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The spatial effects of domestic aviation deregulation: A comparative study of Australian and Brazilian seat capacity, 1986-2010

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Abstract

The aim of this paper is to examine the link between the volatility of aviation policy and the spatial evolution of air transport supply. We focus on the domestic aviation sector of two comparative cases – Australia and Brazil – each of which represents a large continental country with contrasting levels of policy volatility. We apply generalized entropy indices to measure the changing spatiality of air transport seat capacity over a 25-year period (1986-2010). We find evidence of a correlation between air transport policy volatility and spatiality. The study finds that the spatial evolution of Brazilian air transport capacity is governed by variations among very large airports, which are often subject to policy and regulatory intervention. In contrast, the distributional pattern of Australian airports was relatively stable and characterized by gradual and consolidative changes.

Keywords: air transport policy volatility; spatial effects of aviation deregulation; Australia; Brazil; generalized entropy index

1. Introduction

Globally, the new geography of air travel has been shaped by a number of forces, including the changing location of air travel demand, aircraft technology, capacity constraints in major airports and deregulation/regulation (O'Connor 2003, Derudder and Witlox 2009, Bowen 2010). In particular, spatial effects of aviation policy have been closely examined in the research literature; namely, from the perspective of accessibility (Chou 1993), the core-periphery pattern of development (Goetz and Sutton 1997), evolution of low-cost airline networks (Reynolds-Feighan 2001, Dobruszkes 2006), regional economic development (Papatheodorou and Arvanitis 2009), emergence and consolidation of airport hierarchy (Thompson 2002) and impacts on tourism (Costa *et al.*, 2010), among others. Research in this domain encompasses, to a varying degree, the cause-effect relations between aviation policy (especially deregulation) and the spatial evolution of air transport.

In regards to the spatial effects of aviation policy, differential experiences across geographic contexts are expected as the political and operating environments vary for airlines in different countries (e.g., Huber 2009, Shaw *et al.* 2009). Deregulation policy is formulated and implemented differentially in various countries, and this difference in contexts complicates the analysis of the spatial effects. One key contextual difference is volatility in aviation policy – defined here as the rapidity in which policy change from one direction to another (such as from deregulation to re-regulation). For example, Hooper (1998) shows that the Indian government often changed its regulatory guidelines at short notice, and partially contributed towards creating an environment that required continuous intervention after deregulation.

Developing nations where issues such as low air traffic density, infrastructure shortages, governmental financial constraints and lack of private investments are preponderant (Fayed and Westlake 2002) might expect greater policy uncertainty and volatility. This is supported by studies from other developing regions of the world, including countries in Africa (Akpoghomeh, 1999; Pirie, 2006), South America (Lipovich, 2012) and Southeast Asia (Rimmer, 2000).

Against this background, this paper aims to examine the link between policy volatility and the spatial evolution of air transport supply. In the absence of an experimental design, the study focuses on two comparative cases, each representing contrasting levels of policy volatility. This paper provides an interpretative account of correlative evidence based on generalized entropy indices and the Gini index. Additionally, the paper adds to the existing body of research by introducing Australia and Brazil as comparative cases – two neglected regions in the study of the spatial effects of deregulation.

2. Domestic aviation in Australia and Brazil

Comparative analyses have been widely employed in air transport studies, addressing airlines (Barbot et al., 2008), airports (Nijkamp and Yim, 2001; Oum et al., 2003; Wang et al., 2004), networks (Reynolds-Feighan, 2010) or countries as a whole (Lohmann et al., 2009). The similarities and differences between Australia and Brazil provide an opportunity to explore the reality of domestic aviation in two similarly large countries with respect to their geographic size as measured by their surface areas. The World Economic Forum Tourism and Travel Report (2009) shows that Australia exhibits the characteristics of a developed economy given its high GDP per capita, a population with a relatively high propensity to fly and a higher ranking in air transport infrastructure quality, among other indicators (Table 1). Both nations commenced deregulation of the domestic aviation sector around the same time period (Australia in 1990 and Brazil in 1992), which is useful for comparative purposes. However, in the years following deregulation, the two nations developed very different domestic aviation policy trajectories. These are briefly described below.

Table 1 Key indicators: Australia and Brazil (source: compiled from World Economic Forum 2009).

	Australia	**Brazil**
Population (million)	20.6	191.3
GDP/Capita (US$)	36,225	9,703
Surface area (1,000 square km)	7,741	8,514
Quality of air transport infrastructure (world rank)*	19th	101st
Airport density (airport per million people, world rank)	7.3 (4th)	0.6 (78th)
Departures per 1,000 population (world rank)	17 (22nd)	3 (62nd)
Domestic ASK (world rank)	,388m (5th)	1,354m (6th)

Note: *Based on Executive opinion survey (2007-2008) (WEF 2009)

In order to provide a systematic comparison of domestic aviation environments between Australia and Brazil, the following subsections discuss key considerations such as deregulation, competition, airport policies and safety issues in the period 1986-2010.

2.1 Australia

2.1.1 Deregulation and re-regulation

In October 1990, the Australian government-enforced duopoly on inter-state domestic aviation terminated. Constraints were removed from control of aircraft imports, the capacity allowed and supplied on trunk routes by airlines, the abolishment of the Independent Air Fares Committee in setting fare levels, and the entry/exit barriers to domestic trunk routes (BTCE 1991).

2.1.2 Competition

During the period analyzed, domestic air transport competition in Australia can be divided into four main stages:

- First wave of entry: 1990-1993 (Compass I and Compass II entry and exit within one year of operation);
- Duopoly: 1994-1999 (Ansett and Trans-Australian, acquired by Qantas in 1996). It is argued that despite the failure of two new entrants, their effect on competition perpetuated because it fostered greater competition between the two incumbents (Sinha 2001);
- Second wave: Impulse (1994-2000) and Virgin Blue (inaugurated in 2000) entered with a low-cost model. Impulse was absorbed by Qantas in 2000, while Virgin Blue was successful in cementing a position in the domestic aviation market, partly helped by the collapse of Ansett in 2001;
- Third Wave: three more carriers entered the market (OzJet, Jetstar and Tiger) of which Jetstar (in 2004, as a subsidiary of Qantas) and Tiger (in 2007) cemented positions in the domestic market alongside Qantas and Virgin Blue.

