Operating Conditions and Performance of Brazilian Airports

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Abstract

Worldwide, more and more states deregulate and privatise domestic airlines and airports respectively; however, the applied measures as well as the level of deregulation and/or privatisation differ considerably. With regard to Brazil, only domestic airlines have so far been deregulated and fierce competition has evolved; albeit, the increasingly competitive and cost-conscious environment also exerts significant pressure on airports. Concerning airports, Brazil represents some kind of laggard to the worldwide developments as Infraero – a division of the Brazilian Ministry of Defence – still owns and operates 65 of Brazil's 67 major airports.

According to Palhares et al. (2001) Infraero does not conduct any detailed studies of airport efficiency – at least no such studies are released to the public and not even excellent airport performance results are published. This gap has so far only partially been filled by isolated efficiency studies[1]; however, no regular efficiency assessment of Brazilian airports has been undertaken so far.[2] This study analyses the performance of 18 major Brazilian airports, i.e. all Brazilian airports handling more than one million passengers in 2005[3], between 2003 and 2005 using the Data Envelopment Analysis (DEA) technique. The continuation and extension of this study on Brazilian airport performance is envisaged as further data becomes available.

Keywords: Airport, Competition, Data Envelopment Analysis, DEA, Efficiency, Performance, Regulation.

JEL Classification: C33: Econometric Methods: Models with Panel Data

L93: Industry Studies: Air Transportation

1 See e.g. Pacheco/Fernandes (2003) who analysed the performance of 35 Brazilian airports; Palhares et al. (2001) for a comparison of four major Brazilian airports to foreign airports of similar size and Fernandes/Pacheco (2005) who analysed the impact of changes in management style on the performance of 58 Brazilian airports.

2 Regular airport benchmarking studies like the ATRS Benchmarking Report or the TRL Airport Performance Indicators usually do not include any Brazilian airport.

3 See Infraero (2006a).

I. Introduction

Although Brazil has an actual population of roughly 190 million only about 30 million emplanements could be accounted for in 2002. In the same year, business travel represented about 70 % of the entire demand for air transportation while the overwhelming majority of intercity travel has been provided by buses.[4] These figures exemplify that Brazil's market for air transportation still is somewhat underdeveloped; however, the recent advent of low-cost carriers like Gol as well as their increasing market share – enabled by the current unassertive liberalisation measures – underline that the Brazilian market has significant potential, even though traditional full service network carriers like Varig suffer of severe financial difficulties.[5] Regarding the situation of airlines in Brazil, significant competition has so far evolved domestically and in some cases even on international routes.

With regard to airports, a different picture has to be painted. 65 of Brazil's 67 larger airports are owned and operated by Empresa Brasilieira de Infraestrutura Aeroportuária (Infraero), which is – for historical reasons – subordinated to the Brazilian Ministry of Defence. Infraero actively engages into nearly all operating and investment decisions, leaving airports merely very restricted leeway for initiating own decisions and nearly no possibility to actively engage in competition.

In essence, the Brazilian market for air transportation still is somewhat underdeveloped; however the deregulation measures implemented so far already led to significant growth. Notwithstanding, re-regulation measures are currently extensively discussed and Infraero's monopoly in airport operation still persists.

Our analysis is structured as follows: The subsequent second section of the paper firstly introduces to the operating conditions and the regulatory framework of Brazilian airports as both differ considerably from those in e.g. Europe or Northern America. Furthermore, the level of competition between Brazilian airports is assessed and the current incentive regime and potential for 'unfair' treatment of local airport management by Infraero's headquarters are highlighted. The third section deals primarily with

[4] See Lima (2004).
[5] See also section II.1.

the applied benchmarking methodology. Following a brief description of Data Envelopment Analysis (DEA), which we apply in order to assess the relative performance of Brazilian airports, the specifications of our model are illustrated. The results of our analysis of Brazilian airports are presented and discussed in section four. The last section comprises a brief conclusion and presents relevant shortcomings as well as potential further lines of development.

II. Conditions and Framework of Brazilian Airport Operations

II.1 Brazilian Market for Air Transportation and its Regulatory Framework

Historically, Brazilian air transportation has been tightly regulated by the state. The Brazilian Civil Aviation Department (Departamento de Aviação Civil – DAC) has been created as early as 1931 and was responsible for the commercial civil aviation regulation since then.[6] The DAC effectively controlled air fares, frequencies, capacity and other aspects[7] and imposed mandatory reference fares.[8] The tight regulation often led to a mismatch in supply and demand, suboptimal aircraft assignments and slow responses to changes in market trends. Initially, the DAC has been put under the control of the Ministry of Transport and Public Utilities (Ministério de Viação e Obras Públicas); however, in 1941 the DAC has been fully incorporated into the newly established Ministry of Air Transportation (Ministério de Aeronáutica) and subsequently into the Ministry of Defence (Ministério da Defesa).

During the period of regulation, which lasted until the early 1990ies, issues of development policy as well as national security concerns played major roles in aviation policy and significantly determined the destiny of air transportation. The Brazilian government e.g. applied a so-called "four national and five regional airlines policy" in order to "regulate and promote" the development of the air transportation sector. This policy effectively prohibited new entries and ensured governmental control of the sector and the protection of the "legitimate economic interests" of Brazilian airlines.[9] Moreover, exist-

[6] The DAC was in particular responsible for the issuance of domestic and international route concessions, the supervision of airfares as well as the specification of the allowed number of frequencies. It will be replaced by the independent regulatory body Agência Nacional de Aviação (ANAC) in due course. For a more detailed history on the DAC see e.g. Rodrigues (1998).

[7] E.g. aircraft and parts import.

[8] For a more detailed history on the evolution of Brazilian air transportation regulation see Febeliano/de Oliveira (2005).

[9] See e.g. Rodrigues (1998).

ing airlines were subsidised through the complementary Regional Integration Air Transport System (SITAR), which, furthermore, effectively divided the Brazilian market for air transportation into five monopoly areas for regional airlines. Virtually no competition existed between these regional airline monopolies and between regional and national airlines.

The first effort to modernise and streamline the sector's legal and institutional environment is represented by the Brazilian Aeronautical Code (Código Brasileiro de Aeronáutica – CBA), which has been adopted in 1986 and stipulates principal regulations and basic regulation procedures concerning all aspects of air transportation.[10] However, national security as well as industrial development issues still played a major part in Brazilian politics and, thus, also extensively influenced the regulation of the sector at that time.[11] Consequently, the Brazilian government's objective was to avoid competition in air transportation and this aim notably biased the CBA's regulations.[12]

In the meantime the success of United States deregulation became apparent. The United States deregulated its domestic air transportation market during the period between 1977 and 1978 in which deregulation was de facto first imposed by the Civil Aeronautics Board (CAB) and then, later, de jure by the United States Congress.[13] The deregulation measures undertaken had a substantial and positive impact on the air transportation sector – productive and allocative efficiency as well as load factors improved while traffic grew substantially.[14]

The success of the deregulation measures imposed in the United States attracted the attention of numerous other states worldwide, among them various Latin American states. The successful deregulation of the United States air transportation sector since then served as a role model for deregulation measures introduced in numerous other countries. Consequently, the 5th Conference of Civil Aviation

[10] The CBA contains principal regulations relating to airport infrastructure and operations, airline certification, concessions, registration, licensing and liability, airline inspection and control, flight protection and safety, crew training, aircraft leasing.
[11] See de Assis Leme Franco et al. (2002), p. 4.
[12] The CBA e.g. required the Brazilian government to prevent 'ruinous competition' and ensure the 'best possible economic revenue' of air transportation services. See Rodrigues, R.A. (1998).
[13] See Borenstein (1992), p. 45.
[14] See e.g. Caves et al. (1987); Borenstein (1992); Baltagi et al. (1995) and Morrison/Winston (1995).

