security remains a major concern for passengers who need to use unsafe expressways to get to the airport, leading many customers to avoid using its facilities, since there is an alternative airport in the central region of the city. The lack of safer and faster transport, such as a railway, also reduces traveler's attractiveness when choosing the airport.

Finally, SDU airport in Rio de Janeiro is the smallest of the four evaluated. Just over 9 million customers went through it in 2019, with nonstop services to 18 exclusively domestic destinations. This airport's main asset is its central location in the corporate center of the city of Rio de Janeiro in the downtown area. It is also close to major tourist attractions and is preferred by corporate and leisure customers, even for its convenience. Its facilities are relatively small (the terminal is only 19,000 square meters), leading to less hassle for boarding and arriving. Also, there is a wide variety of shops and hotels nearby, a new shopping center with direct access to the passenger terminal, and is the only airport of the four with a light rail line that quickly connects the passenger terminal to the city center region, which houses many offices and headquarters for some of the major Brazilian companies, as well as headquarters for several multinationals. With these facilities, it becomes the preferred airport for a portion of travelers.

In Table 4  below, we consolidate information regarding traffic, passenger movement, destinations served, amount and size of airport terminals, accessibility, distance from main places of interest in the cities, and operating curfew.

Table 4

*Comparison between the four airports of the analysis. Data refers to the entire year of 2019, except for the number of airlines, destinations, seats, and flights, which was an average of the last quarter of 2019.*

| | São Paulo | | Rio de Janeiro | |
|---|---|---|---|---|
| | **CGH** | **GRU** | **SDU** | **GIG** |
| **Total Passengers** | 22.261.392 | 43.002.119 | 9.091.258 | 13.507.881 |
| **Domestic Passengers** | 22.261.392 | 28.238.490 | 9.091.258 | 9.191.793 |
| **International Passengers** | - | 14.763.629 | - | 4.316.088 |
| **Airlines operating** | 4 | 32 | 4 | 22 |
| **Non-stop Destinations** | 38 | 103 | 18 | 53 |
| **Non-stop Destinations (Domestic only)** | 38 | 53 | 18 | 27 |
| **Daily Departures** | 243 | 379 | 140 | 118 |
| **Daily Departures (Domestic only)** | 243 | 285 | 140 | 87 |
| **Daily Seats** | 39.811 | 72.893 | 20.374 | 21.987 |
| **Daily Seats (Domestic only)** | 39.811 | 49.815 | 20.374 | 15.199 |
| **Average Seat per departure (domestic only)** | 164 | 174 | 146 | 174 |
| **Terminals** | 1 | 3 | 1 | 1 |
| **Size of all passenger terminals (in square meters)** | 64.579 | 192.000 | 19.000 | 280.000 |
| **Train or Subway lienes serving the airport** | 0 | 1 | 1 | 0 |
| **Average distance from main corporate districts (in kilometers)** | 12 | 39 | 13 | 19 |
| **Operating hours** | 6am-23pm | 24 hours | 6am-23pm | 24 hours |

## Chapter V

## The study of the demand

The period between 2013 and 2018 shows a reduction in the number of passengers sold, according to the ANAC database, leaving 52 million passengers in 2013 to 38.5 million in 2018. A reduction of about 25% in the total volume of passengers sold between 2013 and 2018, as seen in the graph below:

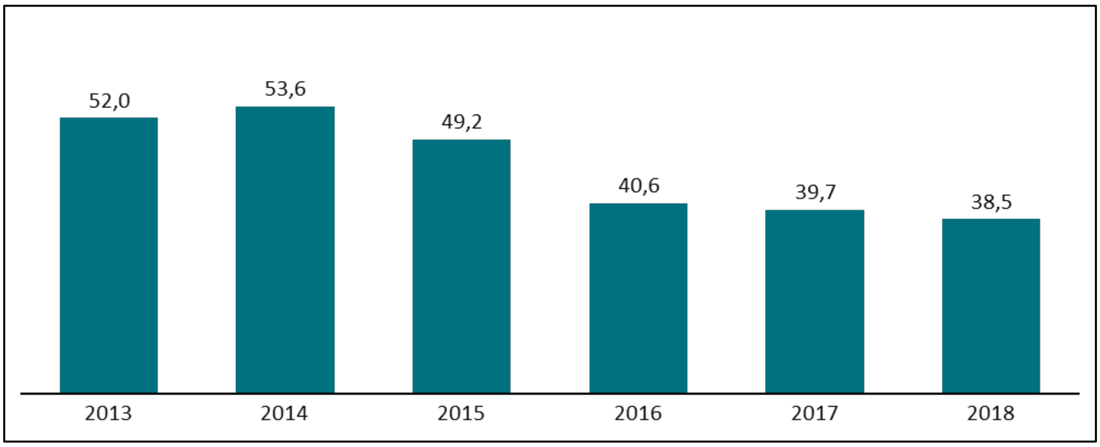


*Figure 25.* Evolution of Passengers Sold - ANAC - Domestic Market - Total - in millions

It is essential to highlight that, despite the ANAC base of passengers sold showing this reduction, when we compare the available number of passengers sold with that of passengers transported over the years 2013 and 2018, this same behavior is not seen: the number of passengers transported in 2018, in the domestic market, is 4% higher than transported in 2013.

This difference in trend between numbers (passengers sold compared to passengers transported) is due to conceptual differences between both bases and, mainly, by sampling aspects.

Conceptually, the Fares Microdata refers to the number of tickets sold in a given pair of origin and destination. The number of passengers transported made available in the ANAC Demand and Offer reports refers to passengers flown on flights. In addition to the difference between sold passengers and flow passengers, ANAC's Demand and Supply base consider passengers who have made a connection more than once (for example, a passenger flying from Porto Alegre - POA to Manaus - MAO, with a connection in GRU, at the base of passengers flown by ANAC he appears twice: once on the POA-GRU section and once on the GRU-MAO section, while in the sold passenger base this passenger appears only once on the POA-MAO section).

