GEOGRAPHY OF DOMESTIC AIR TRANSPORT IN BRAZIL FROM 2004 TO 2008

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ABSTRACT

This article discusses the geographic supply of seats to domestic air passenger transportation in Brazil. Data was based on the flight authorization due by the ANAC (National Civil Aviation Agency) called Hotran and municipal socioeconomic data from IBGE (Brazilian Institute of Geography and Statistics) and IPEA (Brazilian Institute of Applied Economic Research). Through a multiple regression analysis, it was developed an explanation of the airline´s seat supply distribution in the domestic air transportation market among the main Brazilian urban areas. All cities with domestic regular air transportation are analysed. The analysis was made considering a year before the total collapse of the biggest Brazilian airline company VARIG, 2004, and later, 2008, when a settle down of the air transport operators of the Brazilian air passenger domestic market can be observed. The results indicate that airline´s seat supply spatial distribution is highly correlated with the Brazilian urban structure distribution, greater than to 80% of the variation of seat offers can be explained by the urban structure distribution. The geographic distribution is revealed steady through these years. When analysed the change of supply between 2008 and 2004, it was found a high linear relation between seat supply change and socioeconomic change of the cities. When the matter is supply, despite the great airline industry instability in this first decade of the 21st century, the results indicate that Brazilian airline´s strategy does not move far from geographic aspects. This can be understood as that strategies pursued by the airlines and government concerning the airport it manage or for which it authorize development will not have large differentiated impact over the urban area supply of domestic passenger air transport.

Keywords: Air transport, Geography, Brazilian cities, Supply

1. INTRODUCTION

Domestic scheduled air transport is responsible for approximately 90% of all the passenger movement in Brazilian airports. The Brazilian scheduled airline companies have freedom to offer trips and prices, being limited only by problems of airspace capacity and the airport

infrastructure. The process of liberalizing the air transport sector in Brazil resulted in fundamental airlines profile changes. Traditional airlines, such as Transbrasil, VARIG and VASP, collapsed leaving room for new players. In this liberalization process, two companies, GOL and TAM, established a domain in the domestic market with more than 80% participation, measured by Revenue Passenger Kilometer (RPK). In this process of transition, a notable point was the collapse of the most traditional Brazilian airline company, VARIG, in 2006. In 2008 there was an absolute domain, called a duopoly of GOL and TAM. However, in 2012 a weakening of the duopoly of these two dominant companies can be observed with a new force appearing on the domestic scene from de association of two companies named AZUL and TRIP, which already has 16% of the market.

In Brazil, there is no significant urban deconcentration of air transport capacity during de last decades. The deregulation of the sector brought similar effects to those observed in Nigeria (Daramola and Jaja, 2011), i.e., a consolidation of the airports in the large urban centers. Figure 1 shows the Lorenz curve for the weekly seat capacity of regular domestic aviation in Brazilian cities for the years 2004 and 2008. The curves are nearly coincident, showing that there was no significant variation in the concentration of this economic activity from 2004 to 2008.

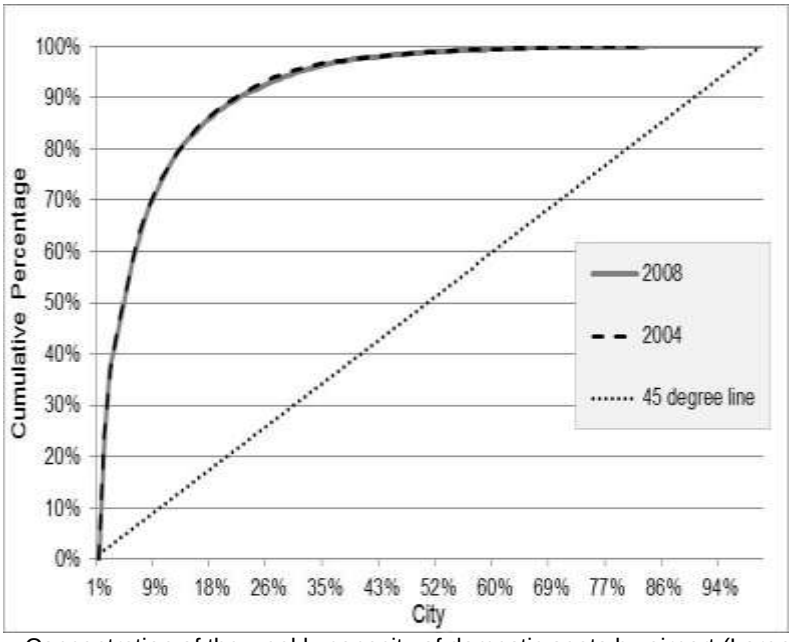

Figure 1 – Concentration of the weekly capacity of domestic seats by airport (Lorenz Curve)

Since 1996, the year 2004 was the year when the regular Brazilian airline industry had their best positive financial results. In 2005 the result was slightly positive but from that year until 2011 the results have been negative (ANAC, 2011). The deregulation of air transport in Brazil brought on a competitive process with the airlines obtaining decreasing yields not compatible with productivity gains, both operational and in costs. It seems that, in order to maintain or improve their market shares, Airlines just concentrated on the domain of high density routes, without looking carefully for their financial performance.