Forsyth (2001) has shown that Australian domestic airlines have improved in productivity during the 1990s and argued that the gains have been passed onto consumers, despite limited competition. While the same cannot be said for the years 2000-2010 due to data limitations, the combination of strong competition and the proliferation of low-cost carrier services (and the longevity of their presence in the market) may be indicative of improvements in airline efficiency.

2.1.3 Airport policies

As part of a series of microeconomic reforms in many sectors of the economy, the Federal Airports Corporation (FAC) was established by the Australian federal government in 1988, administering 22 airports in the country (Hooper et al., 2000). All major airports managed by the FAC were eventually privatized in 1997 and 1998; Sydney airport, in 2002 (Kain and Webb 2003). Pricing caps were removed on aeronautical charges in most airports in 2002, while pricing reforms also took place in the air traffic control and airspace management services provided by Airservices Australia, which involved shifts toward user-based and cost-reflective pricing strategies (Kain and Webb 2003).

2.1.4 Safety

Between 1999 and 2008, accidents (both fatal and non-fatal) fluctuated between 14.4 and 30.9 accidents per million departures, while the rate of fatal accidents ranged between zero and four per million departures. In this period, there were no occurrences of fatal accidents among high capacity regular public transport (defined as capacity greater than 38 seats) or commercial air transport.

2.2 Brazil

2.2.1 Deregulation and re-regulation

In Brazil, regional air services, excluding services between state capitals, were deregulated in 1992, followed by the deregulation of the main state capitals' domestic routes in 1998 (Williams, 2002). This was followed by re-regulation of the industry in 2003, including the granting of code-share rights between the two main carriers, as well as limits on frequency of air services and new aircraft import, in response to the airline financial crisis in 2002. All of this occurred before reverting to the pre-2003 deregulatory state in 2006 (Bettini and Oliveira, 2008).

2.2.2 Competition

Following the deregulation of 1998, in the early 2000s, Transbrasil and Vasp exited the market, with Gol (which commenced operation as a low cost carrier in 2001) later acquiring Varig, which was once the largest domestic carrier in Brazil. The only large incumbent airline to survive deregulation was TAM Airlines, which since the Gol/Varig merger dominated the domestic market in a duopoly with Gol/Varig. In 2008, TAM and Gol/Varig accounted for approximately 92% of the domestic ASK. In the same period, the remaining airlines comprised several small- and medium-sized regional airlines as well as the two main low-cost carriers, Webjet and Azul.

2.2.3 Airport policies

In the period studied, airports in Brazil were managed by Infraero, which controlled around 67 airports that handled approximately 95% of the passenger traffic, while CINDACTA (Center of Air Defense and Air Traffic Control) was responsible for services related to air traffic management. Both services were centrally managed. In the case of Infraero, there was cross-subsidization between profitable and non-profitable airports. Also, there were wide variations in the efficiency across airports (Pacheco and Fernandes, 2003; Pacheco et al., 2006).

2.2.4 Safety

Contemporary Brazilian aviation is marred by two major accidents. In October 2006, a mid-air collision between a Gol Boeing and an executive jet killed all 154 passengers and crew on-board Gol Airlines B737. In July 2007, an A320 from TAM slipped off the Congonhas' airport runway in São Paulo and crashed into a building, killing 200 people. These resulted in 'crisis-level' cancellations and congestions between 2006-2008, with the civil aviation authority decentralizing traffic from congested airports, particularly Congonhas (Lohmann and Trischler, 2012).

3. Methodology

3.1 Generalised entropy and Gini

Our chosen measurement tool should be capable of encapsulating changes in the spatial concentration and dispersal trends across the given number of airports over time. Ratios are indicative but too restrictive because they ignore the distributional characteristics of the data. The Gini method is well understood, so its details are not replicated here (see, for example, Burghouwt 2007, Reynolds-Feighan 1998). Reynolds-Feighan (1998: 250-251) has argued that 'the Theil and Gini indices are considered superior statistics … allowing for comparison of traffic distributions over space and time by presenting an absolute measure of concentration based on the entire traffic distribution'. We chose to use the Theil as a primary tool of analysis for the reason that the Theil index also belongs to a family of entropy-based measures. This quality, as will be observed later, provides the analyst with ways to test the spatial concentration-dispersal characteristics of different parts of the distribution (e.g. among smaller or larger airports) by the control of the sensitivity parameter. Furthermore, Theil, as is the case with Gini, is decomposable into a 'within' and 'between' component akin to ANOVA. The 'within' refers to the variation in concentration/dispersal sourced from variation within a group of airports, whereas 'between' refers to the part of the overall variation sourced from the variation across the mean of each airport group. The Theil index is of the form:

$$T = \frac{1}{n}\sum_{i=1}^{n}\frac{y_i}{y'}\left[\log\left(\frac{y_i}{y'}\right)\right] \qquad \text{equation (1)}$$

where y_i is the seat capacity in i^{th} airport and y' the average airport seat capacity. It is well-established that the Theil index can be decomposed into within-group (WG) and between-group (BG) component:

$$T = \sum_{i=1}^{J} s_i T_j + \sum_{i=1}^{J} s_i \ln\frac{y'_j}{y'} \qquad \text{equation (2)}$$

where y'_j is the average seat capacity in j^{th} group of airports and y' the average airport seat capacity of the entire sample. s_i is airport *i*'s share of seat capacity and T_j is the Theil index for group *j*.

The Generalised entropy (GE) is of the form (following Cowell 2011):

$$E_a = \frac{1}{a^2 - a}\left[\frac{1}{n}\sum_{i=1}^{n}\left[\frac{y_i}{y'}\right]^a - 1\right] \qquad \text{equation (3)}$$

where y_i is the seat capacity in i^{th} airport and y' the average airport seat capacity. 'a' is a parameter that, when equals to 1, is equivalent to Theil - equation (1) (Cowell 2011). Higher 'a' means that the entropy index will be more sensitive to the changes in airport capacity shares among large airports (high-end of the distribution), whereas lower 'a' means that GE will be more sensitive to the changes in airport capacity shares among small airports (low-end of the distribution). Thus, through the control of weights we can learn more about the effects of aviation policy on the distributional characteristics of air transport capacity.