However, the main difference is related to the sampling concept of both bases. As stated in Chapter III, the Microdata database considers only sales made in the public environment and without discounts. With the intensification of competition over the last few years and with the maturity and greater segmentation of pricing strategies by airlines, the volume of sales of discounted fares and/or in private segments (leisure or corporate agencies) grew more than the sale of fares in a public environment, explaining why we see the drop in the number of passengers sold in the period while the Brazilian air market was stable in terms of total demand.

Although the trends are different, the database used for this work is a good proxy to understand the differences between the markets and their prices.

With that said, when we observe the evolution of the market share of SAO (origin or destination) in the composition of the total demand sold, we see a growth in participation from 28.3% in 2013 to 35.4% in 2018, while the participation of RIO and other markets declined during the period. The demand share between São Paulo and Rio de Janeiro, the busiest and most relevant market in the country, however, remained stable during the period, corresponding to about 6% of the volume of passengers sold, as shown below:

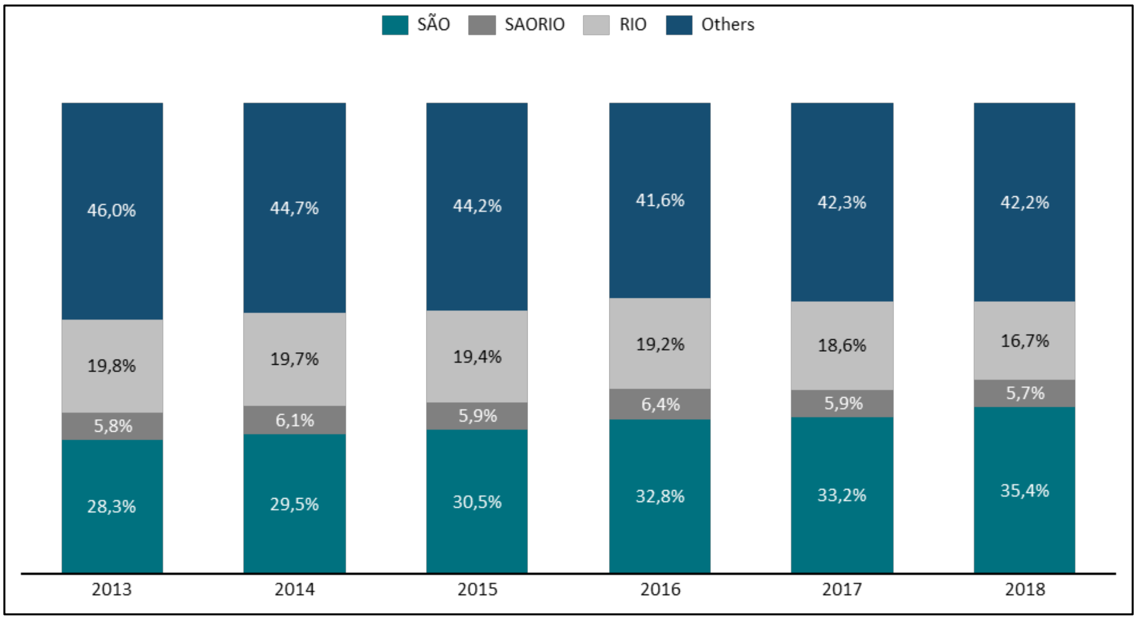


*Figure 26.* Evolution of Passengers Sold from 2013 to 2018 - Domestic Market - by City (ANAC)

Over the next sections, we will analyze the evolution of demand in São Paulo and Rio de Janeiro, the cities with more than one commercial airport in their metropolitan region, and focus on analyzing this work.

**São Paulo: Evolution of demand and the average price**

As demonstrated in previous sections, São Paulo's share, excluding connections between SAO-RIO, in the overall composition of sales, increased between 2013 and 2018.

Throughout this period, as shown in figure 29 below, there was a growth in the share of markets that originate or are destined for CGH, especially between 2015 and 2016, characterized by the increase in demand for nonstop CGH destinations. This is due to the diversification of the airport's offer, with changes in its operational restrictions.

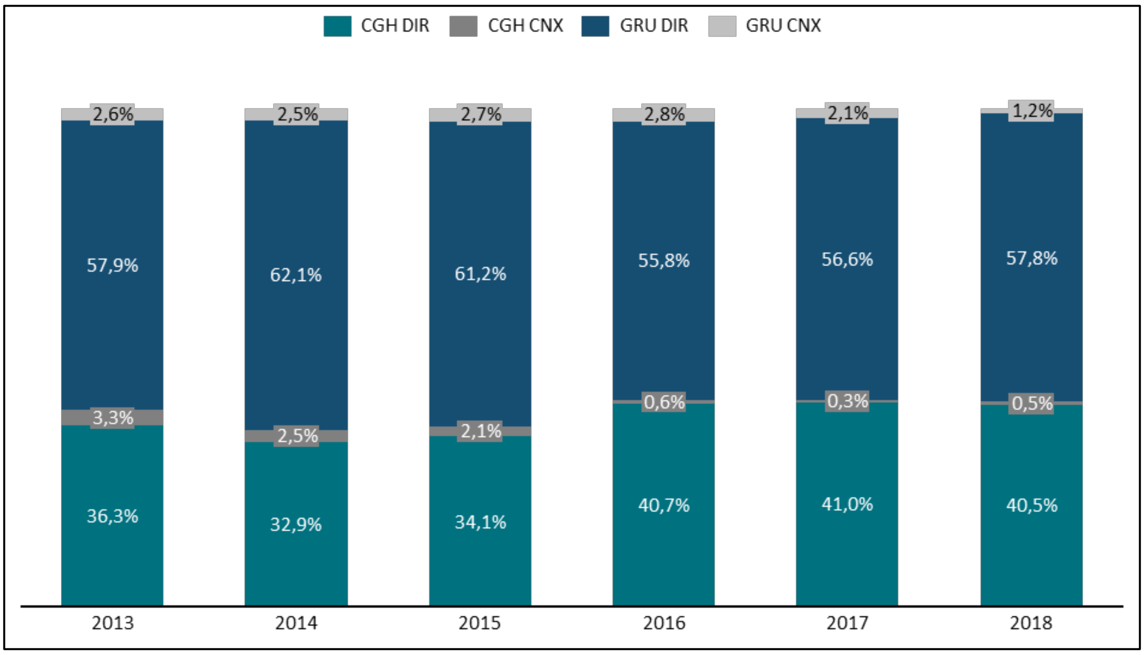


*Figure 27.* Demand Sold Composition - SAO - Domestic Market - by Airport (ANAC)