(Conselho de Aviação Civil – CONAC[15]) in 1991 resulted in guidelines, which for the first time focussed on customers' needs and consistently recommended a major shift in the way air transportation was regulated in Brazil. Simultaneously, the Brazilian economy witnessed a far-reaching governmental program aiming at the deregulation of the country's economy. A fully liberalised air transportation market has consequently been postulated by CONAC – the deregulation of the US air transportation market, the experiences made and its effects set the example. The deregulation measures recommended by the 5th CONAC have been subsequently implemented in three steps by the DAC.[16]

The first deregulation step in air transportation has been undertaken by the Brazilian government in 1992. In the course of this step, regional airline monopolies were eliminated and market entry was allowed. Furthermore, the Brazilian government's policy towards air fare regulation has been revised as price competition was now being considered as beneficial; although further deregulation steps were needed to ultimately and entirely abolish regulation of air fares.[17] In essence, this initial deregulation step is characterised by the giving up of the Brazilian "four national and five regional airlines policy" of the 1970ies and 1980ies.[18]

The second deregulation step in the late 1990ies witnessed the abolishment of two remaining regulatory measures. On the one hand the air fare boundary regime has been put an end to and on the other hand the rights granting certain airlines to exclusively operate direct flights to selected major airports (Vôos Diretos ao Centro – VDC) including to the airports of Santos Dumont (Rio de Janeiro), Pampulha (Belo Horizonte), Congonhas (São Paulo) and Brasília have been revoked. In 2005, these airports accounted for approx. 31.5 million passengers and their share of the total Brazilian air transportation market amounted to 32.7 %.[19] The importance of these routes illustrate their corresponding fig-

[15] CONAC has been established as an advisory body to the Brazilian President in 1961 and its recommendations guided Brazilian aviation policy since then. CONAC's recommendations are adopted and carried by the Brazilian Air Force Command and the DAC (soon ANAC). Members of the advisory council are the Ministry of Defence, the Ministry of Civil Affairs, the Ministry of Finance, the Ministry of Development, Industry and Foreign Trade, the Ministry of Foreign Relations, The Ministry of Tourism and High Command of Aeronautics (Comando da Aeronáutica).

[16] See e.g. de Oliveira/Huse (2004), p. 5.

[17] See de Assis Leme Franco et al. (2002), p.5.

[18] See de Oliveira/Huse (2004), p. 5.

[19] Own calculations based on data provided by Infraero (2006a).

ures: Passengers travelling on the former VDC routes amounted to 3.427,912 in 2004 equivalent to 9.3 % of total passengers or 10.8 % of all domestic passengers in the same year.[20] This deregulation step triggered numerous new entries and fierce competition between airlines, namely in terms of prices and frequencies. Simultaneously, demand increased significantly.[21] By 2001, most remaining economic regulation had been removed and market entry, the decision on air fares and frequencies were almost entirely deregulated.

Following market entry deregulation and its own restructuring TAM[22] – a former regional carrier – expanded rapidly in the 1990ies and reached a market share of 36.4 % (measured in available seat km) in 2004. The low-cost carrier Gol was founded in August 2001 and operated its inaugural flight in January 2002. Similar to TAM Gol witnessed considerable growth since its inception and reached a market share of 20.3 % in 2004.[23] The emerging competitive environment put incumbent airlines under severe pressure. With Vasp, the Transbrasil Group and Varig, three major Brazilian airlines went bankrupt during the last few years and two exited the market entirely.[24] The troubled national incumbents and their mounting problems led to the official viewpoint that the fierce competitive environment in the air transportation sector, which emerged after deregulation, was directly responsible for the incumbent airlines crisis, so that the Brazilian government revised its liberalisation measures undertaken so far. The resulting re-regulation process included among other things the re-introduction of price and supply control measures, the 'active' avoidance of new entries as well as the gradual and 'guided' expansion of recent market entrants. Furthermore, the alleged excess capacity and 'over-

[20] Own calculations based upon data provided by DAC (2005).
[21] See Salgado (2005), pp. 3-5.
[22] See The Economist (1998).
[23] See Table 1.
[24] The Transbrasil Group ceased its operations in December 2001.
The regulatory authority DAC grounded Vasp from operating scheduled services in response to the beginning of a financial investigation on 27 January 2005. Meanwhile VASP is no longer operating any flights; however, a recovery plan has been approved on 27 August 2006.
Varig filed for bankruptcy protection under Brazilian law – similar to US chapter 11 rules – in June 2005. The court protection should serve to give Varig time to restructure, protection from aircraft seizures or forced lease returns and finally, time to sort out its debt issues with the Brazilian Government. However, Varig's flight operations were separated from its commercial and non-airline activities and sold separately. After a nearly two month lasting bidding hullabaloo, Varig was finally sold to Volo for $24 million on 20 July 2006. Volo will not inherit Varig's previous debt; however, it will have to undertake extensive financial reforms. A day after the acquisition Varig cancelled all flights except for those operated between Rio de Janeiro and São Paulo. Varig soon laid off 5,500 of its 9,485 employees at the time of its sale. Similar to Vasp Varig also plans to resume more of its original routes, in particular more international flights. However, the future of both airlines does not look very promising at the moment.

competition' in the market were tackled by the re-regulation package. New aircrafts imports were banned and strategic movements increasing market concentration, such as the envisaged code-sharing agreement between two major airlines, Varig and TAM, were prohibited.

Nowadays, Gol and TAM dominate more than 50 % of the domestic Brazilian market.[25] However, the newly established ANAC is expected to promote new entry and expansion of smaller companies, so that business and leisure travellers will eventually benefit from increased competition and so that demand for air transportation services will rise further. The supply of flights has increased since the first liberalisation measures have been implemented in 1992 and price competition as well as product differentiation and resulting competition have led to significant growth of the Brazilian air transportation sector so far.[26]

Table 1: Market Shares (measured in available seat km), 1991-2004

	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Gol	-	-	-	-	-	-	-	-	-	-	4.5	10.7	17.9	20.3
TAM Group	3.1	4.0	6.6	8.4	13.2	15.4	17.8	19.3	23.8	28.8	32.6	37.2	34.1	36.4
Transbrasil Group	19.7	20.8	24.1	23.8	20.0	18.6	17.1	15.1	16.2	13.6	7.4	-	-	-
Varig Group	43.7	44.3	48.7	46.0	45.4	45.5	43.6	43.6	39.1	40.6	40.2	37.5	29.1	29.4
Vasp	32.2	29.5	18.4	18.9	18.5	18.5	19.2	18.1	17.2	15.3	13.7	13.2	13.2	10.1
Others	1.3	1.4	2.2	2.9	2.9	2.0	2.3	3.9	3.7	1.7	1.6	1.4	5.7	3.8
TOTAL	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Source: Salgado (2005), p. 4, supplemented with data provided by DAC (2004) and DAC (2005).

All in all, the market potential of the Brazilian aviation sector looks anything but bleak and might turn out to be an interesting market and investment opportunity. So far, most intercity connections are served and dominated by bus operators; however, their position is nowadays heavily contested by airlines, especially by Gol.[27] Although the Brazilian market for air transportation services witnessed the emergence of fierce competition as well as market entries and exits so far, the situation regarding airports looks somewhat different as described by the following section.

[25] See Table 1.
[26] See Salgado (2005), p.3.
[27] See Turolla et al. (2005).

II.2 Airport Operations in Brazil

Today, the Brazilian Ministry of Defence is the highest authority of the federal state responsible for the air transportation sector. Its authorities are still predominantly justified by national security issues. The Ministry of Defence assumes all duties related to the air traffic sector or delegates its competencies to subordinated authorities like the DAC.