3.2 Data and airport grouping

Data were obtained from the OAG and the Bureau of Infrastructure, Transport and Regional Economics (BITRE) for Brazil and Australia, respectively, for the 25 years ranging from 1986 to 2010, inclusive. These are yearly uplift and discharge data for each airport in seat numbers. Aircraft information is not reported. The two countries share a similar number of airports with regular public transport services, although the actual numbers have fluctuated over the 25-year period (Figure 1). For the purpose of decomposition, it was necessary to group airports. With the aid of cluster analysis (specifically, the complete linkage and Ward linkage methods), we identified a clear group of airports serving three largest cities of each country (see Table 2). This first group was easy to establish based on cluster analysis results. However, without a priori hypothesis to guide the grouping process, cluster analysis could not find a clearly distinguishable group of airports among cities other than the three mentioned above. Consequently, we chose to use politically salient boundaries as the basis for the remaining groups. An obvious choice was state/provincial capitals. Thus, three groups were established for each country: the 'top 3 state capital cities' (Group 1), 'airports in remaining capital cities' (Group 2), and all other (Group 3). We note that, as a robustness test, different grouping was attempted (for instance, a four-group structure with an additional 'secondary' destination category). However, the basis for the additional category was not clear and, more importantly, the overall conclusion did not change as a result of the change in grouping. Political saliency as a choice of grouping criterion also made good sense in that, as previously discussed, the regulatory changes (particularly in Brazil) were effected at this level – as some state capitals in Brazil were subject to different regulatory barriers compared with all other airports. Although not state capitals, Gold Coast and Cairns city and the airports serving them are outliers in that they are larger than some capital cities (sixth and eighth largest airports in 2010, respectively) and thus were added to Group 2. It is common in the Australian policy-making arena to treat these two airports alongside Group 1 and Group 2 airports (see, for example, Dept. Transport and Infrastructure 2009).

Figure 1 Number of airports served with scheduled services (more than 10,000 seats per annum) (source: processed from BITRE and OAG data)

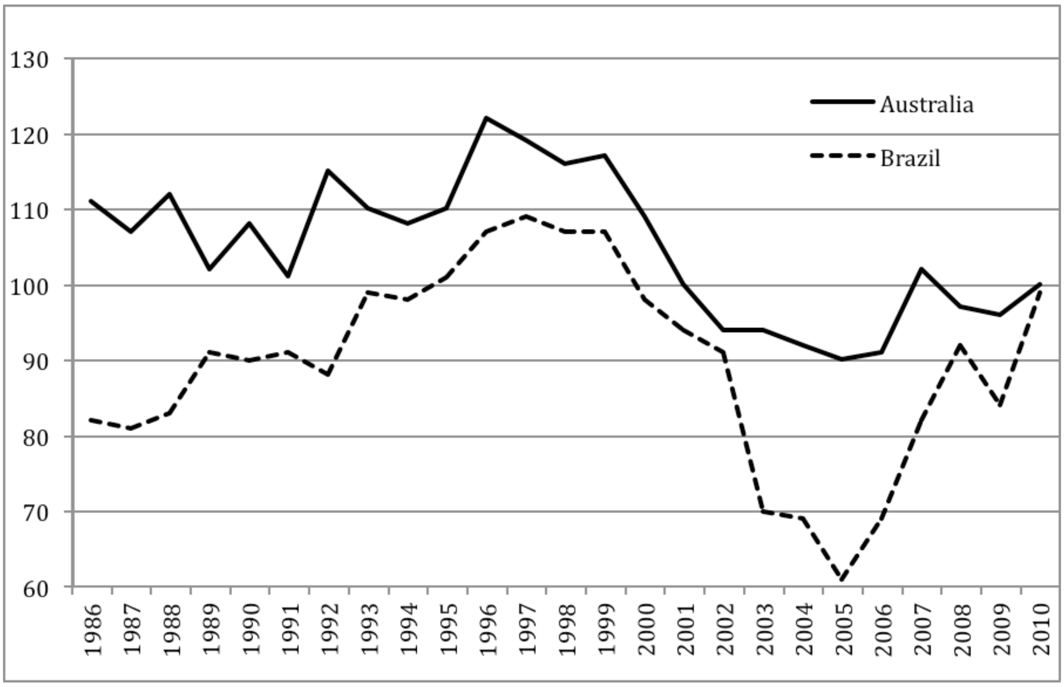


Table 2. Airport groups

	Brazil	Australia
Group 1 (airports serving 'top 3 cities'	São Paulo Guarulhos; São Paulo Congonhas; Brasília; Rio de Janeiro Santos Dumont; Rio de Janeiro Galeão	Sydney, Melbourne, Brisbane
Group 2 (airports serving provincial or state capital cities)	Recife, Porto Velho, João Pessoa, Aracaju, Salvador, Palmas, Porto Alegre, Campo Grande, Macapá, Boa Vista, Belo Horizonte (Pampulha), Fortaleza, Vitória, São Luiz, Florianópolis, Maceió, Natal, Curitiba, Teresina, Manaus, Rio Branco, Belém	Canberra, Hobart, Darwin, Adelaide, Gold Coast, Cairns, Perth
Group 3	All other airports in Brazil with a scheduled seat capacity greater than zero in 2010	All other airports in Australia with a scheduled seat capacity greater than zero in 2010