The growth in demand in markets with nonstop CGH service happened in markets with an overlap of nonstop GRU supply, as shown in Figure 13. In 2015, 69.7% of all demand in São Paulo (except SAO-RIO) had in markets where both CGH and GRU had nonstop service (32.5% in CGH and 37.2% in GRU). This number grew to 84.3% in 2016 (37.0% in CGH and 47.3% in GRU).

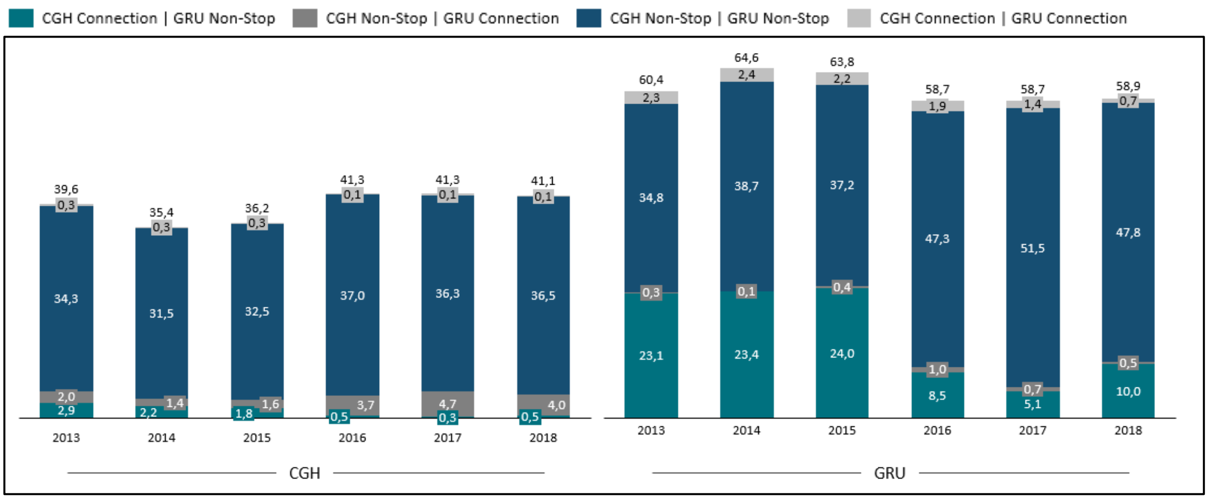


*Figure 28.* Demand Sold Composition - SAO - Domestic Market - by Airport (ANAC)

This growth in participation in markets with direct overlap between CGH and GRU was due to the following markets: CGH-REC (Recife), CGH-FOR (Fortaleza), CGH-BEL (Belém), CGH-MCZ (Maceió), CGH-JPA (João Pessoa), CGH-NAT (Natal), and CGH-SLZ (São Luiz). Until 2015, those markets were only operated on a nonstop GRU basis (demand from/to CGH should make some connection at some airport). In 2016, with the CGH offer's diversification, they started to be operated directly from CGH.

As a result, the share of markets operated directly by GRU in the total composition of demand declined from 25.8% in 2015 to 9.0% in 2016.

This growth tendency of CGH participation in the existence of direct service is related to many of the factors previously mentioned in the literature:

- The importance of direct service as a choice factor: CGH participation grew when this airport began to have more services and the access factor and;
- Centrality and access predictability: CGH, more central, has greater predictability than GRU in terms of transit time and is also an airport with easier access to the central, south, and west regions of the city of São Paulo.

Considering only the markets that directly overlap between CGH and GRU (except SAO-RIO), we see that the average price of GRU's nonstop markets that overlap with direct services of CGH became higher than that of CGH markets in 2016, seen in Figure 31.

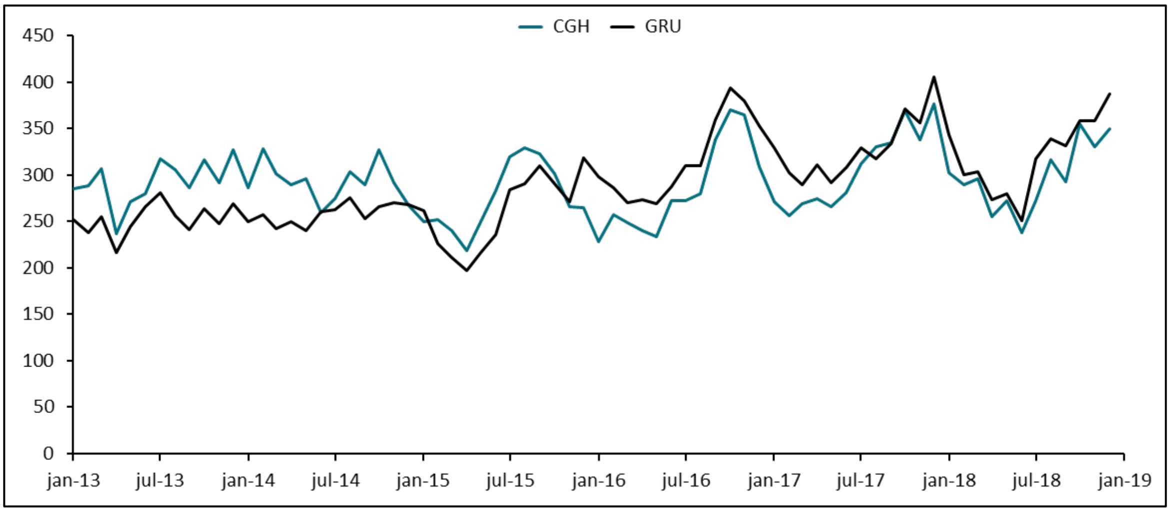


*Figure 29.* Average Fare Evolution - SAO - ANAC - Domestic Market

The average rate for CGH was about 15% higher than the GRU in 2013 and 2014. This difference was reversed, with GRU surpassing CGH and CGH rates getting close to 7% below the GRU. However, the stage length[2] of GRU passengers is higher than that of CGH, as the market mix is different between airports, as seen in Figure 31 below:

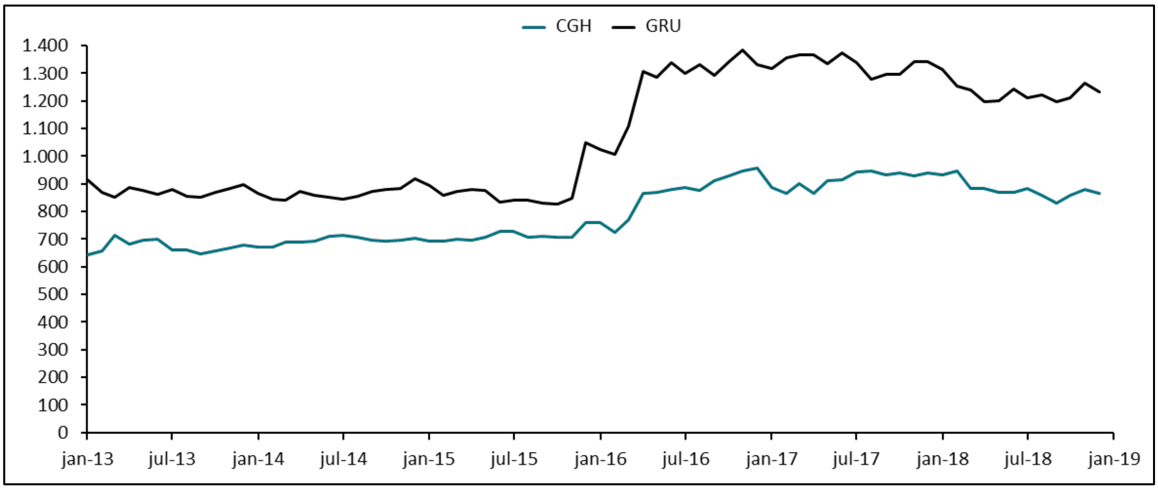


*Figure 30.* Passenger Stage Length – SAO

As seen in the previous graph, the average stage of GRU is about 40% higher than CGH, mainly due to the greater volume and participation of long segments than in comparison with CGH, which has a greater volume of demand concentrated in shorter

[2] Stage Length = RPK/passenger

stretches - and corporate, such as CGH-CWB (Curitiba), CGH-POA (Porto Alegre), and CGH-CNF (Confins).

Figure 32 below shows the evolution of demand by each airport's air region (considering only markets that have direct service overlap between both). The average GRU stage, for example, became larger in overlapping markets due to the increased relevance of the northwestern markets in Brazil, reducing the share of shorter markets in the composition of demand as a whole.

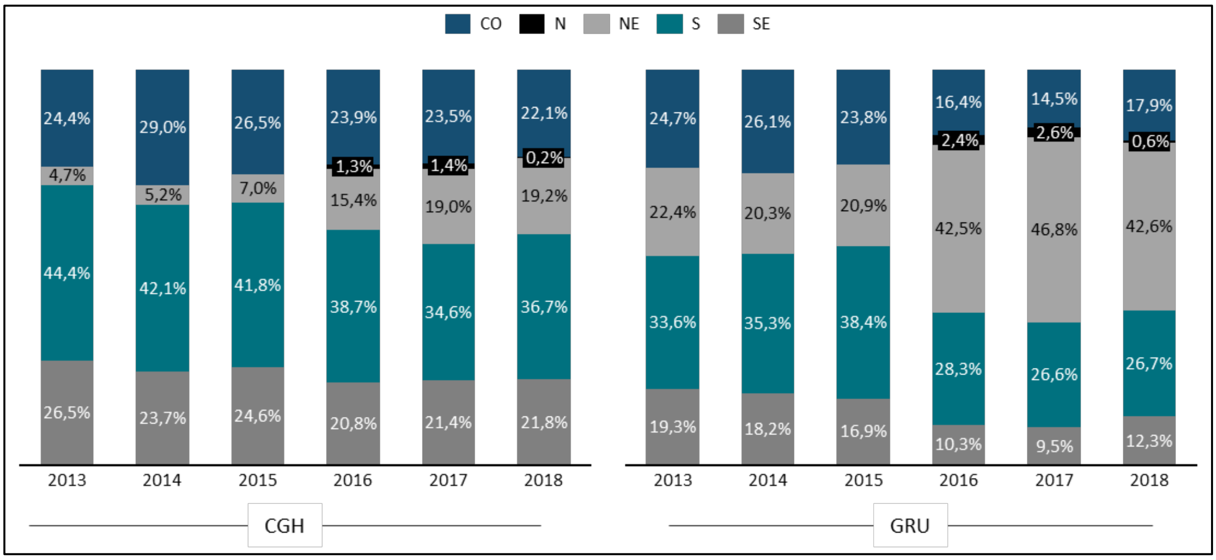

Figure 31: Passenger Distribution by Region – SAO – Only nonstop and overlapped markets

As it has a higher average stage, it is natural that the average GRU rate is higher than CGH. Therefore, to compare the evolution of the tariffs practiced in each of the airports is important to evaluate the average Yield's evolution, which weighs the average rate by distance, correcting it to the same average stage (of 1000km). So, when we calculate and correct each airport's Yield, we see what we already expected: the Yield of CGH is approximately 10% higher than that of GRU[3].