As far as civil aviation regulation is concerned the DAC – established in 1931 by Getúlio Vargas, the Brazilian president at that time – is the responsible authority in Brazil. The DAC is still under the supervision of the Comando da Aeronáutica, which is subordinated to the Ministry of Defence. As already stated in II.1 the recently formed Agência Nacional de Aviação Civil (National Civil Aviation Agency; ANAC) was created to replace the DAC in the near future and is gradually assuming all duties and responsibilities of the DAC. Apart from various other duties, the DAC plans, guides and supervises civil and private air traffic. In line with its duties the DAC is divided into four subdivisions (Planejamento, Infra-Estrutura, Operações and Técnico). What is more, the DAC defines airport charges for all airports administered by Infraero. These predefined airport charges are mandatory for all airports and will be discussed in detail in section II.3. Similar to the German Luftfahrtbundesamt – the German regulatory authority supervising German air transportation – the DAC is also responsible for the approval of aircrafts and pilots.

The federal authority responsible for the Brazilian airport sector is Infraero (Empresa Brasilieira de Infraestrutura Aeroportuária). Infraero, which is also subordinated to the Brazilian Ministry of Defence, moreover owns and operates 65 of Brazil's 67 larger public airports.[28] Furthermore, Infraero maintains 68 meteorological stations all over Brazil to centrally provide airlines with weather. In addition, Infraero is responsible for all telecommunication issues concerning air transportation; for this reason, it operates 72 communication centres. According to Article 25 of Law No. 7565 of the Brazil-

[28] All Brazilian public airports – airports like Uruguaiana, which accounted for 716 passengers in 2005, included – are either managed by Infraero or by transportation authorities of the federal states.

ian Code of Aeronautics (CBA)[29], Infraero is furthermore responsible for the investigation of air traffic accidents and incidents and the improvement of air transportation security.

It is noteworthy that Infraero has always been subordinated to some Ministry concerned with military affairs[30] and its organisational structure consequently bears resemblance to military command structure, although it features a civilian presidency since 1999.

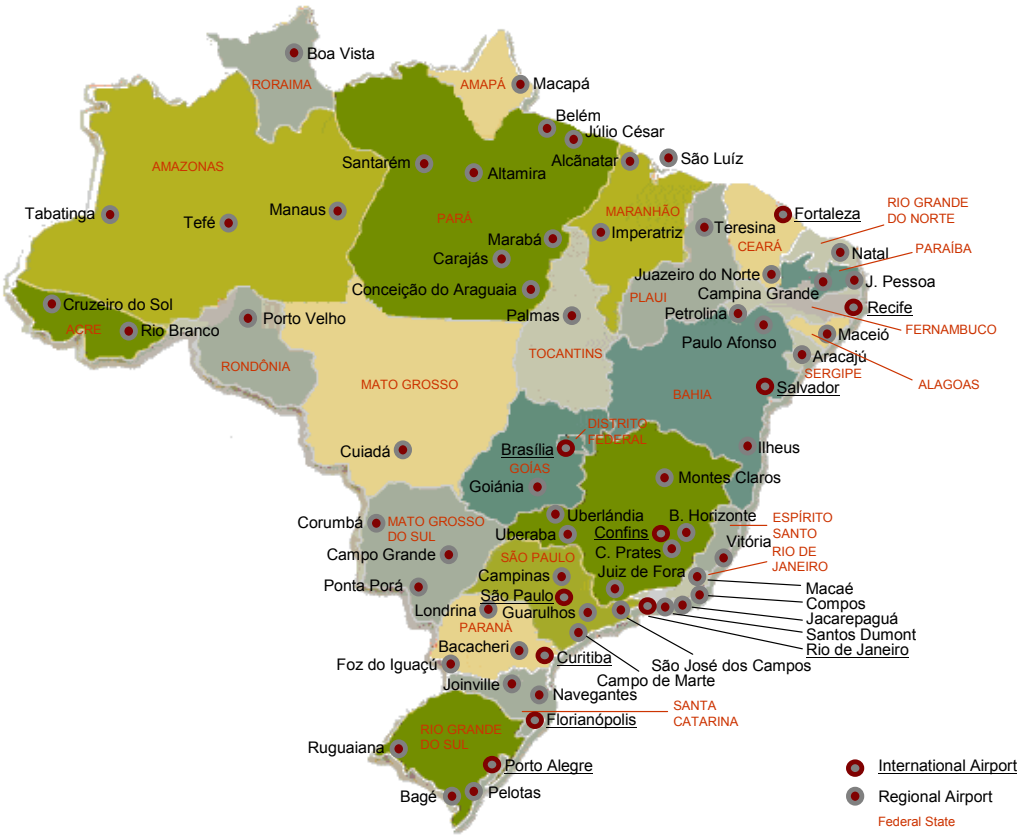
Brazil's airport infrastructure currently consists of 2,014 civil airfields – 715 of these are publicly owned airports whereas 1,299 are privately owned and cannot be approached by any aircraft without the consent of their owners.[31] The 65 largest airports of Brazil are owned and operated by Infraero and accounted for 97 % of regular Brazilian air traffic[32] (equivalent to 96.1 million passengers[33]) and 99 % of Brazilian air cargo operations in 2005; thus, Infraero represents a monopoly. Infraero is based in Brasília and its operations are divided into seven regional districts – Belém, Brasília, Manaus, Porto Alegre, Recife, Rio de Janeiro and São Paulo –, which are responsible for administrative and operational issues of the airports in their respective region. Today, roughly 9,500 employees and 15,900 indirect employees are employed at Infraero's headquartes.[34]

Figure 1 illustrates the distribution of the Brazilian airports. Brazil's major hub airport nowadays is the International Airport of Guarulhos (GRU), located in the state of São Paulo. Guarulhos is situated 22 km northeast of São Paulo's city centre. As Guarulhos suffers of severe congestion it is currently being extended and a third passenger terminal shall be finished in 2007 in order to increase the airport's capacity from currently 18 million[35] to 29 million passengers per annum. The airport connects

[29] See section II.1 for a description of the content of the CBA. The CBA is the underlying basis of all legislation concerning air traffic and regulates all issues arising with regard to air transportation. It also defines the responsibilities of federal authorities like the DAC and Infraero.
[30] See section II.1.
[31] See Fernandes/Pacheco (2005), p. 4.
[32] See Infraero (2006b), p. 8.
[33] See Infraero (2006c), p.1.
[34] See Infraero (2005b), p.1.
[35] In 2005 Guarulhos accounted for 15.8 million passengers.

Brazil to 28 countries and the 370 companies situated at the airport currently generate approx. 53,000 Jobs.[36]

Figure 1: Distribution of Brazilian Airports



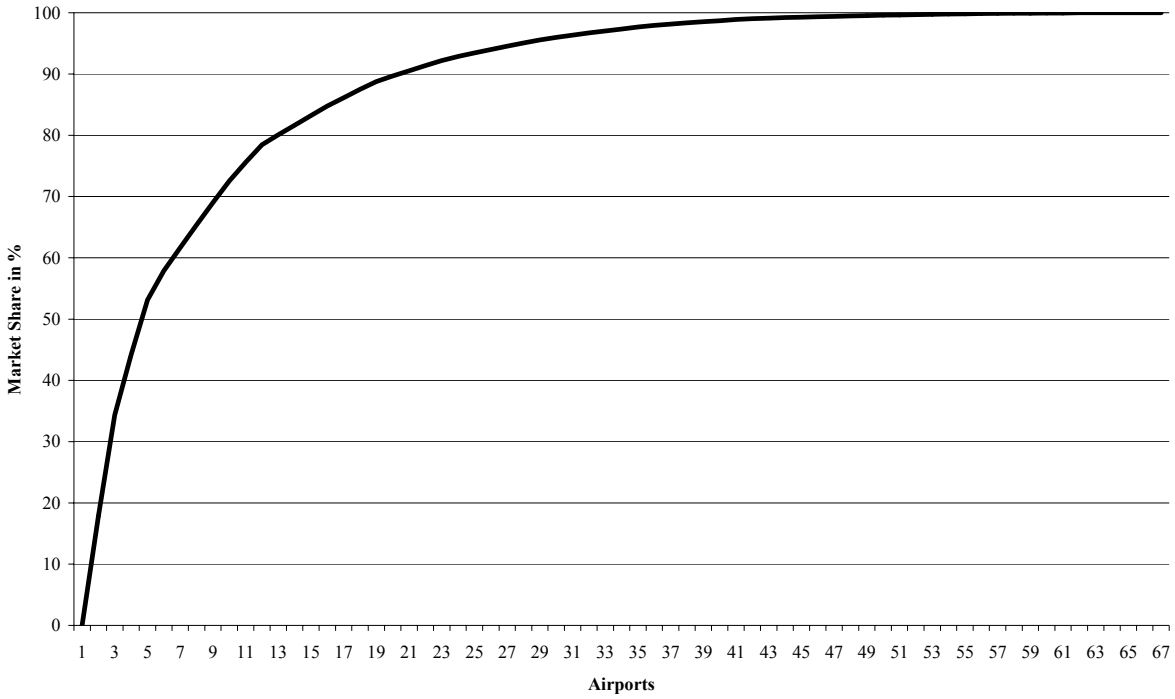
In contrast to São Paulo's airport Guarulhos Rio de Janeiro's Aeroporto Internacional Antônio Carlos Jobim/Galeão (GIG) is Brazil's second most idle airport. For this reason, many experts considered the construction of Galeão's new second terminal a waste of resources as Guarulhos was at the same time heavily congested and operating beyond its designed capacity limit. Consequently, Infraero was criticized by many for not investing its resources appropriately.