The spatial distribution of air transport supply is a fundamental factor for estimating the business potential, as much for the airports as for the airline companies. The current demand forecasting studies, in Brazil, have not taken into consideration the behavior of the airlines relative to socioeconomic aspects of the cities (Fernandes and Pacheco, 2010). There is the point-to-point demand between cities, but the passenger trip plan is done considering the airline route logistics. Another fact is that Brazil does not have a structure of secondary airports preventing alternative routes and the operation of Low Cost Carriers as happens, mainly, in the United States and Europe. The leverage of secondary airports is problematic when considering the poor highway interurban network and the non-existence of a railway system to transport passengers between cities, among other difficulties related to the urban design of Brazilian cities. These obstacles associated to an airport network with serious capacity problems leads to the fact that a deconcentration of air transport in the medium term should not be expected. Another factor that does not favor deconcentration is the model of Brazilian airport concession, which has concentrated the investments in expanding the central airports to solve the bottlenecks of airport infrastructure of large cities, without considering building secondary airports. The present model of airport network development links regional growth to the expansion of the existing airports in the large metropolitan cities. It cannot be seen any development of an alternate air transportation network to reach the large economic centers of the country. There are several difficulties of establishing a more dynamic model for Brazilian air transportation which would allow the airline companies to innovate in the competitive process, for example, in service supply.

Therefore, this paper seeks to verify how the spatial distribution of seat capacity was in 2004, before the collapse of VARIG and in 2008, when the market was already stabilized. The stagnation of the geographic model of capacity distribution can lead us to consider that society is very little benefitted from the competitive process, as it becomes predatory, in the sense that one company benefits from the loss of the other, not occurring a process of effective gain of the airline industry. In a developing market, such as the Brazilian one, it would be expected that the airline industry presented positive, and not negative, financial results as it occurred from 2006 to 2011 (ANAC, 2011).

2. REVIEW OF THE LITERATURE

Diverse studies have showed concern with the spatial dimension of air transport distribution, not only in the world, but in some countries as well. O'Connor (2003) verified that passenger movement through the major international cities had changed, between 1990 and 2000, which was detected by the change in connectivity between cities during this same time period. Lee (2009) analyzed the period between 1992 and 2004, through the model of social network analysis. Analyzing the networkability of the cities he was able to estimate the connectivity of air routes, using the number of air routes and the air traffic. They analyzed the structural changes of the international global network. Dobruszkes and Van Hamme (2011) showed that there exists a change on the international level, where South America, Middle East and, mainly, Asia have presented growth in air transport, while the traditional regions of North American and Europe are stagnant. They show the link existing between the changes

in a nation's economics and air transport, during periods of recession. Dobruszkes et al. (2011) indicated a strong relation between the distribution of air transport in Europe and the specificities of metropolitan urban economies. Suau-Sanchez and Burghouwt (2011) showed the deconcentration of the seat capacity in Spanish airports, where a trend for higher growth of airports in smaller cities was perceived. Daramola and Jaja (2011) showed that the process of deregulating air transport in Nigeria resulted in abandoning the airlines with less density and the reduction of airports operated by the regular domestic companies in favor of more important economic centers. O'Connor and Fuellhart (2012) analyzed the air services in metropolitan areas. To this end they used the hierarchy of the cities of Global and the World City Project (GaWC) produced by the University of Loughborough. They calculated among others, the concentration indices for categories of air companies relative to the different hierarchic levels of the cities.

Liberalization, economic crises and low cost carriers are issues approached in the literature in the discussion of spatial distribution of the airline industry and their financial results. The legacy carriers needed to adjust in function of the transformational changes that had occurred in the market. The solution found by various legacy carriers to survive these changes of the sector was to form coalitions (mergers, alliances and acquisitions) and establishing Hub-and-spokes (Button, 2012). Coalitions have been a common practice to achieve greater financial stability, mitigate risks, obtaining scale and scope advantages, while the Hub-and-spokes seek to create barriers to the entrance of other companies. Nonetheless, the industry continues to present high risk rates and, therefore, low attractiveness to investors (Button, 2011). Stability of air transport geography in regions with mature markets is expected, however, in developing markets, this could be interpreted as stagnation of the decentralization process of the economy, so necessary to the regional development in developing countries. On the international level a significant change can be observed as shown by Dobruszkes and Van Hamme (2011). Nonetheless, on the country level, distinct behaviors can be observed as those presented by Suau-Sanchez and Burghouwt (2011) for Spain and Daramola and Jaja (2011), for Nigeria.

3. CONCEPTUAL BASIS AND CASE STUDY

Our research uses regression analysis for the definition of domestic weekly seat supply functions (SEATS) for the Brazilian cities, having the Potential of the City (PCITY) as an independent variable. These equations explain the domestic supply spatial distribution of the airline companies with the trend estimated by a polynomial equation for 2004 and 2008. The change of seat capacity from 2004 to 2008 is explained by the change of the Gross Domestic Product (GDP) for the same period. Through these functions both, the spatial capacity distribution and the dynamics of its evolution can be studied. The hierarchy of Brazilian cities is based on the study developed by the IBGE (2008). Another relevant aspect that will be discussed is that circumstantial issues may occur that explain the seat supply distancing of the capacity expected behavior by the estimated function.

