



Spatial concentration and connectivity of international passenger traffic at Brazilian airports



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ABSTRACT

This paper examines concentration and connectivity of international passenger airport traffic in Brazil. The analysis considers seat supply and scheduled flights from 1999 to 2012. The 2000–2005 period was marked by concentration and limited international flight links, which was followed by the movement to recover capacity and connectivity from 2005 to 2010. Brazil started to liberalize bilateral agreements in 2002, and eventually moved towards the “open skies” concept in 2010, facilitating the process of operational de-concentration and increasing seat supply. The Brazilian government's liberalisation policy through bilateral agreements did not spark off a significant turnaround for national airlines; rather, the revived traffic growth was led by foreign airlines. This movement brought significant changes in the composition of international passenger traffic in Brazil, although changing little in terms of concentration and connectivity. The real change was the dominance of foreign airlines and seat distribution by regions, with the Latin America and Caribbean region shrinking to less than half of the market.

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1. Introduction

With a land area of 8.5 million square km, Brazil has an extensive airport system with 2472 airports. Of that total, 711 are public airports and, of these, 22 served international passenger traffic in 2012. These airports processed 18.9 million international passengers out of the total of 190 million passengers in 2012, recording 108% growth over 1999. The concentration of cities serving as Brazil's entry and exit gateways is important to sector planning.

International air traffic accounts for only a small percentage of total movements at Brazilian airports (around 10% of total passengers embarked and disembarked). That traffic, however, represents activity fundamental to dynamic components of the economy, such as high-tech industries and high value-added services, including the banking system and tourism. The process of air transport, particularly airfare, liberalisation started with the intention to stimulate air service activities in Brazil's economy. Brazil's liberalisation of the international market began in the South America markets, with the 1996 Fortaleza Agreement. However, it was not until 2002 that demand started to increase substantially,

and by 2008 airfares were completely liberalised. Liberalisation of international services were extended to the rest of the world in 2009, and in 2010, international airfares were completely liberalised.

Despite the growth of international traffic, the percentage of international passengers in total passengers at Brazilian airports has declined, from 14.5% in 1999 to just over 9.8% in 2012. International passenger traffic is highly concentrated at the international airports of São Paulo (Guarulhos) and Rio de Janeiro (Galeão), which jointly accounted for more than 80% of total international movement in all years over the period 1999 to 2012. Table 1 shows international passengers at Brazil's main airports in 2012.

In 1999 international passenger traffic at Galeão represented 22% of the Brazil total and by 2012 the figure had risen to 23%. Over the same period, Guarulhos in São Paulo represented, respectively, 67.4% and 61%.

From 1999 to 2012 the number of Brazilian cities serving regular international traffic rose from 15 to 18 and the number of cities outside Brazil connected by regular international flights from Brazil, directly or with a stopover, fell from 60 to 59. These figures indicate a slight de-concentration of international passenger traffic demand in Brazil, with supply of seats at Guarulhos plus Galeão decreasing from 87% of the total in 1999 to 82% in 2012. The composition of passenger traffic also changed substantially at these

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Table 1
International passengers at Brazil's airports (000).

Airport	ICAO CODE	1999	2012
Guarulhos	SBGR	6,138	11,543
Rio de Janeiro	SBGL	2,007	4,295
Porto Alegre	SBPA	198	655
Confins	SBCF	64	446
Brasília	SBBR	4	411
Salvador	SBSV	151	309
Florianópolis	SBFL	188	216
Recife	SBRF	132	212
Fortaleza	SBFZ	51	200
Manaus	SBEG	37	199
Natal	SBNT	21	108
Curitiba	SBCT	30	90
Campinas	SBKP	0	78
Foz do Iguaçu	SBFJ	4	73
Belém	SBBE	52	48
Campo Grande	SBCG	0	21
Maceió	SBMO	20	6
Others		16	5
Total		9,114	18,915

Source: ANAC and Infraero

two airports: Guarulhos' share of international passengers fell from 46% in 1999 to 35% in 2012, while Galeão's decreased from 40% in 1999 to 25% in 2012.

This paper discusses the new trend towards de-concentration of international air travel in Brazil in terms of the Lorenz curve, the HHI concentration index and the connectivity of Brazilian airports in relation to the world's major geographic regions as defined by the Airports Council International (ACI): Africa, Latin America/Caribbean, North America, Europe, Asia/Pacific, and Middle East.