[36] For a detailed description of Guarulhos and other Brazilian airports see http://www.infraero.gov.br/usa/aero.php.

The international airport of Congonhas (CGH), which is also situated in the state of São Paulo, accounted for a total volume of 17.1 million passengers in 2005 and is the most congested airport in Brazil. This is startling as Congonhas only serves domestic and not international air traffic.

The chart below, which is based on data provided by Infarero[37], illustrates the passenger distribution at Brazilian airports in 2005. The two most congested airports, Congonhas (CGH) and Guarulhos (GRU) – both situated in the state of São Paulo – accounted for approx. one third of all passengers handled at Brazilian airports. All in all, passengers handled at the four airports located in the state of São Paulo (Congohas, Guarulhos, Campinas and Corumbá) accumulated to more than 35 % of all Brazilian airports' passengers.

Figure 2: Airport Market Shares in Brazil



[37] See Infraero (2006a).

Similar to most national airport infrastructure markets, in particular supported by the initiation of comprehensive hub-and-spoke systems[38], the Brazilian market is concentrated and its thirteen largest airports dealt with more than 80 % of the total amount of passengers transported in 2005. Moreover, more than half of all passengers were handled at the five largest airports whereas the 40 smallest airports accounted for a mere five percent of all passengers.

II.3 Competition between Airports

Airports are the multi-modal interchange nodes in an air transportation network and represent the sine qua non for aviation. In principle, airport size and structure are decisively influenced by market forces; however, in reality governments or the assigned regulatory authorities often get the upper hand in investment decisions. As most countries successfully deregulated air transportation markets, airports are now forced to justify their existence by attracting and accommodating enough flights or passengers respectively.[39] On the one hand airports compete 'locally' for origin or destination passengers; however, in case of transfer connections airports also compete with other airports, which might even be located in other countries[40], for transfer passengers.

When faced with competition airport operators in principle might employ different measures in order to initiate or alter a competitive strategy. Airports could e.g. adopt a different structure of airport charges, improve their service quality, invest in additional infrastructure facilities or improve airport access or links to other modes of transport. However, airports are not always free to employ such measures and this could lead to significant distortions in their competitiveness as proven below. What is more, lacking opportunities or incentives to engage in active competition ultimately lead to all negative concomitants of uncompetitive markets. In order to be able to properly analyse, clarify and compare the competitive situation of Brazilian airports, the current structure of the German airport market is briefly described in the following and referred to in various passages.

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[38] While hub airports still play a major role in aviation, low-cost carriers usually concentrate on offering so-called point-to-point flights, which can be easily terminated in case a route turns out to be unprofitable. Therefore, this development might be somewhat thwarted in countries were low-cost carriers operate and account for significant market shares..

[39] See Pels et al. (2000).

[40] The European hub airports located in various European countries provide an excellent example.

In Germany, the highest federal authority responsible for civil aviation affairs is the Bundesministerium für Verkehr, Bau und Stadtentwicklung (BMVBS – Federal Ministry of Transport, Building and Urban Affairs), which is based in Berlin. A special department, Unterabteilung LS 1: Luft- und Raumfahrt (subdivision LS 1: aviation and astronautics), of the BMVBS is responsible for all issues related to the aviation sector. With regard to airports, the regulatory authority is delegated by the BMVBS to the German federal states (Länder) by means of the so-called Bundesauftragsverwaltung (federal executive administration), which can be described as transposing the subsidiarity principle. The federal states established own regulatory authorities responsible for airport affairs. These authorities are in particular responsible for airport approval and airport charge approval, airport usage guidelines, airport operating regulations as well as regulations on airport construction and protection areas; moreover, the federal states have to approve groundhandling services.[41] Most airports in Germany are owned by the federal states or local authorities. Thereby, the federal states are in many cases owners and, at the same time, regulators of airports. This structure frequently leads to moral conflicts, e.g. when the approval of airport charges is concerned. On the one hand, federal states as airport owners might be interested in high airport profits or in levying higher charges for extremely polluting aircraft indicating that from their point of view high airport charges are preferable. On the other hand the competitive situation of a particular airport might force it to levy low airport charges. In general, airport privatisation or the setting-up of independent regulatory authorities are two promising means to resolve this moral conflict.

In Brazil, all major airports are owned and operated by Infraero while the DAC (soon ANAC) is responsible for airport regulation.[42] Both entities are subordinated to the Brazilian Ministry of Defence and, therefore, to the federal state. Moreover, the competencies of the DAC resemble those of the German regulatory authorities and are even more extensive in some areas. With regard to Brazilian airports, moral conflicts similar to the ones described above might consequently also occur.

Notwithstanding, significant regulatory reforms were implemented in Brazil during the last years in order to improve the efficiency of the aviation sector. With the successful implementation of these

[41] See Maurer (2002), p. 14.
[42] See section II.1.

reforms the DAC lost some of its initially extensive competencies, e.g. with regard to air fares. Furthermore, the regional division, i.e. the regional monopolies of Brazilian domestic carriers and also the monopolies in international air transportation were abolished.[43] However, the Brazilian authorities swiftly commenced a discussion on the re-regulation of the sector soon after Vasp and Varig experienced severe financial difficulties.[44]

Whereas Brazilian airlines witnessed substantial deregulation measures during the last years airports are still heavily regulated. Nevertheless, certain efforts were made to deregulate and privatise Brazilian airports[45]; however, up to now no significant changes in governmental policy have occurred. Some medium sized airports in Bahia (a federal state situated in northeastern Brazil) are managed by private groups[46] and initially the privatisation of further Brazilian airports was taken into consideration in order to improve airport competition. The federal state of São Paulo particularly discussed and intended the privatisation of its major airports.[47]

As yet, Infraero is responsible for all investment decisions with regard to airport infrastructure, i.e. a correlation between an airport's earnings and investments undertaken at this particular airport must not necessarily exist. Similar to the German BMVBS, which centrally plans major infrastructure projects in its regularly adopted Bundesverkehrswegeplan[48], Infraero centrally evaluates the importance of different projects. Since Infraero pools all revenues of the airports it owns and operates, airports have no possibility to initiate own investment schemes. Infraero centrally decides about all airport investments and their priority; thus Brazilian airports are unable to assume any own investments.

[43] See section II.1.
[44] See also footnote 20.
[45] See e.g. Palhares et al. (2001).
[46] These airports yet have to implement Infraero's requirements and the level of their airport charges is still determined by the DAC. See also Espírito Santo Jr. et al. (2002).
[47] Ibid.
[48] Note that the Bundesverkehrswegeplan merely represents a skeleton investment plan and a planning tool of the German federal government; however, it does not serve as a financing plan or program for new infrastructure projects.