[3] CGH and GRU Adjusted Yield (1000km):

| | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 |
|---|---|---|---|---|---|---|
| **CGH** | 35,3 | 35,2 | 32,4 | 30,1 | 32,0 | 31,4 |
| **GRU** | 27,0 | 27,7 | 27,5 | 28,0 | 28,4 | 28,6 |
| **Dif.** | **30,8%** | **27,1%** | **17,6%** | **7,7%** | **12,5%** | **9,9%** |

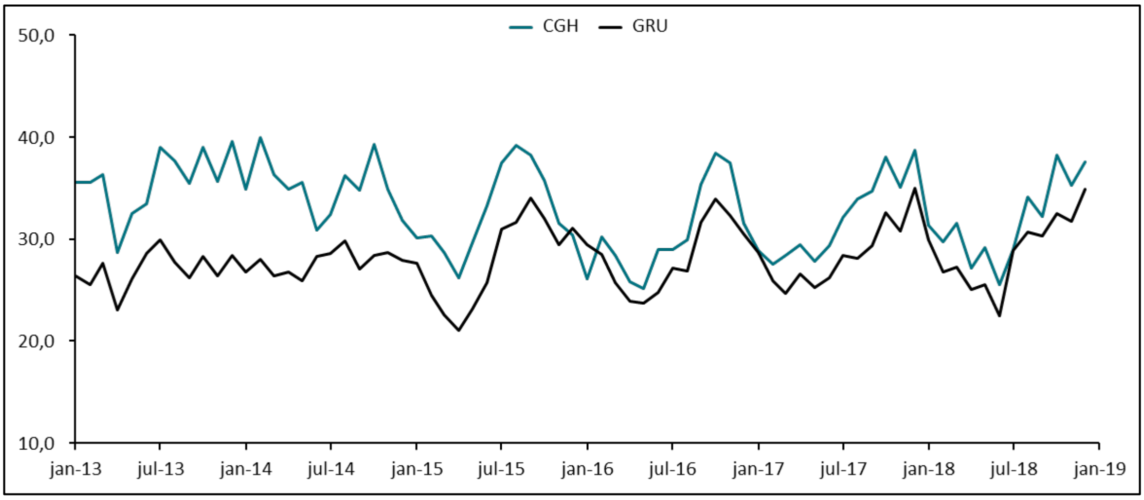

*Figure 32.* Yield adjusted by a Stage Length of 1.000km – SAO – BRL cent

An interesting analysis, widely used in industrial economics studies, evaluates price dispersion through the evolution of the price percentiles practiced. In Figure 34 below, it is possible to see, for example, how the average rate in the first decile of the demand distribution evolved: in Jan/13, 10% of all rates sold to the overlapping CGH markets were below BRL 120; in GRU, 10% of all rates sold to overlapping markets with CGH were below BRL 112.

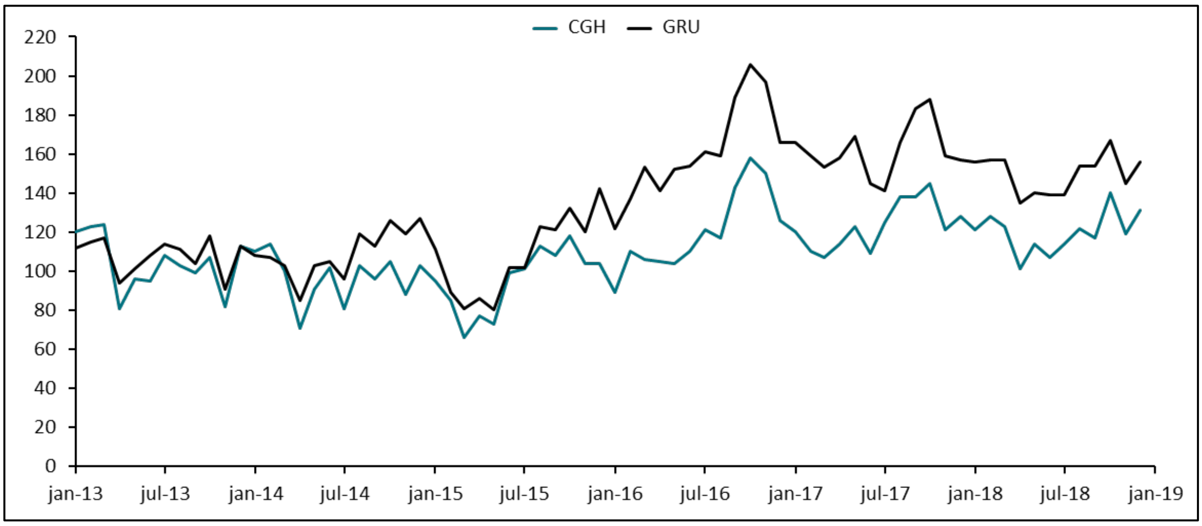

*Figure 33.* Average Fare: demand's First Decile – SAO – BRL

Following the previous steps of weighting the Average Fare considering the Average Yield with the average stage adjusted to 1000km, we have the following results demonstrated in Table 5 with the evolution of the difference between the Average Yield Adjusted to an average stage of 1000km between CGH and GRU for all deciles:

Table 5

*Evolution of the difference in Adjusted Yield (Average Stage = 1000km) between CGH and GRU per decile*

| Decile | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 |
|---|---|---|---|---|---|---|
| **10%** | 23,3% | 9,6% | 9,1% | 7,0% | 10,7% | 11,6% |
| **20%** | 22,7% | 12,8% | 8,1% | 6,7% | 11,2% | 11,8% |
| **30%** | 20,2% | 14,0% | 8,6% | 6,0% | 11,0% | 9,4% |
| **40%** | 23,2% | 18,2% | 9,0% | 6,1% | 13,4% | 8,5% |
| **50%** | 35,7% | 25,8% | 13,0% | 6,6% | 16,4% | 9,8% |
| **60%** | 47,9% | 37,3% | 16,5% | 6,9% | 19,3% | 13,7% |
| **70%** | 59,7% | 48,3% | 23,0% | 14,3% | 25,0% | 17,4% |
| **80%** | 64,0% | 57,5% | 35,7% | 33,5% | 38,5% | 28,3% |
| **90%** | 67,9% | 60,8% | 47,1% | 61,3% | 61,5% | 52,0% |
| Total | **30,8%** | **27,1%** | **17,6%** | **7,7%** | **12,5%** | **9,9%** |

As seen from the table above, over time, the difference between the adjusted Yield of the cheapest rates for CGH and GRU is narrowing (23.3% in 2013 and reduced to 11.6% in 2018).