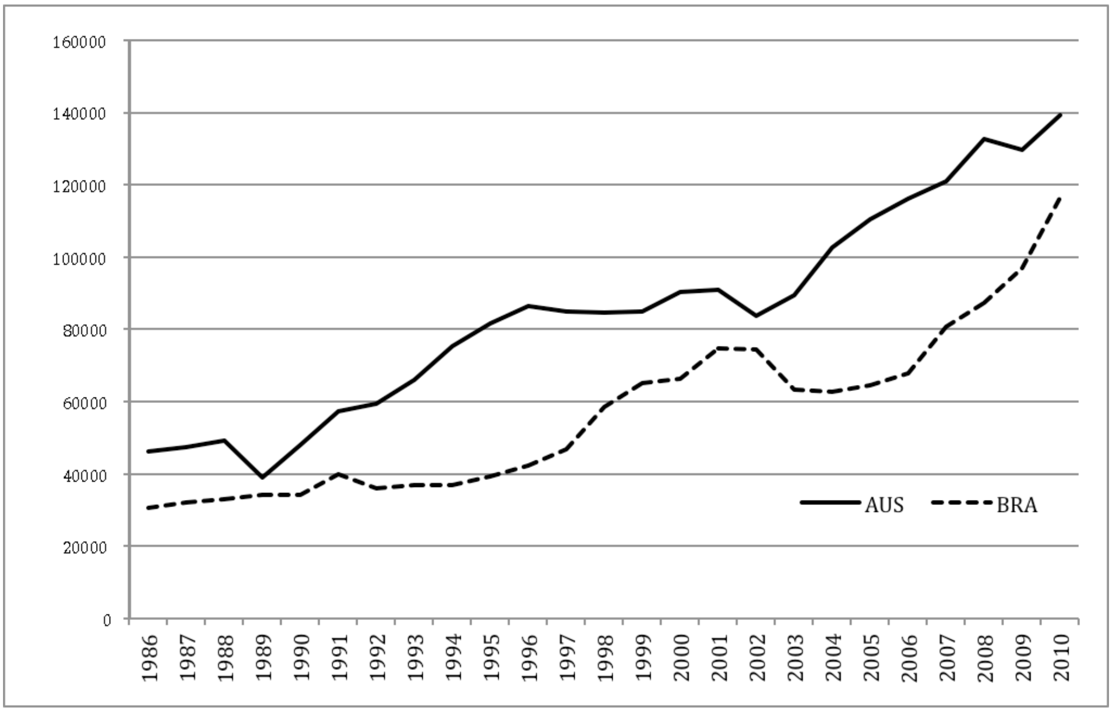
4. Results

4.1 Seat capacity

Seat capacity in the analyzed timeframe shows consistent patterns over time (Figure 2). In Australia, the 1990s were characterised by a gradual capacity growth, followed by a steep decline after the collapse of Ansett in 2001. Capacity recovered to levels prior to the collapse of Ansett by 2003, with Virgin Blue (in 2011 rebranded as Virgin Australia) and Jetstar adding significant domestic seat capacity, resulting in the acceleration of capacity growth. As for Brazil, the significant increase in capacity after 1998 was also followed by decreases in capacity between 2002-

2004. Improved Brazilian GDP growth, a strong national currency, connectivity and the presence of a LCC (Gol Airlines) with lower airfares increased demand (Bettini and Oliveira 2008). The excess capacity that existed in the early 2000s was adjusted in the 2002-2005 period as a result of code-sharing allowance between major airlines and the imposition of capacity restrictions on adjacent airports (particularly in the cases of Rio de Janeiro, São Paulo and Belo Horizonte, the largest multi-airport cities of Brazil). These majors contributed to load factor improvements. Both countries experienced the same underlying trend: an increase in domestic aviation demand and supply over time, although the growth curve proved more volatile for Brazil. It is worth noting that load factors remain consistently high in Australian domestic aviation, fluctuating around 79% between 2000-2009 (BITRE 2010). In the Brazilian domestic aviation market, the total load factor was 58% in 2000, reached a peak of 71% in 2006 and declined to 70% in 2010 (ANAC's annual reports).

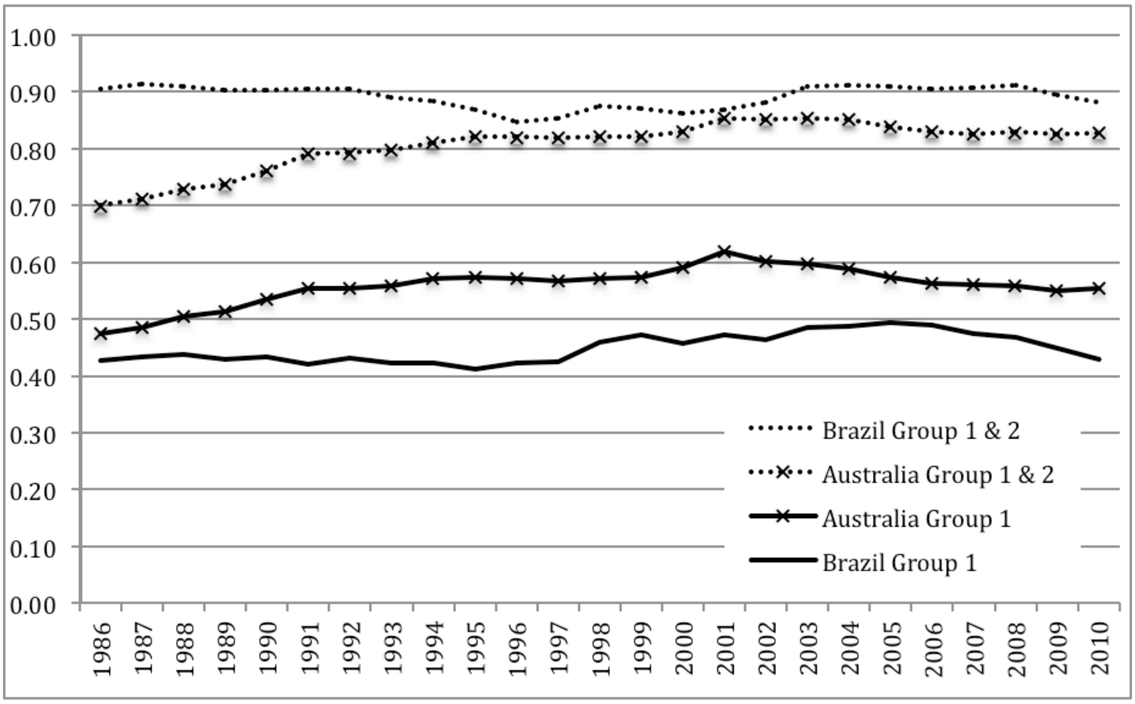
Figure 2 Number of incoming seats over time (1986-2010) (source: processed from BITRE and OAG data)