On the one hand highly profitable airports such as São Paulo's Guarulhos are rigorously discriminated by this scheme[49], as their profits accrued are centrally pooled by Infraero and cannot be invested in own facilities. On the other hand unprofitable or smaller airports benefit in case Infraero decides that they require investment they could otherwise not afford. However, a definite danger exists that the centrally planned investment schemes might not match the particular airport's requirements.[50] In August 2003, the Brazilian federal government adopted its Plano Plurianual (PPA) for the period from 2004 to 2007. This plan contains all intended investments in airport infrastructure worth over 1 billion US-$. The intention of the Brazilian government is to satisfy the anticipated changes in air traffic over the next years, e.g. a growing demand for air transportation services has been forecasted for northeastern Brazil.[51]

With regard to the possibility to use airport charges as a competitive measure, one has to mention that airport charges are currently and as yet centrally set by the DAC in Brazil (ANAC will assume this task in future), i.e. Brazilian airports are not allowed to implement own price differentiation strategies. Moreover, all airports are classified into different airport classes and their charges are centrally set according to their class. In essence, larger airports like São Paulo Guarulhos (GRU) or Rio de Janeiro's Aeroporto Internacional Antônio Carlos Jobim (GIG) are forced to levy higher charges than smaller airports like Belo Horizonte's Aeroporto de Pampulha (PLU) or the Aeroporto de Vitória (VIX). This means, that airport charges are fairly homogenous in Brazil. The following example illustrates the system of Brazilian airport charges: The level of landing, parking and passenger charges depends on the class of the airport in question. In principle, the DAC classified all airports in two groups (class 1 and class 2) in order to define the level of airport charges. However, airports are further subdivided in three subclasses (class a, b and c) for the calculation of the terminal navaid charge. In short, the charges levied at an airport entirely depend on the respective airport's class. International airports like Guarulhos are classified as class 1a and have to levy higher charges than smaller airports such as Belo Horizonte's Pampulha airport (PLU), which is classified as 2c.

[49] See also Espírito Santo Jr. (2001).
[50] See the example of Rio de Janeiros's Aeroporto Internacional Antônio Carlos Jobim/Galeão in section II.2.
[51] See de Azevedo (2004), p. 96.

Table 2 shows the classification for all 18 airports analysed. Table 3 shows the level of airport charges according to the five classes, which can be found in our airport sample. The charges are calculated for the example of an Airbus 320-200 with 73.5 t MTOW assuming two hours ramp parking time. Note that passenger charges are not included in our example as these are only levied of international passengers.[52]

Table 2: Brazilian Airport Charging Classification

Class	Airports (IATA Code)
1a	BEL, BSB, CNF, GIG, GRU, MAO, POA
1b	CWB, FOR, NAT, SSA
2a	CGH, FLN
2b	GYN, REC, SDU
2c	PLU, VIX

Table 3: Airport Charges in Brazil (Airbus 320-200, 73.5 t MTOW)

Class	Airport Charges in US-$ (passenger charges excluded)
1a	537.87
1b	513.51
2a	499.65
2b	475.29
2c	446.05

In comparison, airport charges are defined by the respective airport's management in Germany; however the responsible authorities of the federal states have to approve the charges suggested. Consequently, German airports are in principle allowed and able to use price differentiation as a competitive measure; such a strategy has e.g. been adopted by Cologne-Bonn (CGN), which can be considered as a low-cost airport or the airport Frankfurt am Main (FRA), the main hub in Germany. In essence, some airports define airport charges levied simply by maximum take-off weight (MTOW) while others introduced further charges such as noise charges.

To summarise, Infraero actively engages into nearly all areas of airport management by assuming the necessary decisions itself. The local airport management merely executes the decisions of Infraero

[52] The calculations are based upon data provided by IATA (2005), p. 85.

headquarters and is furthermore responsible for the operative management whereby only very restrictive leeway is granted with regard to the initiation of own initiatives and decisions. In Brazil, virtually no opportunities not to mention incentives to engage in competition between airports exist.

In general, airports in Germany are expected to operate cost-efficient; thus, all major German airports are now being operated according to commercial management principles. During the last years, German airports evolved from mere infrastructure providers to full service providers. Consequently, commercial, i.e. non-aviation, revenues are gaining more and more significance. The by far less restricted German regulatory framework supports this development and grants German airport management a fairly high degree of autonomy in decision making.

The significantly differing political environment and the regulations implemented by regulatory authorities in Brazil and Germany have a substantial influence on airport management and the airport industry as a whole. In essence, airport management in Germany enjoys a high degree of autonomy whereas airport management in Brazil is bound to strict and tight regulations and central decisions.

III. Benchmarking of Airports

As more and more countries successfully deregulated their aviation sector and in some cases airport operations as well, airports nowadays operate in an increasingly competitive environment. However, although Brazilian airports have so far neither been deregulated nor privatised, the assessment of their performance can still prove to be informative for stakeholders, e.g. their owner, Infraero, or airlines. What is more, proper assessment of an airport's performance could and should guide future investment decisions by Infraero, so that the appropriate allocation of resources is enabled.[53]

Historically, benchmarking of airports has been conceived as a particularly complicated task due to the diversity of inputs employed, outputs produced and the considerably differing operational environ-

[53] See Lemer (1992), p. 37.

ments of individual airports.[54] However, in Europe and elsewhere the recent transformation away from the historical view of airports as public utilities resulted in airport operators seeking to gain insights into their operations and efforts to improve their performance by benchmarking their own operations against others. This change of mind has been boosted by the emerging increasingly competitive and, in particular after 9/11, much more cost-conscious environment.[55]

However, regarding benchmarking of airports in Brazil a different picture has to be painted. According to Palhares et al. (2001) the owner and operator of all major Brazilian airports, Infraero, does not conduct any detailed studies of airport efficiency – at least no such studies are released to the public and not even excellent airport performance results are published. This gap has so far only partially been filled by few isolated efficiency studies[56]; yet no regular efficiency assessment of Brazilian airports has been undertaken so far.[57] Nevertheless, as described in section II.1 the deregulation of the Brazilian aviation sector led to increased competition among airlines; thus airports themselves have been put in a more competitive environment.

According to Lemaitre (1998) the measurement of airport performance can be viewed from three general management perspectives: financial, marketing and operational perspective. Our analysis will focus on the last perspective. As environmental issues gained significant political attention during the last decades a further environmental perspective can be added.[58] If partial performance measures are used different and usually competing or conflicting performance measures might be needed in order to cover all four management perspectives and airport management faces the task to prioritise these measures.[59] Partial performance measures such as passengers per employee or work load units (WLU)[60] per employee are often used by airport authorities in order to assess airport efficiency. Such measures are usually relatively easy to compute and simply require data readily available. However,

54 See Graham (2005), p. 99.
55 Ibid., p. 100.
56 See e.g. Pacheco/Fernandes (2003) who analysed the performance of 35 Brazilian airports and Palhares et al. (2001) for a comparison of four major Brazilian airports to foreign airports of similar size.
57 Regular popular airport benchmarking studies like the ATRS Benchmarking Report or the TRL Airport Performance Indicators do not include any Brazilian airport.
58 See Humphreys et al. (2002), p. 269 and Graham (2005), pp. 105-6.
59 See Humphreys et al. (2002), p. 270.
60 One WLU is defined as one passenger or 100 kg of freight respectively.

these measures regularly do not shed any light on the way a specific airport chooses to substitute one input for another as the measures are only partial. What is more, different managerial arrangements, in particular with regard to the level of outsourcing, may result in differing performance measures.[61] Thus, performance assessment techniques which allow a holistic view of the entire organisation and the inclusion of a variety of different inputs and outputs, such as Data Envelopment Analysis (DEA), should be preferred.