It is interesting to note that the difference between the Yields of the highest deciles remains greater - in particular, the 90% percentile, in which the difference in the adjusted average Yield of CGH and GRU was 52% in 2018. With that, the prices among the most inelastic passengers (higher prices) are higher in CGH than in GRU, indicating the preference of CGH for passengers willing to pay higher fares (especially those with a more corporate profile).

**Rio de Janeiro: Evolution of demand and the average rates**

This section will replicate the qualitative analysis on the evolution of demand and average rates at airports in Rio de Janeiro, focusing on cases of direct service overlap between SDU and GIG airports.

Unlike São Paulo, the demand mix between SDU and GIG airports remained relatively stable, with small changes in the number of destinations offered and overlapping.

SDU airport, due to its characteristics, is an airport with a low range of destinations, and, unlike São Paulo, where CGH underwent a process of supply diversification caused by a review of operational parameters.,

Figure 35 shows how the distribution of demand between SDU and GIG airports by type of service has evolved steadily over time, keeping GIG as the main airport in RIO for example, SAO-RIO connections. It is interesting to reinforce how both cities - São Paulo and Rio de Janeiro - have a low volume of connections in general: this effect is expected, considering how socio-economically relevant these cities are and the airlines' strategy of offering a product direct (where they can extract a higher price level and serve the most inelastic audiences with a better service).

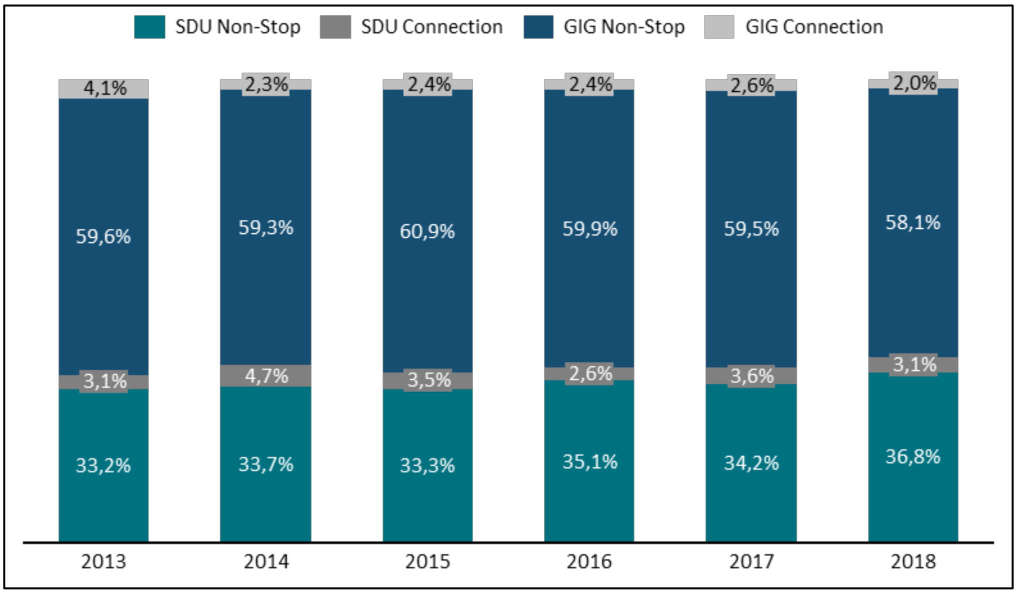

*Figure 34*. Demand Sold Composition - RIO - ANAC - Domestic Market - by Airport

When analyzing the evolution in each airport's participation by type of overlap and service between airports, it is possible to verify a significant behavior change, which is the growth of the participation of markets with nonstop GIG services in markets where the SDU airport only serves with connection (the number of destinations with overlapping nonstop service, oscillated, until 2015, around 10 destinations; this number changed to around 7 destinations: AJU-SDU (Aracaju) stopped operating in 2015, SDU-SSA (Salvador) stopped being a continuous market for a seasonal market and GYN-SDU (Goiania) which, after a long period of continuous supply, started to be offered seasonally as well).