4.2 Concentration ratios

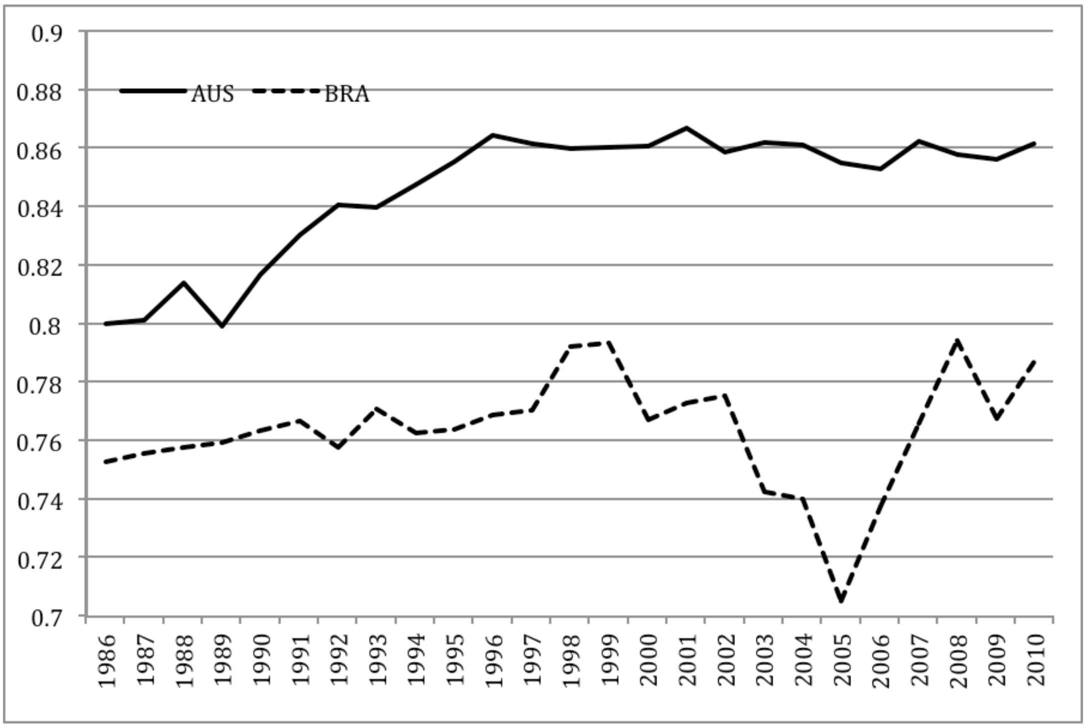
Australian and Brazil seat capacity is concentrated (Figure 3). This is particularly the case in Australia where three airports, for most part of the period examined, account for more than half of total domestic seat capacity. There is clear evidence of increasing shares in the airport Groups 1 & 2 over time, reaching a peak in 2001. As expected, the share of Australian Groups 1 decreased since 2001 as a result of the strong low-cost-carrier-led-growth in capacity in Group 2 and other remaining (Group 3) airports. Brazilian deregulation in 1992 does not seem to have had much effect on the concentration ratio of Group 1, however, the concentration effect of 1998 deregulation can be seen. Group 1 & 2 ratio decreased since 1992, which is partly an outcome of the increased number of airports served (over 10,000 seats p.a.). Since then, the Group 1 & Group 2 ratios peaked in 2004-2005, which is partly an outcome of significant decline in total capacity across all airports between 2003-2005, with many very small airports (less than 10,000 seats per annum) dropping out of our analysis.

Figure 3 Concentration ratio approach (1986-2010) (source: processed from BITRE and OAG data)



4.3 Gini
For Australia, the Gini index shows a pattern of increasing concentration from 1990 onwards before stablizing in the years following 1996 (Figure 4). Deregulation forced the incumbent airlines to rationalize their networks, as well as to increase capacity on trunk routes in response to competition from the early entrants, whom have entered trunk routes. The combined effect has been growths in capacity especially among the major airports, increasing the Gini index. Brazilian experience was similar in that between 1992 and 1997 there was a gradual increase in concentration. From 1998 and onwards, however, Brazilian airport capacity distribution was much more volatile, especially in the decade following 2000; the value of the Gini dropped from the height of 0.79 (1999) to 0.71 (2005) before rapidly returning to 0.79 in 2008. As discussed in Section 2, Brazilian aviation sector has been subjected to considerable turbulence since 1998, including a number of entry and exits, financial crisis, accidents, introduction of new airport slot provisions and the volatility in the deregulatory/re-regulatory policy. The combined effects of this turbulence are reflected in the fluctuating Gini scores since the 1998 deregulation. The following section revisits these turbulences in more detail with the aid of generalized entropy indices.