The principles of DEA have initially been set out by Farrell in his seminal work on the measurement of productive efficiency.[62] In principle, DEA is a mathematical programming technique concerned with the measurement of relative efficiency within a sample consisting of different decision making units producing identical outputs while consuming identical inputs. Such decision making units may include entire undertakings, industry sectors or smaller fragments of an.[63] Relative efficiency indicates that the efficiency measures estimated when using DEA are assessed relative to the best-performing decision making unit(s), which form a frontier. More formally, our sample consists of A airports with m outputs using n inputs. Based on Farrell's ideas, Charnes et al. (1978) proposed the following measure of efficiency, which is the maximum of a weighted output ratio to a ratio of weighted inputs subject to the condition that for every decision making unit, i.e. in our case every airport, the efficiency measure is smaller than or equal to 1[64]:

$$\max h_0 = \frac{\sum_{i=1}^{m} u_i y_{i,o}}{\sum_{j=1}^{n} v_j x_{j,0}}$$

subject to:

[61] See Commission for Aviation Regulation (2005), p. 14.
[62] See Farrell (1957).
[63] Charnes et al. (1978) originally envisaged the use of DEA for not-for-profit entities rather than regular firms or industries – see Charnes et al. (1978), p. 429 – albeit DEA meanwhile is widely accepted and applied in nearly every fragment of economies. For further examples of DEA applicability see Ramathan (2003), pp. 25-6.
[64] See Charnes et al. (1978), p. 430.

$$\frac{\sum_{i=1}^{m} u_i y_{i,a}}{\sum_{j=1}^{n} v_j x_{j,a}} \leq 1, \quad a = 1,..., A$$

$$u_i, v_j \geq 0$$

This ratio above represents the maximum of the ratio of weighted outputs to weighted inputs and u_i and v_j are the variable weights to be determined by the solution of the problem. Note that consequently an input output vector is said to be technically efficient if and only if increasing any output or decreasing any input is possible only by decreasing some other output or increasing some other input.[65]

Once conducting a DEA, different orientations of the analysis relating to inputs and outputs might be chosen. When using an input-oriented DEA-model all outputs are held constant in order to assess the maximum permissible proportional reduction in all inputs. Input-oriented DEA-models may thus e.g. be used when decision making units have limited influence on output quantities, i.e. in case the respective output set is determined by exogenous factors.[66] With regard to air transportation, demand usually is subject to certain macro-economic factors while in some cases it might even be subject to state requirements. Furthermore, some airports face restrictions on the maximum number of aircraft and/or passenger movements allowed or on operating times.[67] Concurrently, the output orientation approach implies that all inputs are held constant in order to assess the maximum allowable increase in all outputs. This approach should be used in case of limited control of input factors, e.g. if considerable political influence on investment decisions exists. While airport administration exerts at least some control over its inputs, passenger and cargo demand – its outputs – largely depend on various factors beyond its control such as regional economic development, prices, income, service levels and others that are harder to measure quantitatively.[68] Following Gillen/Lall (1997) our analysis also employs an in-

[65] See Sengupta (2003), p. 1.
[66] See Wetzel/Growitsch (2006), p. 11.
[67] See table 4 below.
[68] See also Fernandes/Pacheco, pp. 7-8.

put-oriented DEA-model as the aforementioned exogenous factors determining airport output play a particularly important role in Brazil.[69]

Our sample consists of 18 larger Brazilian airports[70] owned and operated by Infraero; hence no data comparability problems due to different ownership structures and different organisational goals occur.[71] However, when analysing airport performance one should recognise that airport characteristics with regard to other contingent variables such as size, traffic profile, age and location may differ considerably, i.e. one should acknowledge that benchmarking is not an exact science.[72]

Table 4: Overview of the Selected Airports

Airport Code (IATA)	Airport Code (ICAO)	Full Airport Name	24h Operation	Near City
BEL	SBBE	Aeroporto Internacional de Belém	Yes	Belem
BSB	SBBR	Aeroporto Internacional de Brasilia	Yes	Brasilia
CGH	SBSP	Aeroporto Internacional de Congonhas	No	São Paulo
CNF	SBCF	Aeroporto Internacional Tancredo Neves	Yes	Belo Horizonte
CWB	SBCT	Aeroporto Internacional Afonso Pena	Yes	Curitiba
FLN	SBFL	Aeroporto Internacional de Florianópolis	No	Florianopolis
FOR	SBFZ	Aeroporto Internacional de Fortaleza	n/a	Fortaleza
GIG	SBGL	Aeroporto Internacional Antônio Carlos Jobim/Galeão	Yes	Rio de Janeiro
GRU	SBGR	Aeroporto Internacional de Guarulhos	Yes	São Paulo
GYN	SBGO	Aeroporto de Goiânia	Yes	Goiânia
MAO	SBEG	Aeroporto Internacional Eduardo Gomes	Yes	Manaus
NAT	SBNT	Aeroporto Internacional Augusto Severo	Yes	Natal
PLU	SBBH	Aeroporto de Pampulha	Yes	Belo Horizonte
POA	SBPA	Aeroporto Internacional de Porto Alegre	Yes	Porto Alegre
REC	SBRF	Aeroporto Internacional de Recife	Yes	Recife
SDU	SBRJ	Aeroporto Santos-Dumont	Yes	Rio de Janeiro
SSA	SBSV	Aeroporto Internacional Luis Eduardo Magalhães	Yes	Salvador
VIX	SBVT	Aeroporto de Vitória	Yes	Vitoria

Data for each airport was assembled for the period from 2003 to 2005 resulting in 54 observations, i.e. – following DEA terminology – decision making units. Following Gillen and Lall (1997) and (1998) we also distinguished between terminal side – the number of passengers being the output measure – and air side services – the number of aircraft movements being the respective output measure. We separately assessed relative efficiency measures for both services. Even though airports can clearly be

[69] Note that if a decision making unit is deemed inefficient according to the input-oriented model, it will also be so according to the output-oriented model.

[70] See Table 4. The airports selected represent all Brazilian airports handling more than one million passengers in 2005.

[71] See Hymphreys et al. (2002), p. 266.

[72] Ibid., pp. 270-1, in particular figure 1.

viewed as multi-product firms and both outputs we distinguish in our analysis are clearly related, the 'technology' used for producing both outputs is quite different.[73] We further assumed air side services to be produced under constant returns to scale (CRS) whereas variable returns to scale (VRS) are assumed in the production of terminal services.[74]

The corresponding inputs used in our analysis are the number of runways, the number of gates and the terminal area (measured in sq. m) in case of terminal side efficiency and number of runways, runway area (in sq. m), apron area (in sq. m) and airport area (in sq. m) for efficiency assessment for air side services.[75] It is recognised that some of the chosen inputs are not truly variable inputs in the short-term.

Table 5: Overview of Input and Output Measures

Outputs	**Inputs**
Terminal Side	
Number of Passengers	Number of Runways
	Number of Gates
	Terminal Area (sq. m.)
Air Side	
Aircraft Movements	Number of Runways
	Runway Area (sq. m.)
	Apron Area (sq. m)
	Airport Area (sq. m)

Similar to a study on relative efficiency of European airports conducted by Pels, E. et al. (2001)[76] we do not include labour data in our analysis. On the one hand Infraero only provides labour data for whole administrative units, i.e. groups of airports, and no conclusions can be drawn on actual employment levels at particular airports. On the other hand information on e.g. subcontracting services such as aircraft groundhandling and the amount of employees working in non-core activities[77] is lacking. This implies that even if efficiency measures were assessed for entire administrative units – a probable solution to the first problem – the data on people employed in an administrative unit would usually contain people who are not employed in core activities. Hence, the employment data provided

[73] See Pels et al. (2001), p. 186.
[74] See Gillen/Lall (1997), p. 265.
[75] See also table 5.
[76] See Pels et al. (2001), in particular pp. 185-6.
[77] Non-core activities are services such as air traffic control, security, groundhandling, commercial activities, car park, terminal cleaning and maintenance. See Doganis et al. (1995).

is too heterogeneous to allow a serious analysis and could significantly distort efficiency measures. Consequence of the exclusion of labour data from our analysis is that an airport deemed efficient according to our analysis may or may not be labour efficient, however by assuming no substitutability between labour and other input factors this assumption should not pose a problem.[78]

Although some authors argue that air cargo should not be included in airport performance measurement as cargo handling at airports is often a pure airline activity[79] and has little effect on an airport's performance, we generally consider the incorporation of cargo necessary. This is due to the fact that some airports handle comparatively large volumes of cargo while at the same time their corresponding number of passengers is relatively low. What is more, air cargo influences the number of aircraft movements at an airport – thus this measure includes air cargo while the other (in case of terminal efficiency assessment) does not. However, as only limited data on air cargo terminal size at the airports we analysed was available, we excluded air cargo from our analysis; please note that the output 'aircraft movements' yet includes cargo flights.