The rest of the paper is structured as follows. Section 2 presents a review of selected literature on air transport concentration and connectivity. Section 3 describes the methodology and data, which are applied in Section 4. Section 5 discusses the main implications of our findings. Conclusions are drawn in the final section.

2. Literature review

Seat supply, flight frequency and connected cities are fundamental to defining international air passenger transport. Recently published studies (O'Connor, 2010; Papatheodorou and Arvanitis, 2009; Pirie, 2006; Van Nuffel et al., 2010) have addressed the level of concentration of air traffic, particularly in geographical terms. Burghouwt and Hakfoort (2001) investigated the evolution of the European aviation network from the supply side during the period from 1990 to 1998. On the basis of seat capacity they evaluated traffic concentration at airports and on air routes in Europe. Dobruszkes (2006) analysed the behaviour of a number of European low-cost carriers (LCCs), focussing on issues such as network growth, route types, connectivity, international flights etc. He also examined LCC seat supply by airport. Grubestic et al. (2008), using network analysis and graph techniques, examined a global connectivity hierarchy in the airline network, in terms of seat supply and flight frequency at the airports considered. They also examined the airport hierarchy through seat supply by airport. Derudder and Witlox (2008) investigated passenger flow data with a view to examining the network of world cities. Their analysis suggests that information on air passenger transport flows, although an important data source, can be impaired by inappropriate statistics. They argue that, for more significant analysis to be constructed, future research should develop alternative approaches of recording airline data. These would include identifying passengers' actual origins

and destinations, rather than the segment flown.

Costa et al. (2010) propose an HHI-based methodology to ascertain the number of hubs in Brazil's domestic air transport system. Specifically, they focus on identifying hub airports and their connection with tourism in Brazil. Dobruszkes and Van Hamme (2011) present an analysis of the dynamics of air services during the recent world economic crisis, seeking to explain how that crisis affected the air transport industry. Using econometric models they show that change in seat supply is highly dependent on country-level economic growth. They thus reason that the air transport crisis affected the United States, Europe and Japan more than other countries. Dobruszkes et al. (2011) analysed the determinants of air traffic volume in the major European urban regions, highlighting those that depend on metropolitan characteristics. They did so by correlating a series of economic variables, such as Gross Domestic Product (GDP), tourism and others, with total and international air service seat supply. They thus related air service levels in metropolitan areas by seat supply.

Suau-Sanchez and Burghouwt (2011) analysed seat capacity supplied by airlines at Spanish airports between 2001 and 2008. They identified concentration and de-concentration patterns for different markets and concluded that seat capacity supply followed a pattern of de-concentration. O'Connor and Fuellhart (2012) examined the interdependencies among operations, air transport industry organisations and air services available in cities. They defined measures relating airlines and aircraft types used to serve cities at different levels in a hierarchy. Koo and Lohmann (2013) examined the link between the volatility of civil aviation policy and spatial distribution of air transport supply in Australia and Brazil. They assert that policy volatility directly influences the spatial distribution of air transport seat capacity in Brazil, while the situation in Australia is relatively stable.

It can be seen that studies of air transport concentration and connectivity are still limited, and more work is needed in this direction. Particularly, international air transport concentration and connections are extremely important to investment decisions during the airport privatisation process in Brazil.

3. Methodology and data

This paper reports on an analysis of international traffic concentration among Brazilian cities using traditional methods, the Lorenz curve (Beach and Davidson, 1983) and the Herfindahl-Hirschman Index (HHI) (Hirschman, 1964). Originally used in income concentration studies, the Lorenz curve became popular as a method for measuring a variety of economic activities, including more recently air transport activities (Suau-Sanchez and Burghouwt, 2011). In a number of cases, this curve demonstrates Pareto's Law, where a small proportion of the elements studied is responsible for a large proportion of the results. A few airports, for instance, can be seen to account for most of a country's air traffic. A curve can be traced for the cumulative percentage of seats supplied, on the vertical axis, against the cumulative percentage of airports supplying them, on the horizontal axis, with airports ordered from the largest to the least supply. This might show, for example, 80% of seat supply concentrated at 20% of airports. The HHI index offers an objective measure of the concentration, as in Equation (1).

$$HHI = \sum_i \left(x_i / \sum x_i \right)^2 \quad (1)$$

where x_i is the number of seats supplied at airport i . In the case of a region with two airports with international flights occurring at only one of them, the HHI would be equal to 1, representing the highest

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