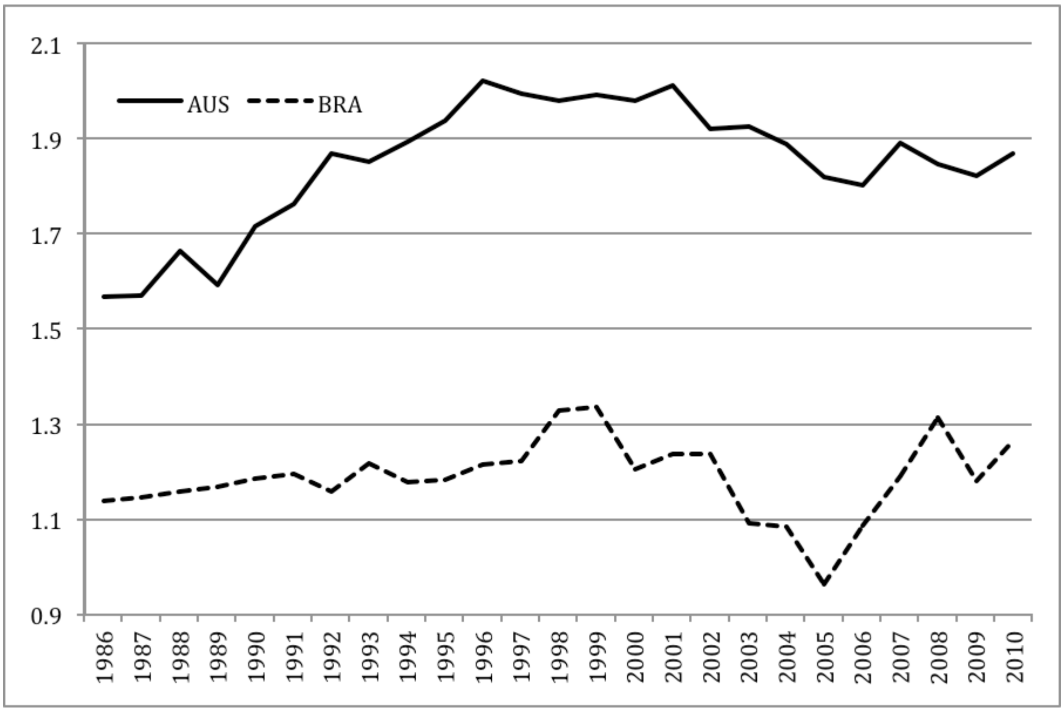
Figure 4 Gini indices (1986-2010) (source: processed from BITRE and OAG data)



4.4 Generalised entropy indices

Further analysis can be done in regards to the spatial-structural variations in domestic aviation capacity using the generalized entropy indices in at least two possible ways: (1) through experimentation with weights; and (2) through the analysis of sub-groups. For the former, entropy measures also allow analysts to change the weight (the sensitivity parameter). By observing the effect of the changes in the weights, we can observe patterns that are otherwise difficult to encapsulate with other measurement tools. For instance, 'a' in equation (3) can be changed to gain a sense of where the concentration and dispersion (among airports of different sizes) have occurred. Specifically, as 'a' increases, the GE's sensitivity to the changes in 'top' (large airports) part of the distribution increases. When 'a' equals one, we obtain the Theil index. Of all possible GE indices, the Theil is the closest to the Gini. For most part, the Gini and Theil (Figures 5 and 6, respectively) methods show similar results. Note that the Gini, in a discrete distribution, has a lower-upper bound of [0, (n-1)/n], whereas the Theil has [0, log(n)].

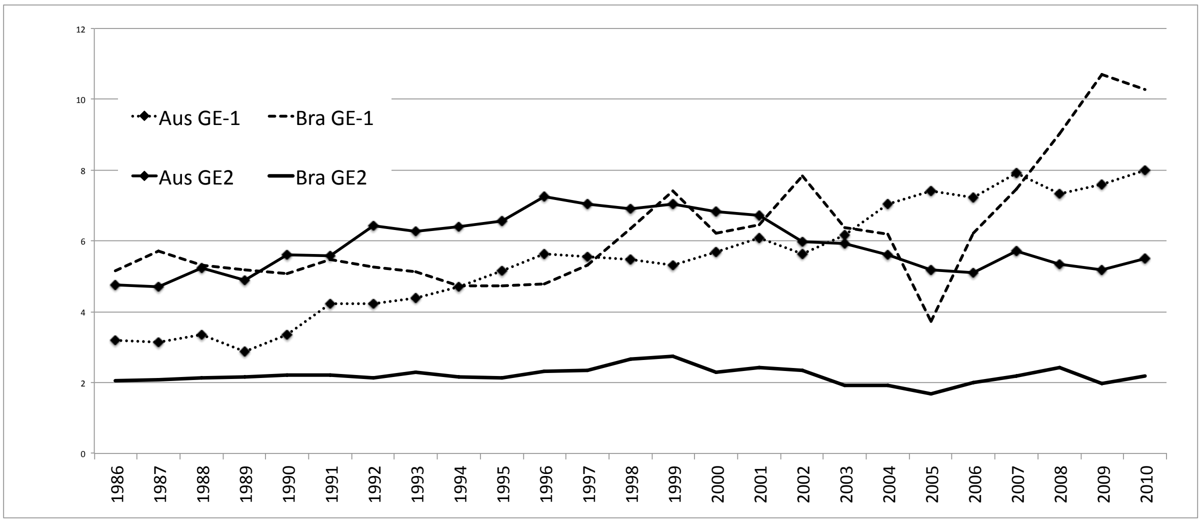
Figure 5 Theil index (GE1) (source: processed from BITRE and OAG data)



4.4.1 Australia

Australian GE(-1) shows consistent increases between 1986-2010, while GE(2) shows an increase between 1986-1996 and then a noticeable decline between 1999-2006 (Figure 6). The GE(2) pattern over the entire period examined is similar to the Theil (GE(1)) albeit more amplified in its movements. The post-2000 patterns, in particular, are not recognized by the Gini, which remains relatively 'flat'.

Figure 6 GE(-1) and GE(2) 1986-2010



Herein 'small' airports are those with seat capacity below average and 'large' are the ones above. Putting these patterns together, we can conclude that first, Australian seat capacity increased in concentration in all parts of the distribution – small and large airports – until 1999. Second, capacity begun to disperse in the period following 1999 among large airports (this is evident by the relative decline in the Groups 1 and 2 ratio – Figure 3), while small airports continued to become smaller relative to the average. The former is confirmed by the fact that, between 1999-2010, Sydney and Melbourne's ratio decreased from 29 to 22 and 22 to 19, respectively. Because GE(2) is a function of [(yi/y')^2] where yi is seat capacity in the airport i, and y' is the average airport seat capacity in a given year, GE(2) is sensitive to this change. The latter is confirmed by the high inverted ratio (where GE(-1) is a function of [(yi/y')^(-1)]), which increases rapidly when small airports become smaller.