The sample comprised 97 cities in 2004 and 117 cities in 2008. In the studied period, the main airports of the Brazilian network are administered by the Brazilian Company of Airport Infrastructure (Empresa Brasileira de Infraestrutura Aeroportuária, Infraero), a state-owned company. They are 67 airports distributed throughout the national territory. All the airports of the capitals of the 26 Brazilian states and the Federal District (capital of the country) were administered by Infraero until 2011. Besides these, there are the airports of middle-sized cities and small cities of strategic interest for the Brazilian government. In 2004, the majority of airports did not surpass the number of 600 thousand passengers. In 2008, the level of these airports increased to 870 thousand passengers.

In 2004, Infraero had a movement of 82 million passengers, with 71 million domestic passengers and 11 million international. In 2008, Infraero moved to 113 million passengers with 100 million domestic and 13 million international. The airports in the cities of Brasilia, Rio de Janeiro and São Paulo represent approximately 58% of the passenger movement registered in airports administered by Infraero in 2004 and 53% in 2008. These 3 cities represent approximately 86% of the international movement of passengers in the country in 2004 and 84% in 2008. In the same way, the air cargo movement is concentrated in few airports. The cities of Campinas, Manaus, Rio de Janeiro and São Paulo concentrated around 70% of the air cargo in the country in 2004 and 65% in 2008. The concentration of international traffic and cargo movement explains the spatial distribution of them, and thus the lesser known issue is the distribution of domestic passenger traffic. The data presented show a certain level of deconcentration of demand from 2004 to 2008. Have the airline companies accompanied this deconcentration relative to the supply or have they kept offering in the same geographic distribution in these two years?

Figures 2 and 3 show the weekly geographic distribution of domestic seat capacity supply of the airlines in Brazilian cities. The spatial distribution does not present significant differences. The concentration along the coastal cities is clear, with dominance in the southeastern and southern regions of the country. São Paulo, Rio de Janeiro and Brasilia, representing respectively the Great National Metropolis and the two National Metropolises of IBGE classification (2008) have remained the main poles of domestic air travel in the country. The city of Brasilia (Federal District – capital of the Country) has the third largest concentration of Brazilian air transport, because its central geographic location makes this city a main air transport connection point between the South/Southeast and North/Center West regions. Approximately 35% of the passengers of Brasilia Airport are travelling in transfer and transit flights, with part of these connections being between one of the four regions cited and the Northeastern Region of Brazil. Those cities are followed by the metropolises: of the southeastern region (Belo Horizonte); of the southern region (Curitiba and Porto Alegre); of the northeastern region (Fortaleza, Recife and Salvador); and the central western region (Goiânia).

Figure 2 – Weekly distribution of domestic seat capacity supply in 2004

Figure 3 – Weekly distribution of domestic seat capacity supply in 2008

Some of the capital regions, the next category in IBGE (2008) classification (Belém, Campinas, Campo Grande, Cuiabá, Florianópolis, Maceió, Manaus, Natal, São Luiz and Vitória) show a trend to assume a more relevant position in the air transport network. Campinas is approximately 80 km from São Paulo. This proximity make its development very linked to São Paulo's, and it can be said that it is the only city with characteristic of having a secondary airport in Brazil.

Figure 4 presents the difference of weekly domestic airport seat capacity supply between 2004 and 2008 in Brazilian cities. This Figure visually presents proportionality with Figures 2 and 3.