As aforementioned some studies use WLU in order to aggregate passenger and freight traffic into a single output measure.[80] However, outputs of an airport related to freight throughput and the resources employed to achieve that output are very much different from those used to generate outputs in terms of passenger traffic. What is more, passenger and freight traffic do not generate the same revenues. In short, the processing of a passenger at an airport has very different demands compared to freight handling. Thus, in our view the usage of WLU in airport efficiency assessment does not seem adequate. Nevertheless the WLU is an important measure for airlines to use as it is related to aircraft payload capability.[81]

[78] See Pels et al. (2001), pp. 185-6.
[79] See Graham (2005), p. 101 for a discussion on this opinion.
[80] See Hymphreys et al. (2002), p. 266 and Graham (2005), p. 101.
[81] See Hymphreys et al. (2002), p. 266.

IV. Efficiency Assessment of Brazilian Airports

Figure 3 and Table 6 provide an overview of the relative air side efficiency of the 18 selected airports. It is noteworthy that with regard to air side operations only São Paulo's Aeroporto Internacional de Congonhas (CGH) and Goiânia's Aeroporto de Goiânia (GYN) are relatively efficient in 2005 and 2004 respectively. Both airports retain the highest efficiency scores during all three analysed years. All other airports have to be deemed relatively inefficient.

Only minor differences in efficiency could be assessed for airports in the sample between 2003 and 2005; however relatively large differences in efficiency could be observed between different airports within a federal state, e.g. São Paulo's Guarulhos (GRU) is significantly less efficient than Congonhas (CGH). Furthermore, in 2005 Belo Horizonte's Aeroporto Internacional Tancredo Neves (CNF) shows a substantial increase while in the same year Belo Horizonte's Aeroporto de Pampulha (PLU) shows a significant decrease in relative efficiency (the corresponding efficiency scores from 2003 to 2005 are 0.0928; 0.0934 and 0.3230 for CNF and 0.6618; 0.6672 and 0.4337 for PLU). As no major air side investments or disinvestments respectively occurred at these airports during the period of analysis, this can be simply explained by a significant increase in output (aircraft movements) at CNF (10,586; 10,650 and 36,842) and by a related decrease in output at PLU (75,476; 76,094 and 49,467).[82]

A further interesting development occurred at Rio de Janeiro's airports Santos-Dumont (SDU) and Galeão (GIG). While a decrease in relative air side efficiency can be observed at SDU (0.7808; 0.6830; 0.5673) a corresponding increase in air side efficiency can be detected at GIG (0.3016; 0.3399; 0.4267). However, although GIG's relative efficiency improved, it still operates far from efficient.

[82] See Infraero (2006a).

