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Capacity shortfall and efficiency determinants in Brazilian airports: Evidence from bootstrapped DEA estimates

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ABSTRACT

This paper reports on the use of different approaches for assessing efficiency related-issues in 63 major Brazilian airports. Starting out with the bootstrapping technique presented in Simar and Wilson (1998, 2004), several DEA estimates were generated, allowing the use of confidence intervals and bias correction in central estimates to test for significant differences in efficiency levels, returns-to-scale, and input-decreasing/output-increasing potentials. The findings corroborate anecdotal and empirical evidence regarding a capacity shortfall within Brazilian airports, where infrastructure slack is virtually inexistent, regardless of the airport type and location.

1. Introduction

In the past few years, accelerated economic growth has increased the demands for airport services in Brazil. Between 2003 and 2008, the number of air passengers grew at an average rate of 10% per year [1] and, although the cargo tonnage remained relatively stable over the course of these years, value-added has increased significantly [2]. This increasing air demand for reliable services has placed enormous pressure upon the Brazilian airport infrastructure. The situation is expected to get worse as the country will host the next Word Cup (2014) and Olympic Games (2016).

Air transportation in Brazil was, until recently, regulated and controlled by the *Departamento de Aviação Civil* (Department of Civil Aviation or DAC) and investment in airport infrastructure was performed and operated by Infraero, a state owned company linked to the Brazilian government founded in 1973. Although a regulatory agency, *Agência Nacional de Aviação Civil* (National Agency for Civil Aviation or ANAC), was created specifically for the oversight of the civil aviation sector, taking over the responsibilities of the DAC [3], thus far, Infraero is still responsible for managing, renovating, building, and equipping Brazilian airports.

Under pressure from anecdotal evidence suggesting a capacity shortfall in Brazilian airports [4,5], the Brazilian government initiated a sector deregulation/privatization process by the end of the first quarter of 2011. The first airport to be privatized, Natal, is a small one located in the Northeast region. This airport will serve as a testing pilot prior to large scale airport concession. The idea is to speed up capacity expansion projects in major airports (runways, gates, terminals, parking lots etc.) – by contracting them out to a private management authority under a long term lease to mitigate the risks of operational bottlenecks in 2014 and 2016 during the World Cup and the Olympic Games.

Since time is short to handle adequately the future investments in infrastructure, an empirical investigation on factors affecting Brazilian airport returns-to-scale and slacks has become important. More precisely, it is desirable to provide benchmarks for improving the operations of airports that perform poorly, investigating which of hub/international/metropolitan area airports present superior performance.

This paper presents a benchmark and efficiency analysis of 63 major Brazilian airports, administered by Infraero, based on cross sectional data for 2009, putting output-increase potentials and input slack – not only regarding the physical infrastructure, but also the available area for future capacity expansion – into perspective. A complementary approach is used for measuring the efficiency levels of major Brazilian airports and for characterizing their returns to scale condition: Data Envelopment Analysis (DEA) in its envelopment and multiplicative forms, respectively.

Despite the increased use of DEA to measure the efficiency of airports over the last decade, there are still few studies that also exploit bootstrapping methodology to account for measurement errors in estimates within this particular transportation area [6–9]. Initially introduced by Simar and Wilson [10–12], bootstrapping

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Table 1
DEA-based studies on airport efficiency.

Authors	Methodology	Sample size	Inputs	Outputs	Year(s)	Country
Tsekeris [8]	DEA VRS/CRS envelopment, output-oriented model with bootstrapped efficiency estimates.	39	Runways, terminal area, airplane parking area, operating hours	Passengers, cargo, landing and take-offs	2007	Greece
Alana et al. [17]	Fractional integration	Monthly series	Number of incidents	Victims, plane crashes, helicopter crashes	1999–2000	Brazil
Curi et al. [9]	DEA VRS envelopment, output-oriented model with bootstrapped efficiency estimates.	18	Employees, runways, apron area	Landings and take-offs, passengers, cargo	2000–2004	Italy
Lozano and Gutierrez [18]	DEA slack-based model	39	Runways, apron capacity, baggage belts, check-in counters, boarding gates	Landings and take-offs, passengers, cargo, percentage of delayed flights, average conditional delay	2006–2006	Spain
Yu [19]	Slack-based measure network DEA.	15	Employees, runways, apron, terminal	Passengers, cargo, landings and take-offs	2006	Taiwan
Suzuki et al. [20]	DEA CRS multiplier, output-oriented model altogether with DFM (Distance Friction Minimization).	30	Runways, terminal area, gates, employees	Passengers, landings and take-offs	2005	Europe
Marques and Simoes [21]	DEA CRS/VRS altogether with congestion models.	141	Runways, gates, terminal area, employees	Landings and take-offs, passengers, cargo	2006	Several
Assaf [7]	DEA NIRS/CRS envelopment, output-oriented model with bootstrapped efficiency estimates.	27	Number of FTE, airport area, runways	Passengers, cargo, landings and take-offs	2007	UK
Chi-Lok and Zang [22]	Two-stage DEA model. First stage: VRS envelopment, output-oriented model. Second stage: balanced panel data with Tobit regression for a random effects model.	25	Runways, terminal area	Cargo, landings and take-offs, passengers	1996–2005	China
Lam et al. [23]	DEA CRS/VRS envelopment, input-oriented models with non-disposable inputs altogether with SBM and cost efficiency models.	11	Employees, capital, soft inputs, trade value	Landings and take-offs, passengers, cargo	2001–2005	Several in Asia
Bhadra [24]	Two-stage DEA model. First stage: VRS envelopment, output-oriented model. Second stage: balanced panel data with Tobit regression for a random effects model.	13	Gallons of jet fuel, employees, utilization of aircraft	Revenue passenger miles, load factor	1985–2006	USA
Barros and Peypoch [25]	Two-stage DEA model. First stage: CRS/VRS envelopment, output-oriented models. Second-stage: bootstrapped truncated regression.	29	Employees, operational costs, planes	Revenue per passenger*km, EBIT	2000–2005	Several in Europe
Barros [26]	Two-stage DEA model. First stage: CRS/VRS envelopment, output-oriented models. Second stage: bootstrapped DEA scores with a truncated regression.	32	Employees, runways, airport ramp, terminal area	Landings and take-offs, passengers, cargo	2003–2007	Argentina
Barros and Dieke [6]	Two-stage DEA model. First stage: CRS/VRS envelopment, output-oriented models. Second stage: balanced panel data with Tobit regression for bootstrapped estimates.	31	Labor costs, capital invested, operational costs	Landings and take-offs, passengers, cargo, handling receipts, aeronautical sales, commercial sales	2001–2003	Italy
Barbot et al. [27]	DEA, input-oriented, slacks based model.	49	Employees, fleet, fuel consumption	Available seat-kilometers, revenue tone-kilometers	2005	Several
Barros and Dieke [28]	DEA CRS/VRS envelopment, output-oriented models altogether with Cross-Efficiency and Super-Efficiency models.	31	Labor, capital invested, operational costs	Planes, passengers, cargo, handling receipts, aeronautical sales, commercial sales	2001–2003	Italy

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