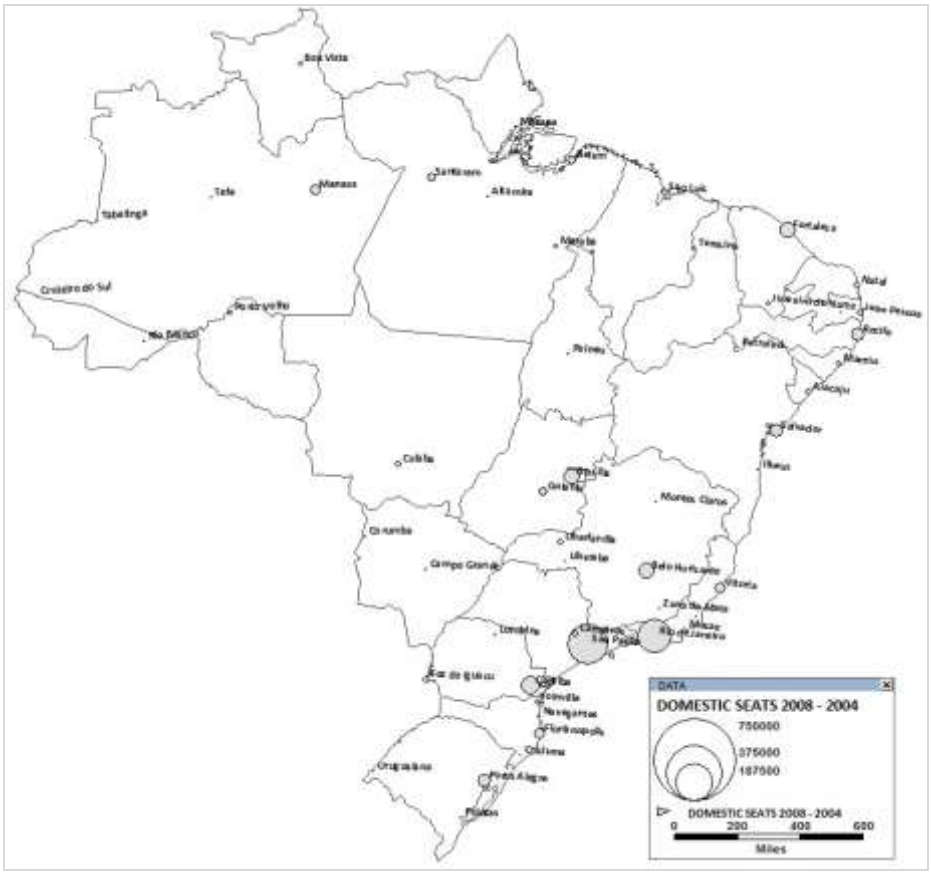

Figure 4 – Distribution of the difference 2004 to 2008 in weekly domestic seat capacity supply

The hypothesis of this study is that the regular domestic transport capacity supply in Brazil is distributed spatially in accordance with the role of the city in the flow of socioeconomic relations of the Brazilian urban network, which is reflected in the hierarchy of the cities (IBGE, 2008), not presenting significant variations from 2004 to 2008. Furthermore, the study tests the hypothesis that the evolution of the capacity supply is significantly linked to the evolution of the GDP of the main municipality served by the airports.

The subdivision of the group of Metropolises of the map of the Urban Network of Brazilian cities (IBGE, 2008) shows that: São Paulo is defined as the only Great National Metropolis;

Brasilia and Rio de Janeiro as National Metropolises; Belém, Belo Horizonte, Curitiba, Fortaleza, Goiânia, Manaus, Porto Alegre, Recife and Salvador as Metropolises. Following those, 70 cities function as regional Capitals (Table I). On this last level the IBGE (2008) study observes a significant relationship with the highest level of the Brazilian urban network. The classification also integrates the Sub-regional Centers with 169 cities and the Zonal Centers with 556 cities. These two last groups are related principally among themselves and with the superior remainder of the city network through the Regional Capitals.

Table I – Hierarchy of the cities with airports from the sample (PCITY in parenthesis)

Hierarchy of the City	**City with airport**
METROPOLIS	
Great National Metropolis	São Paulo (4.68)
National Metropolis	Brasília (2.14), Rio de Janeiro (2.59)
Metropolis	Belém (1.19), Belo Horizonte (1.42), Curitiba (1.43), Fortaleza (1.3), Goiânia (1.2), Manaus (1.39), Porto Alegre (1.36), Recife (1.23), Salvador (1.31)
REGIONAL CAPITAL	
Regional Capital A	Aracaju (1.07), Campinas (1.14), Campo Grande (1.11), Cuiabá (1.09), Florianópolis (1.18), João Pessoa (1.08), Maceió (1.1), Natal (1.15), São Luís (1.14), Teresina (1.08), Vitória (1.19)
Regional Capital B	Cabo Frio (1.07), Campina Grande (1.06), Caxias do Sul (1.07), Chapecó (1.06), Ilhéus - Itabuna (1.06), Joinville (1.06), Juiz de Fora (1.07), Londrina (1.06), Maringá (1.07), Montes Claros (1.06), Palmas (1.06), Passo Fundo (1.06), Porto Velho (1.06), Ribeirão Preto (1.07), São José do Rio Preto (1.07), Uberlândia (1.07), Vitória da Conquista (1.06)
Regional Capital C (Median population 250 thousand)	Araçatuba (1.05), Araguaína (1.05), Bagé (1.05), Barreiras (1.05), Boa Vista (1.06), Campos dos Goytacazes (1.06), Dourados (1.05), Governador Valadares (1.05), Guarapuava (1.05), Imperatriz (1.05), Ipatinga - Coronel Fabriciano - Timóteo (1.05), Juazeiro do Norte - Crato - Barbalha (1.05), Macapá (1.05), Marabá (1.05), Marília (1.05), Mossoró (1.05), Pelotas - Rio Grande (1.05), Petrolina - Juazeiro (1.05), Presidente Prudente (1.05), Rio Branco (1.05), Rio Verde (1.05), Santarém (1.05), São José dos Campos (1.06), Uberaba (1.05), Varginha (1.05)
SUB REGIONAL CENTER	
Subregional Center A	Caçador (1.05), Foz do Iguaçu (1.05), Franca (1.05), Guanambi (1.05), Itajaí (1.05), Ji-Paraná (1.05), Macaé (1.05), Parnaíba (1.05), Paulo Afonso (1.05), Redenção (1.05), Rondonópolis (1.05), Santa Rosa (1.05), Santo Ângelo (1.05), Sinop (1.05), Uruguaiana (1.05)
Subregional Center B	Altamira (1.04), Balsas (1.04), Bauru (1.04), Bom Jesus da Lapa (1.04), Caruaru (1.04), Cruzeiro do Sul (1.04), Erechim (1.04), Gurupi (1.04), Itaituba (1.04), Parintins (1.04), Tefé (1.04), Toledo (1.04), Tucuruí (1.04), Vilhena (1.04)
ZONAL CENTERS	
Zonal Center A	Almeirim (1.04), Alta Floresta (1.04), Araxá (1.04), Conceição do Araguaia (1.04), Corumbá (1.04), Criciúma (1.04), Diamantina (1.04), Juína (1.04), Pará de Minas (1.04), Paraubebas (1.04), Pato Branco (1.04), Ponta Porã (1.05), Porto Seguro (1.04), Porto Trombetas (1.04), Tabatinga (1.04)
Zonal Center B	Cacoal (1.04), Caldas Novas (1.04), Carauari (1.04), Confresa (1.04), Eirunepé (1.04), Juara (1.04), Lábrea (1.04), Lucas do Rio Verde (1.04), São Félix de Xingú (1.04), São Félix do Araguaia (1.04), São João del Rei (1.04)
Local Center	Aripuanã (1.04), Barcelos (1.04), Bonito (1.04), Borba (1.04), Cascavel (1.04), Castilho (1.04), Coari (1.04), Concordia (1.04), Fernando de Noronha (1.04), Fonte Boa (1.04), Francisco Beltrão (1.04), Goianá (1.04), Humaitá (1.04), Joaçaba (1.04), Lençóis (1.04), Manicoré (1.04), Maués (1.04), Minaçu (1.04), Oriximiná (1.04), Ourilândia do Norte (1.04), Santa Isabel do Rio Negro (1.04), Santa Maria (1.04), Santana do Araguaia (1.04), São Gabriel da Cachoeira (1.04), São Paulo de Olivença (1.04), Umuarama (1.04), Una (1.04)