4.4.2 Brazil
The GE measures for Brazil closely follow Gini. Similar to Australia, the spatial evolution of Brazilian air transport capacity is governed by the 'top of the distribution'; that is, by variations among very large airports. Below explains the events that precipitated the concentration/dispersion in different moments of the timeframe considered in this research:

- 1998 (an increase in concentration): the government deregulated some capital city routes, resulting in the increase in capacity mainly on the top three airports (Congonhas, Santos Dumont and Brasilia);
- 2002-2004 (sharp dispersion): the government implemented capacity control to limit route expansions, airline entry and fleet expansion of major airlines such as TAM and Varig, as well as the grounding of Transbrasil, in 2001, and VASP, in 2004. The combined effects were large decreases in total domestic seat capacity;
- 2005-2007 (sharp concentration and strong capacity growth): capacity growth continued and more efficient airlines such as GOL acquiring Varig. Despite the slots introduced in major airports in 2005, concentration continued because capacity re-distribution occurred only among the largest airports. For instance, limiting rapid capacity growth in the largest airport, Congonhas, resulted in dispersed capacity to other significant airports such as Galeão (Rio de Janeiro) and Guarulhos (São Paulo). The above airports are among the five largest airports in Brazil when measured in annual seat capacity;
- 2008-2010 (relative dispersion and strong capacity growth): at least two policy-induced changes appear to be responsible for the relative weakening of spatial concentration: (1) capacity control was relaxed and more competition was allowed, resulting in airlines such as Azul entering and operating out of under-utilized airports, such as Campinas (which serves São Paulo); and (2) after the two fatal accidents, long-distance flights (over 1,000 km) and connections were banned from Congonhas (São Paulo), which resulted in transit passengers been connected through other airports.

4.5 Decomposition
Generalized entropy decomposition is particularly useful for identifying the group that accounts for the inequality. Aviation policies, including airport slot controls, tariff restrictions, and traffic right allocations, are often applied discriminately across airports. This means that it is important to observe how groups of airports contribute towards the overall level of spatial concentration and dispersion. The results in Figures 8 and 9 reveal that the airport hierarchy is cemented in Australia, which is

made evident by the stability of the decomposed GE measurements over time. Between-group (BG) variation explains the majority of spatial volatility (across Group 1, 2 and 3). The ratio of within-group and between-group halved from 0.2 to 0.1 in the 25 year period, providing further evidence of consolidation in the airport hierarchy.

Figure 7 Theil decomposition Australia (source: processed from BITRE and OAG data)

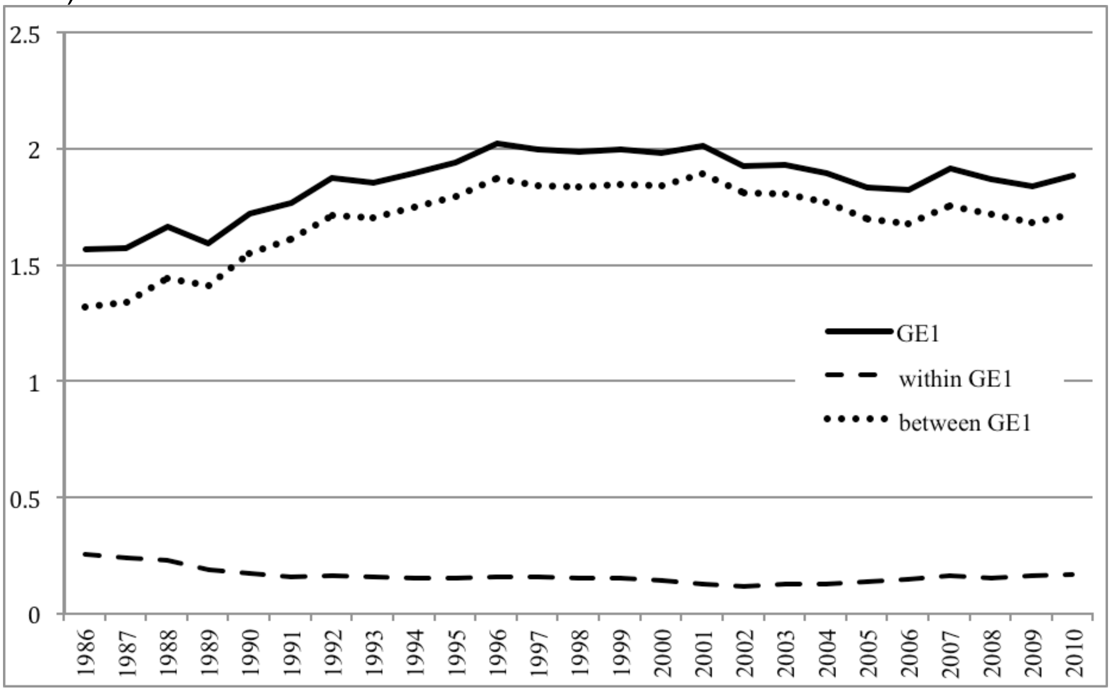
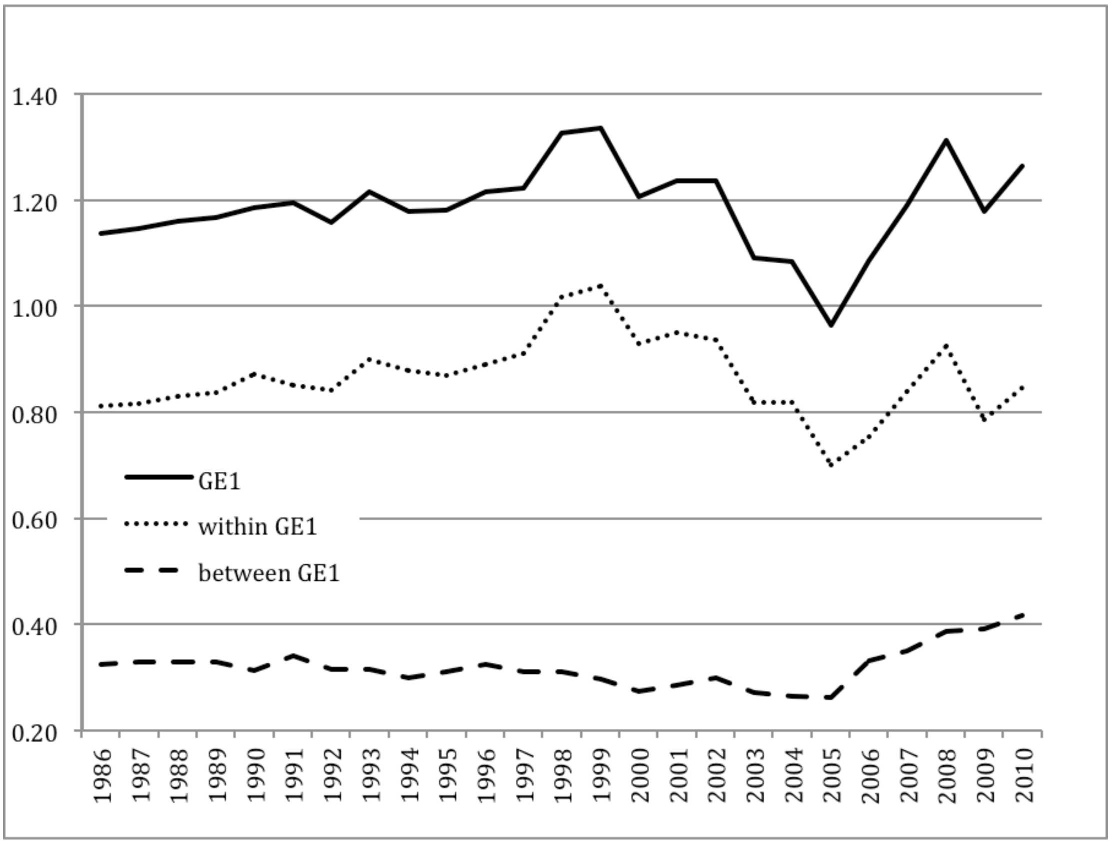