Figure 3: Air Side Efficiency

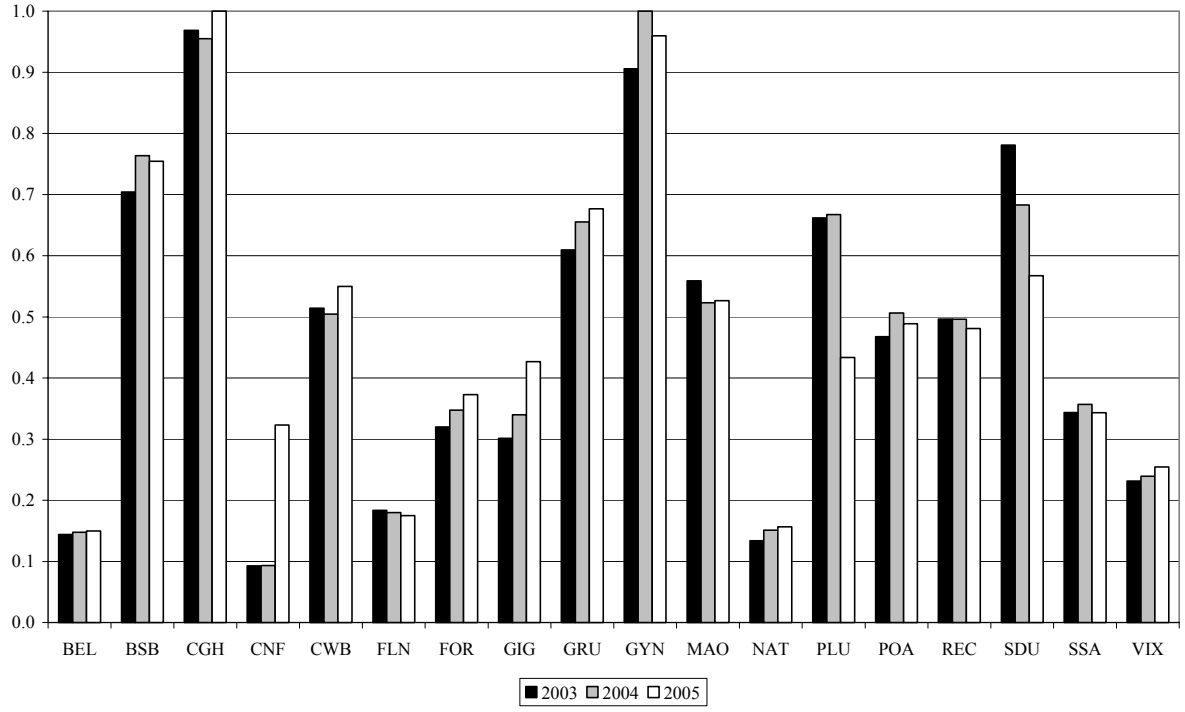

Figure 4: Terminal Side Efficiency

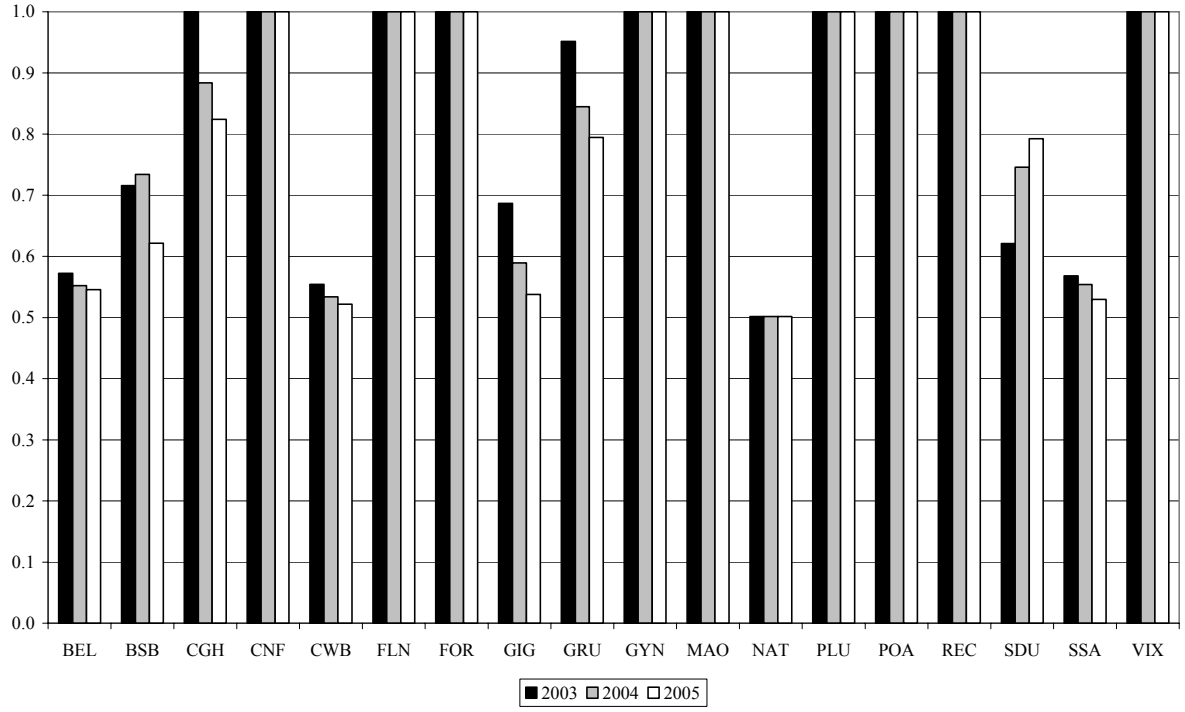

Figure 4 and Table 7 show the related results on relative terminal side efficiency. It is noteworthy that far more airports operate relatively efficient on terminal side than on air side. However, with regard to terminal side efficiency it is noteworthy that, apart from Congonhas (CGH) in 2003, all efficient air-

ports are relatively small ones – the smallest being Goiãnia (GYN) with 1,236,466 passengers and the largest being Porto Alegre handling 3,521,204 passengers in 2005.

Compared to their output levels (the number of passengers handled), these small airports feature somewhat low input levels, in particular with regard to terminal size.[83] The largest airport in our sample, Congonhas (CGH), handled 17,147,628 passengers, i.e. more than four times as many passengers in 2005. Similar to its air side efficiency scores terminal side efficiency decreased during the period from 2003 to 2005 while the terminal side efficiency of São Paulo's international hub Guarulhos (GRU) decreased as well. The reason for the decreasing terminal efficiency of Congonhas might be the opening of a new second terminal in August 2004 expanding the terminal area from 37,311 to 51,535 sq. m although passenger volume at São Paulo's domestic airport increased significantly during the last years. Still the new second terminal has obviously been constructed to allow a higher passenger capacity, which has so far not been reached.

[83] See Infraero (2006a) for data on airport output levels.

Table 6: Relative Air Side Efficiency

Airport	Efficiency Score		
	2003	2004	2005
BEL	0.1442	0.1477	0.1500
BSB	0.7042	0.7635	0.7544
CGH	0.9683	0.9547	1.0000
CNF	0.0928	0.0934	0.3230
CWB	0.5141	0.5043	0.5496
FLN	0.1835	0.1800	0.1747
FOR	0.3199	0.3474	0.3730
GIG	0.3016	0.3399	0.4267
GRU	0.6095	0.6554	0.6766
GYN	0.9056	1.0000	0.9597
MAO	0.5591	0.5231	0.5264
NAT	0.1337	0.1513	0.1568
PLU	0.6618	0.6672	0.4337
POA	0.4676	0.5062	0.4889
REC	0.4963	0.4958	0.4808
SDU	0.7808	0.6830	0.5673
SSA	0.3434	0.3567	0.3431
VIX	0.2315	0.2394	0.2545

Table 7: Terminal Side Efficiency

Airport	Efficiency Score		
	2003	2004	2005
BEL	0.5732	0.5523	0.5455
BSB	0.7158	0.7340	0.6213
CGH	1.0000	0.8837	0.8240
CNF	1.0000	1.0000	1.0000
CWB	0.5540	0.5337	0.5217
FLN	1.0000	1.0000	0.9999
FOR	1.0000	1.0000	1.0000
GIG	0.6865	0.5894	0.5375
GRU	0.9515	0.8447	0.7925
GYN	1.0000	1.0000	1.0000
MAO	1.0000	1.0000	1.0000
NAT	0.5015	0.5015	0.5015
PLU	1.0000	1.0000	1.0000
POA	1.0000	1.0000	1.0000
REC	1.0000	1.0000	0.9999
SDU	0.6210	0.7458	0.7924
SSA	0.5680	0.5537	0.5296
VIX	1.0000	1.0000	0.9999

Table 8: Air Side Efficiency – Peers

DMU	2003	2004	2005
BEL			
BSB			
CGH			50
CNF			
CWB			
FLN			
FOR			
GIG			
GRU			
GYN		17	
MAO			
NAT			
PLU			
POA			
REC			
SDU			
SSA			
VIX			

Table 9: Terminal Side Efficiency – Peers

DMU	2003	2004	2005
BEL			
BSB			
CGH	22		
CNF	14	14	14
CWB			
FLN	5	2	
FOR	14	14	14
GIG			
GRU			
GYN	36	22	22
MAO	14	14	14
NAT			
PLU	14	15	14
POA	26	14	14
REC	24	14	
SDU			
SSA			
VIX	23	19	

Table 8 and 9 present a summary of the number of times that each airport, which operates relatively efficient, i.e. on the frontier, is a peer for the other (inefficient) airports. The two airports operating relatively efficient with regard to air side operations have been peers 17 times in case of GYN and 50 times in case of CGH; thus, in particular air side operations at Congonhas symbolize an excellent example to examine for the other inefficient airports.

With regard to relative terminal side efficiency a different picture emerges. Most airports featuring relatively efficient terminal side operations are peers for a rather large number of inefficient airports. However, two airports immediately attract attention. On the one hand Aeroporto de Goiãnia (GYN), which has been a peer for 36 airports in 2003 and for 22 airports in 2004 and 2005 respectively and on the other hand Aeroporto Internacional de Florianópolis (FLN), which has merely been a peer for five and two other airports in 2003 and 2004 respectively. The Aeroporto de Goiãnia again seems to be a good example for all other inefficient airports.

V. Conclusion

As labour is not included in our analysis an airport that is deemed efficient according to our investigation, in reality may or may not be labour efficient. Our results may provide a guideline but cannot be absolutely accurate due to the limited data available and the differing physical characteristics of Brazilian airports. Furthermore, various contingency variables[84] might have an additional effect on efficiency scores and should not be disregarded. Especially the size of an airport as well as its traffic profile might have a significant influence on the performance of Brazilian airports. However, further research is necessary in order to quantify the influence of such contingency variables on the performance of Brazilian airports.

The timeframe of our analysis is up to now relatively short but we envisage the extension of our analysis to previous and subsequent years if the required data can be collected, so that a regular efficiency assessment of Brazilian airports might be available in future. What is more, in order to reach more accurate performance measures, airports could segment their market and identify relevant performance standards and measures for different groups of customers. These measures should not be used and compared in isolation and care must be taken when analysing them.[85] However, as only limited data is available about Brazilian airport operations, this approach is not feasible so far.

[84] Humphreys et al. (2002), pp. 270-1; list the following contingency variables: airport size, traffic profile, age, ownership, regulations, location, culture and stakeholders.

[85] See Humphreys et al. (2002), p. 273.

In case the Brazilian federal government will finally decide to privatise its airport operations, airport efficiency studies might be a valuable source of information for prospective acquirers. However, private capital will in most cases not be attracted unless airports yield satisfactory financial returns.[86] Furthermore, commercialisation and the probable privatisation are generally thought to improve airport performance nevertheless these measures should be accompanied by matching deregulation measures. Regardless of the actual ownership of an airport's assets the continuous monitoring of airport performance is advisable and might in future also be demanded by stakeholders.[87]

[86] See Fernandes/Pacheco (2005), p. 2.
[87] See Martin/Román (2001), p. 156.

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