4. DISCUSSION

Figure 5 presents the relation between the PCITY and GDP2008. There is a strong relation between these two variables, although the PCITY has a stronger correlation with the dependent variable of the study, weekly domestic seat capacity supply of the Brazilian airline companies (SEATS). A similar relation occurs in 2004.

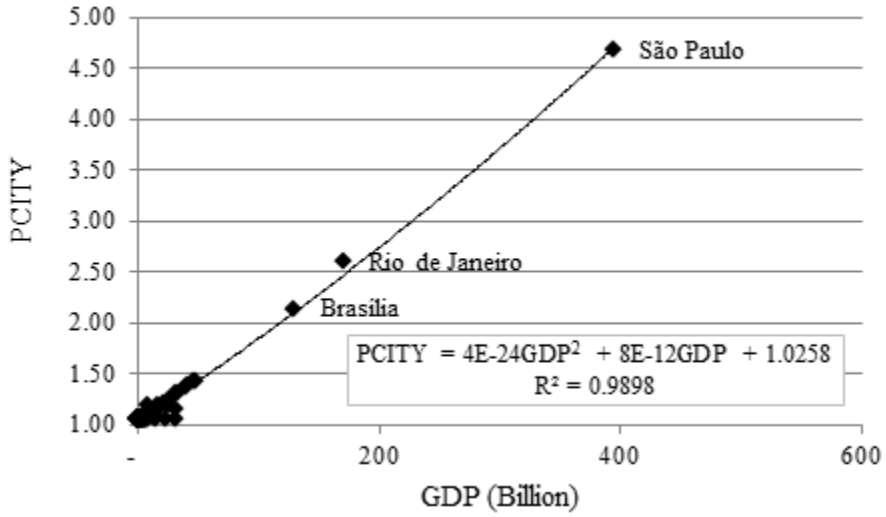

Figure 5 – Relation between PCITY and GDP2008

Bearing in mind the economic distance existing between the Great National Metropolis, São Paulo, the two National Metropolises, Rio de Janeiro and Brasilia, and the remaining cities, a separate analysis will be performed for the remaining cities. Figures 6 and 7 show the relation of SEATS2008 and SEATS2004, respectively, with PCITY for the entire city sample.

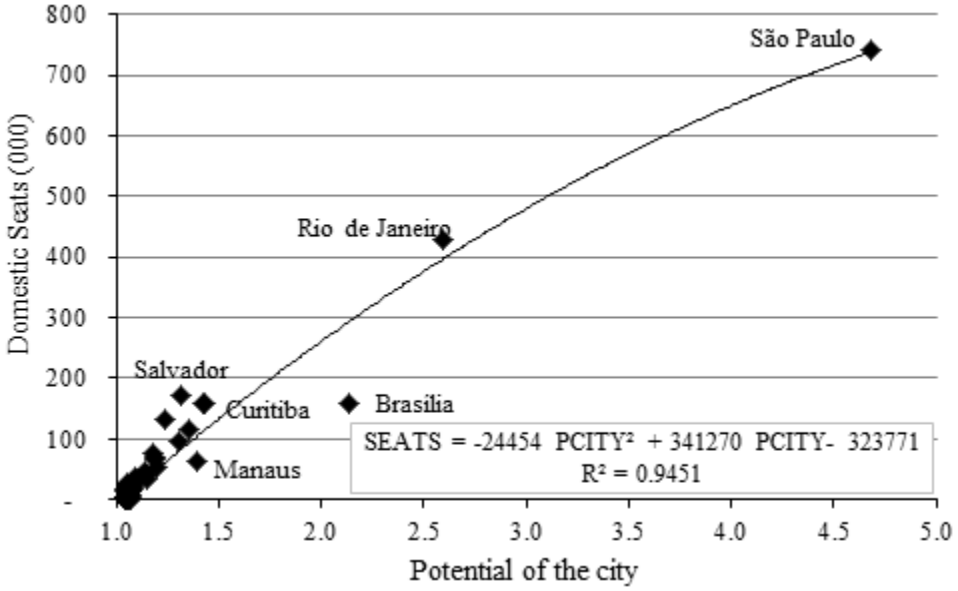

Figure 6 – Relation of SEATS2008 and PCITY for the entire sample (117 cities)