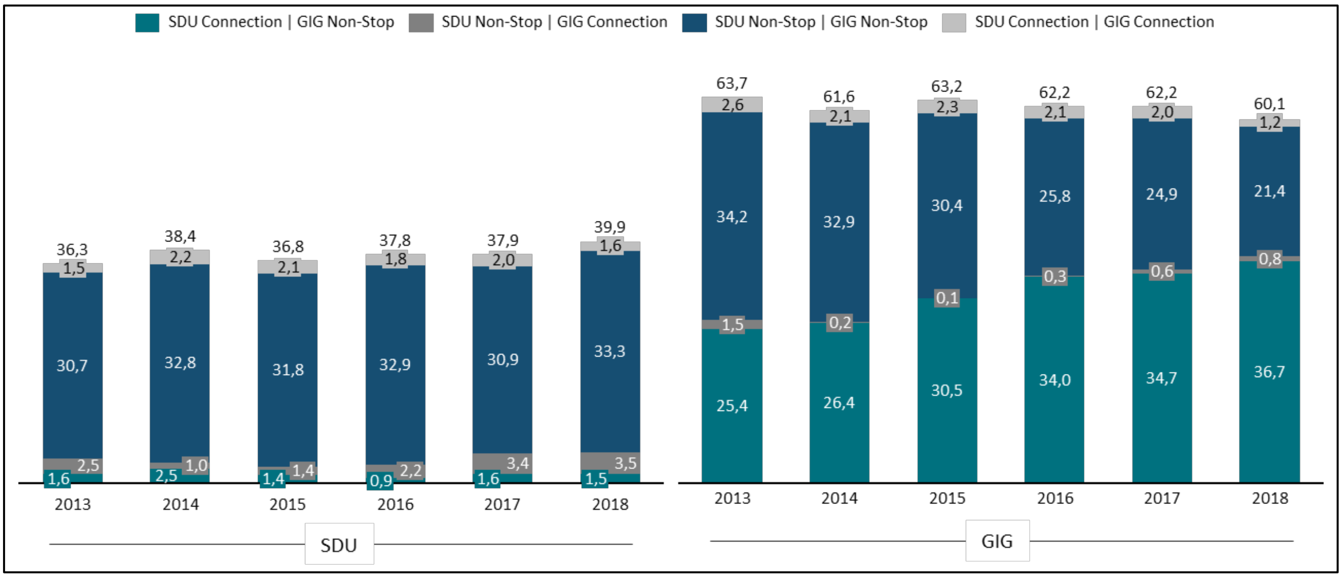


*Figure 35.* Demand Sold Distribution - RIO - ANAC - Domestic Market - by type of service GIG and SDU

In addition to this growth in market share that only has a connection service since SDU, it is important to highlight two other points:

- For those markets that overlap between nonstop SDU and GIG services, SDU's share grew;
- Unlike São Paulo, where around 80% of ex-SAO-RIO demand is concentrated in markets overlapping direct service between its two airports, a smaller share of demand is concentrated in these overlapping markets, falling by around 65% in 2013 to 55% in 2018.

When we analyze the evolution of the adjusted average Yield of GIG and SDU in those markets that offer direct service at both airports (Figure 38), we see that the difference between both airports is narrowing (the Yield of GIG was 18.6% lower than that of SDU in 2013 and this difference dropped to -11.9%) due to the growth of the average GIG Yield. This reduction in the Yield difference between GIG and SDU is associated with: i) increased competition in the SDU (which experienced a slight increase in the level of competitiveness between 2013 and 2018, with the HHI[4], which measures the degree of concentration, falling from about 0.34 to close to 0.32); ii) increase in the GIG concentration level in 2018 (the GIG HHI went from around 0.37 in 2013 to close to 0.5 in 2018) and; iii) improvement in the infrastructure of the GIG airport.

There was also a reduction in the price difference between GIG airport and SDU for those markets where GIG has a nonstop service and the service since SDU involves a connection: the average adjusted Yield of GIG was 22.6% lower than that of SDU in 2013. It decreased to -14.3% in 2018 (Figure 37 ). Despite the drop, the price difference between SDU and GIG for these markets is still greater than where both airports have direct flights. This difference is due to the natural dynamics of prices and Revenue Management, which tends to charge a higher price for those markets with a connection due to the dynamics of bid price and displacement risk of selling a connection.

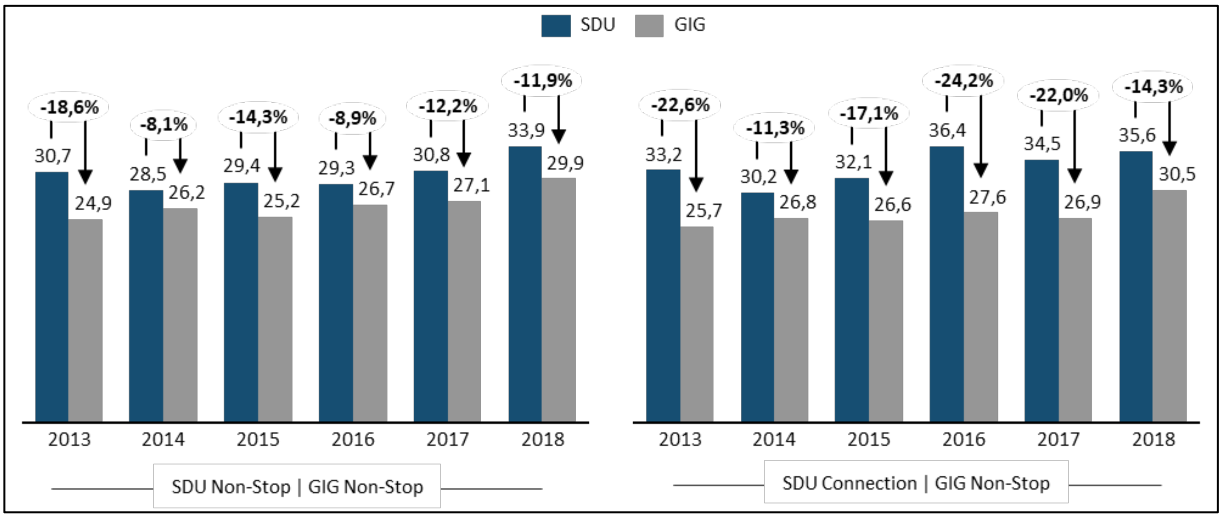

*Figure 36.* Yield evolution adjusted by type of service GIG and SDU - per year - BRL cent

Analyzing the evolution of the differences between the adjusted Yield of GIG vs. CGH by percentile (Table 6) for the markets that have direct flights at both airports, it is

[4] The higher the HHI, the more concentrated a market is. The smaller, the more competition.

possible to see a trend similar to that of São Paulo: reductions in the price differences of the percentile fares lower and equal differences or lower falls for the highest percentiles. The price difference between SDU and GIG for markets where both airports offer direct service has fallen more for the lower fares than for the higher fares.

As SDU is a more central airport with easy access to Rio de Janeiro's shopping centers, more inelastic passengers, with a more corporate profile, are willing to pay higher prices to fly in SDU compared to GIG, which requires a greater displacement.