Figure 8 Theil decomposition Brazil (source: processed from BITRE and OAG data)



The results for Brazil are different. First, within-group (WG) variation assumed a greater influence in Brazil than it did in Australia. Second, WG and BG increased after 2005. This increase appears to be policy-related, including the effects of (1) slots control; (2) regulatory change to introduce new competition in 2007, which opened up more entry into secondary airports serving large centers such as São Paulo; and (3) the banning of flights with distances over 1,000 km from Congonhas. The concerted outcome of these factors has been some dispersing of capacity to airports outside Group1. Interestingly, this has had an effect of reducing the inequality within Group 1 (the sub-group GE1 decreasing from 0.14 to 0.02 between 1986-2010) while increasing within-group inequality for other two groups. Among Group 2, the sub-group GE1 has increased from 0.28 to 0.41 between 1986-2010 with a peak of 0.44 in 2009, while the sub-group GE1 of Group 3 increased from 0.93 to 1.27. These results suggest that Brazilian domestic aviation is still undergoing major spatial restructuring in terms of its airport hierarchy. Deregulation has yet to fully consolidate an airport hierarchy, and this volatility is expected to continue as long as there is ongoing growth in capacity and changes in aviation policy. To some extent, aviation policy volatility appears to be related to specific changes in policy that pertain to the most significant domestic airport, Congonhas.

5. Conclusions

This paper found correlative evidence that policy volatility and the spatiality of air transport are linked. Australia and Brazil experienced relative concentration in air transport seat capacity since deregulation. However, there is significant variation in the extent to which the spatiality fluctuated during the 25 year period examined. In Australia, there has been an increasing level of concentration in the lower part of the distribution and a concurrent dispersion among airports in the upper part of the distribution. Overall, since the deregulation in 1990, with the exception of the collapse of Ansett in 2001, the sector has experienced ‘spatially stable’ growth.

In contrast, rapid changes in the Brazilian aviation environment have partly resulted in the need for the government to re-intervene after deregulation. The spatiality of Brazilian air transport capacity was comparatively more volatile. This spatial fluctuation can be traced to a number of key factors, including changing policy, growing demand for air travel, accidents and financial difficulties of incumbent airlines. In particular, rapid policy changes resulted in the fluctuations in capacity between the five largest airports serving the three largest cities since the deregulation in 1992 and 1998, re-regulation in 2003 (and introduction of slots and the resultant capacity re-distribution among the largest airports in 2005), followed by the relaxation of capacity control in 2008. Accordingly, we found that these changes in policy were directly manifested spatially through our chosen measurement tools, the Gini and the generalised entropies.

Furthermore, we decomposed the Theil index to explore structural variations in the spatial evolution of air transport capacity. In particular, given the fact that aviation policies, including airport slot controls, tariff restrictions, and traffic right allocations, are route- and airport specific, it was insightful to analytically trace how sub-groups of airports contribute towards the overall spatiality of domestic aviation. Specifically, through the control of sensitivity parameter and decomposition, we have shown that the inequality in the spatial evolution of Brazilian air transport capacity is still undergoing significant spatial restructuring in its airport hierarchy. Deregulation has yet to fully consolidate an airport hierarchy, and this volatility is expected to continue as long as there is ongoing growth in capacity and changes in aviation policy. Thus, policy volatility directly influences the spatiality of Brazilian air transport seat capacity. In contrast, the distributional pattern of Australian airports was relatively stable and characterized by gradual, and to an extent, predictable, changes. Furthermore, airport hierarchy appeared to have consolidated over 1986-2010.

We focused on correlative evidence indicating that policy volatility can be closely linked to spatial volatility. The study used seat capacity as measure of air transport supply. Future work should incorporate aircraft and flight frequency information as more robust measures of air transport supply characteristics. An evaluation of the appropriateness of different policy options was beyond the scope of this study. Despite its effects on inconsistency and volatility of air services over the short-term, continuing policy and regulatory involvement may contribute towards securing consistent air services in the long run.

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