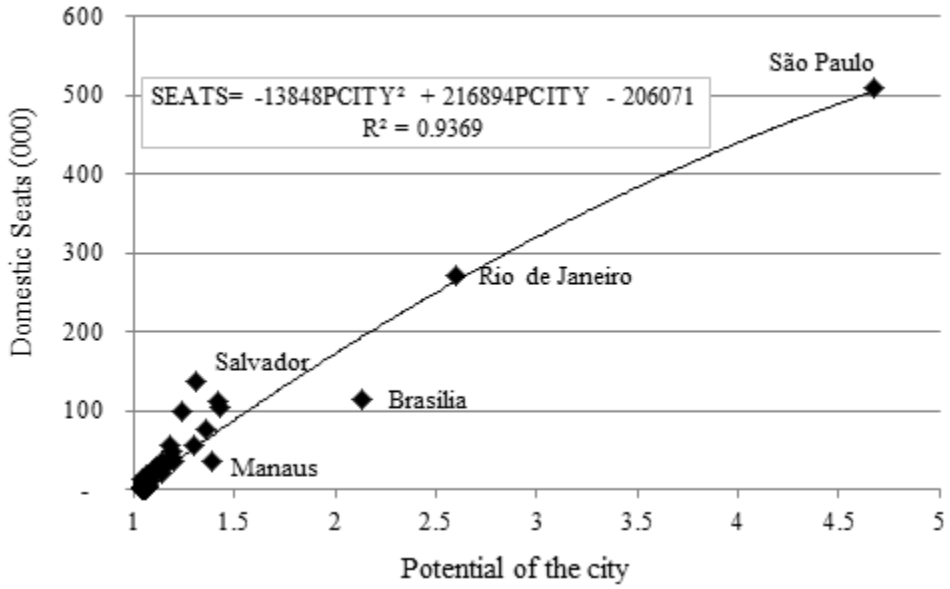

Figure 7 – Relation of SEATS2004 and PCITY for the entire sample (97 cities)

The behavior of the samples is quite similar. A growth can be seen from one year to the other, but the relative position of the cities remains stable. The direction given to the trend, expressed by a polynomial function of second order, explains much of the sample variance. Removing the three national metropolises from the sample, a lesser degree of explanation of the equation is obtained, although still significant. Figures 8 and 9 show the relation of SEATS2008 and SEATS2004, respectively, with PCITY for the sample of the cities without the national metropolises.

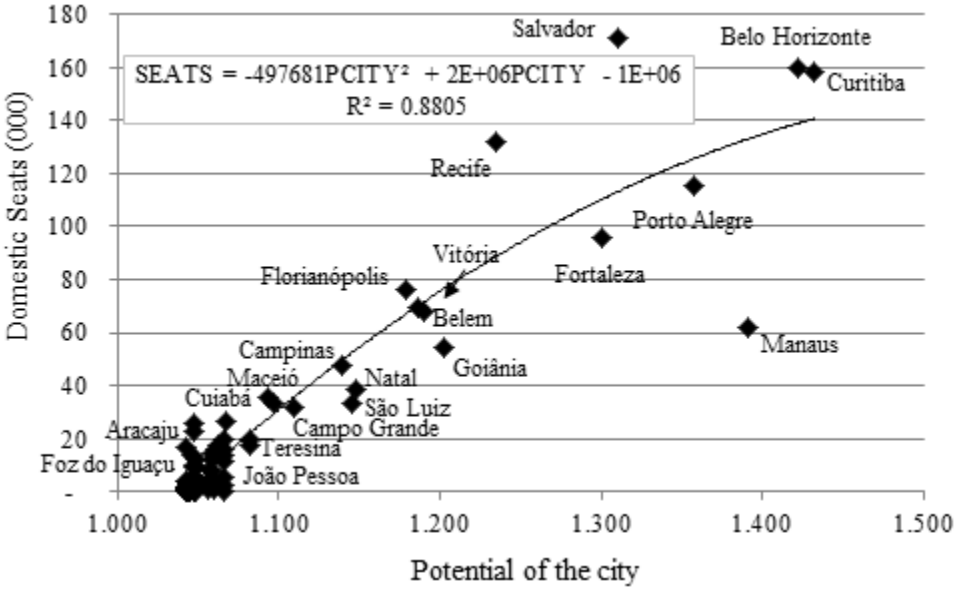

Figure 8 – Relation of SEATS2008 and PCITY without the national metropolises.

The reduced sample of Figure 8 represents 114 cities which have approximately 57% of the SEATS2008 capacity supply. In this Figure, groups of cities with low potential, unnamed in the Figure can be observed. These are 95 cities that represent 12% of the seat capacity supply. These 95 cities constitute the portion of regional air transport in Brazil. Through these data we can infer that the regional air transport in Brazil participates with approximately 24% of the total, this considering that these 12% replicate in larger airports. Nonetheless, the two big Brazilian companies, GOL and TAM, operate in numerous smaller airports with jets having more than 100 seats, once these companies operate with a strongly standardized fleet.