Table 6:

*Evolution of the difference in Adjusted Yield (Average Stage = 1000km) between CGH and GRU per decile*

| Percentile | 2013 | 2014 | 2015 | 2016 | 2017 | 2018 |
|---|---|---|---|---|---|---|
| **10%** | -28,2% | -14,3% | -15,6% | -8,2% | -15,6% | -8,8% |
| **20%** | -28,2% | -13,4% | -17,9% | -7,0% | -12,4% | -9,2% |
| **30%** | -31,8% | -12,7% | -17,8% | -6,9% | -13,6% | -10,5% |
| **40%** | -32,6% | -15,8% | -21,5% | -7,2% | -12,8% | -9,5% |
| **50%** | -35,3% | -19,2% | -24,3% | -9,1% | -15,1% | -9,5% |
| **60%** | -35,2% | -20,0% | -25,6% | -8,7% | -16,0% | -11,9% |
| **70%** | -32,1% | -21,4% | -26,0% | -11,6% | -18,3% | -14,9% |
| **80%** | -27,1% | -21,0% | -26,8% | -18,9% | -21,4% | -18,4% |
| **90%** | -24,8% | -20,1% | -25,9% | -22,1% | -28,4% | -23,9% |
| Total | **-18,6%** | **-8,1%** | **-14,3%** | **-8,9%** | **-12,2%** | **-11,9%** |

**Impact of variations in the level of competition on substitute market prices**

As previously mentioned in Chapter II, previous studies regarding the impact of greater market concentration on prices do not contemplate changing supply in a substitute airport for a metropolitan region in another given airport's pricing composition.

To estimate whether the relationship between price and supply variations at a substitute airport remains, we will estimate the following regression for markets that have a direct overlap of:

$$\ln\left(AVG\_PRICE_{mt}\right) = \theta_0 + \alpha * \ln\left(HHI_{mt}\right) + \beta * \ln\left(HHIsubstitute_{mt}\right) + \gamma_m + u_t \quad (1)$$

Where:

$\boldsymbol{AVG\_PRICE_{mt}}$ = Average price sold in a given market in a given month

$\mathbf{ln}\ (\boldsymbol{IHH_{mt}})$ = HHI indicator level log for a given market and month (this variable allows us to assess the level of concentration of supply in a market)

$\mathbf{ln}\ (\boldsymbol{IHHsubstitute_{mt}})$ = the HHI log of the substitute market (example: if the evaluated Market is GRU-FOR, the substitute market will be the CGH-FOR)

The variables $\boldsymbol{\gamma_m}$ $\boldsymbol{and\ u_t}$ are fixed market and time effects (the fixed effects allow us to isolate temporal aspects - such as increased costs, seasonality, price shocks - and exclusive marketing aspects of a respective market).

The data used for this regression will be those mentioned above: average fare and demand data from ANAC. To define the level of concentration on a given route, we will use the supply level for the current month and future months obtained through OAG / Diio. The effects will be estimated only for markets with nonstop flights from the markets treated throughout this text (CGH, GRU, GIG, and SDU).

The estimates obtained for equation (1), shown in Table 7, confirm what has been expected in the literature that an increase in market concentration is related to an increase in the average tariff practiced in a given market. Furthermore, an increase in market concentration in a substitute market is related to an increase in the average price of a market: this effect is statistically different from zero (both are) and reinforces the impact of substitute airports on the average price, highlighting the need to study this effect when assessing price composition.

Table 7

*Estimates for AVG_PRICE_mt*

| | $AVG\_PRICE_{mt}$ |
|---|---|
| $\ln(HHI_{mt})$ | 0,270<br>(0,0613) |
| $\ln(HHIsubstitute_{mt})$ | 0,145<br>(0,0378) |

*Note.* Robust Standart Error was adjusted for 92 clusters (markets), and it is shown under the estimative between ( ).

Another important observation in Table 6 refers to the magnitude of the coefficient: an increase in direct competition in the market has an impact greater than that found for an increase in competition from a substitute market. The average price for a market is reduced by 2.7% if there is a 10% reduction in the concentration level of a market and by 1.4% if there is a 10% reduction in the concentration level of a substitute market.

# Chapter VI

## Conclusions and Recommendations

Brazilian aviation has gone through decades of growth. In recent years, many developments have taken place, with companies appearing and disappearing from our Market and new cities entering the airlines' route map.

Our increasingly demanding customer base is looking for new services, destinations, and markets to meet the diverse travel needs in a country of continental dimensions and with wide challenges and deficiencies in the transport infrastructure.

One of the major drivers of this growth in the airline industry occurs in the cities of São Paulo and Rio de Janeiro and its Multi-Airport System structures, which are the largest centers for air travel services in the country as well as two of the most important flight distribution centers in South America. Its airports have characteristics inherent to its target audiences, whether they are frequent corporate travelers or the family that travels for leisure from time to time.

### Conclusions

We can see that airlines adopt specific network and pricing strategies better to adapt their products to the communities' demands. As time went by, there was an increase in destinations served in overlap in MAC, with cities, especially in the Northeast, South, and Southeast regions of Brazil, gaining more relevance in the connection of the four airports studied.

In our research, it was possible to verify that large metropolises' main airports have a higher Yield than those farther away from corporate centers, but the price difference between them on the same routes reduces over time. Also, we found that the evolution of pricing levels is different between the percentiles: the lowest fares are closer to cheaper values regardless of the airport of choice in MAC, while the more expensive fares available for short-term purchases remain distant.

This statement corroborates the idea that customers who have more flexibility look at lower prices. In contrast, the customer who buys at the last minute pays more for central airports' amenities and privileges.

With this, we also concluded that over the years, the increase in overlap routes in MACs was healthy for competition between airports, airlines and had a positive effect in increasing airfare competitiveness that brings gains to the consumer in general and the transport industry, logistics, and tourism, vital for our country and economy.

**Recommendations**

The group believes that an evolution of this research may be a study of the consequences to the airline market in terms of general consumer volume, flight occupancy rate, fare values, the mix of classes sold, and the interaction between these indicators airports of the same MAC from 2019 when AVIANCA Brasil that had relevant importance in the two airports of SAO and RIO had its operation suspended in and, later, was declared bankrupt. Other competitors partially replenished this company's offer after a few months. In this way, it would be possible to assess the immediate impact on demand and price after the shock of a company's bankruptcy and which indicators were most affected at the moment when the offer started to be replenished

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