The behavior observed in Figure 9 is quite similar to that in Figure 8. However, an increase in the regional movement can be seen. In 2004 the cities with regional air transport had a maximum capacity supply of 16,500 seats per week, while in 2008 this capacity went up to approximately 22,000 seats weekly. From 2004 to 2008 there was an increase in the number of cities served by regional air transport from 75 to 95, however there was not an increase in the percentage of the participation of these cities in the total capacity supply. It is important to note that among the cities considered as with regional air transport there are still capitals of Brazilian states such as the cities of João Pessoa, Palmas and Teresina.

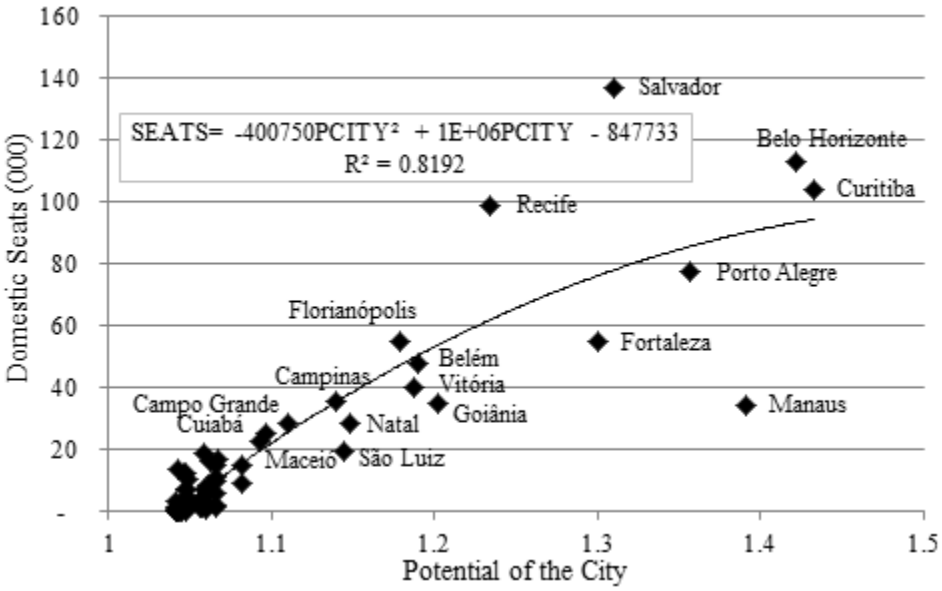

Figure 9 – Relation of SEATS2004 and PCITY without the national metropolises.

The change in level observed from 2004 to 2008 can be explained in large part by the variation of the GDP of the cities. Although the relative hierarchy variation of the cities does not change in the short term, they present absolute variations that influence air transport capacity supply. Figures 10 and 11 present the relation between the change of the weekly domestic seat capacity supply (CSEATS) and the change of the Gross Domestic Product (CGDP) in Brazilian cities with regular domestic aviation, respectively for the entire sample and for the sample without the national metropolises. Considering the entire sample, the second order polynomial line of the trend explains 79% of the sample changes (Figure 10). When the national metropolises are removed this explanation is reduced to 74% (Figure 11).

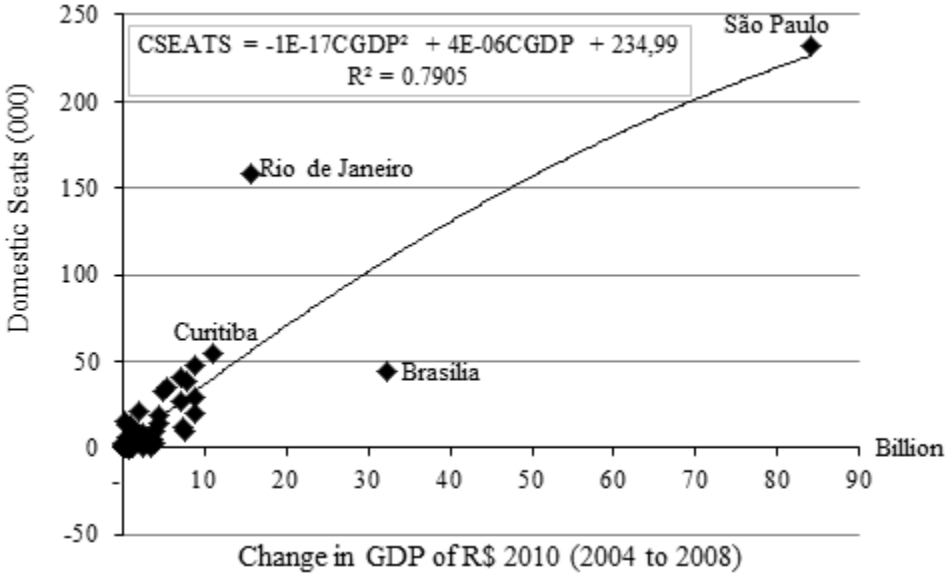

Figure 10 – Change of weekly domestic seat capacity supply from 2004 to 2008 by the change of the GDP of all the cities in the sample.

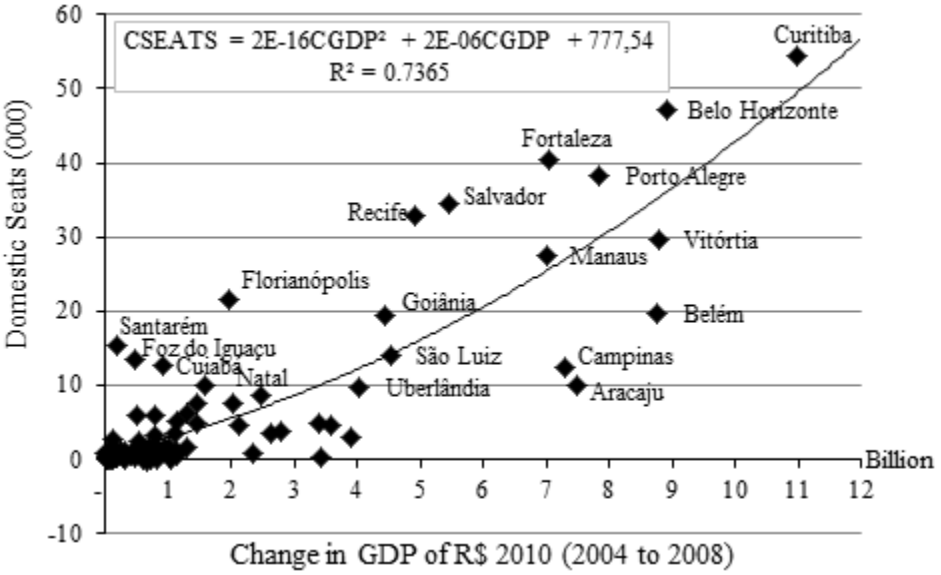

Figure 11 –Change of weekly domestic seat capacity supply from 2004 to 2008 by the change of the GDP of the cities in the sample without the national metropolises.

In Figure 10 a large variation of capacity in the airports of the city of Rio de Janeiro and a more moderate variation in Brasilia can be observed, although the GDP variation of Brasília was more accentuated. These deviations are due to circumstantial factors and airport capacity restrictions. These factors lead companies to define new positions related to Hubs and, consequently, new operational logistics. Hub-by-pass, for example, is one of the alternatives to limitations of capacity in the main airports, as in the case of Brasília which is a large Hub of connections for the major Brazilian airline companies. In 2008 the city of Rio de Janeiro was already being rediscovered as an important Hub in the Brazilian air transport

network. This can be attributed to the saturation of São Paulo's airport infrastructure, but also because of the great appeal that the boost of oil economy brought to the state of Rio de Janeiro, and the orientation of the city to host major international events. The smaller airports, which constitute the greater part of the air transport network and can be classified as regional, do not present regular behavior (Figure 11). The regional airports responded for about 13% of the total variation of seat capacity supply during the period from 2004 to 2008. Being that the participation of this group was approximately 12% of the total offered in 2008, this indicates that there was a slight trend for increased participation of the regional airports in the total capacity supply. This might be the great opportunity that the new entrant to the domestic Brazilian air transport system, AZUL airline, sees to become an important player in the market. Recently (June, 2012) AZUL merged with the main regional airline of the country, TRIP, forming the third largest national air transport company.

The city of Brasília presented a position below the line of estimated trend, for both, the size of the capacity supply and the capacity supply variation during the period studied. This behavior is due, probably, to the lack of airport capacity, which makes changes in supply structure impossible, especially during peak hours. The city of Manaus presented a position also below the trend line, however the reason is very distinct. The city of Manaus is a natural Hub for the northern region of the country. Nonetheless, the regional aviation is very little developed in the region and as such the city depends fundamentally on its own trips generation, benefitting very little from the regional connections of passengers travelling to other regions of the country.

5. CONCLUSIONS

The hypothesis of the study was confirmed, and the study indicates that the geography of seat capacity supply at domestic airports in Brazil is strongly linked to the hierarchy of the cities, with no significant alteration from 2004 to 2008. There has been no significant change in the capacity structure with the collapse of VARIG. The role of this company has been assumed by the other companies in the market. A possible bottleneck to the development of domestic air transport in Brazil is the inexistence of secondary airports in the national metropolises and in some regional cities of greater expression. The congestion of central airports inhibits the development of regional aviation, which has a low priority in these airports. Approximately 25% of the movement in Brazilian airports comes from regional aviation, with half of that occurring in regional airports and the other half in larger-scale airports. The air transport capacity supply of cities having a lower hierarchy did not present a statistical relation with hierarchy of the city or GDP. The opportunity observed by the companies seems to be linked to specific or circumstantial issues. The duopoly of the two dominant companies led to a model of predatory competition, where the benefits of one company imply in the loss of the other. The growth of market share of the coalition of TRIP and AZUL can bring a new perspective to the competitive process, inducing a spatial distribution of a more deconcentrated seat capacity supply based on a real increase of the

demand base. However, if the growth of this new coalition is obtained by the fall of one of the dominant companies, Brazil will be returning to the past. Airlines still not observing the changes in demand behavior, they just follow the city's economic potential and defend traditional markets, without considering new potential regional markets. Otherwise, air transport policy just focuses on the large airports growth, which does not, necessarily, open space for the growth of regional air transport. Secondary airports in the large urban centers and the opportunity for regional aviation have been identified as research themes of great relevance for the development of domestic air transport in Brazil.

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