A Study of Multiple Airport Metropolitan Regions Worldwide: Implications for AITN and Belo Horizonte

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Abstract

This subproject utilizes an extensive cross-national airport database to document the prevalence, reasons for, and varied nature of multi-airport systems in metropolitan regions worldwide, and draws implications for Tancredo Neves International Airport (AITN) and Belo Horizonte. It discusses the competitive and operational factors favoring a single metropolitan airport, even when multiple airports are in operation. The available evidence shows that 1) there are strong advantages to the consolidation of air traffic in a single airport, 2) few metropolitan regions operate multiple airports unless the region's airports are capacity constrained, and 3) even under severe capacity constraints, multiple airports result in significant disadvantages without counter-balancing advantage. Single commercial airport metropolitan regions, on the other hand, permit aviation network economies of scale allowing more destinations to be served and greater frequency of service to those destinations improving the prospect of hub status. In addition, a single airport is better able to manage the significant demand uncertainty in air transport markets, lowers risks of excess regional infrastructure capacity, and thereby lowers overall finance costs as air transport markets develop.

On the basis of existing theory and research and our cross-national evidence, we conclude that Belo Horizonte does not need two commercial airports: AITN and closer-in Pampulha Airport. The metropolitan region can offer superior service with greater technical and economic efficiency with one modern airport which has substantial capacity to expand and potentially serve as a hub (AITN). Reopening Pamulha Airport will severely undermine AITN's remarkable recent progress and weaken the region's position in domestic and global aviation networks. This is because splitting the region's air traffic between AITN and Pampulha will limit AITN's ability to meet the passenger

thresholds needed to maintain and grow routes which will further hinder efforts to attract transfer passengers. Accordingly, airlines would be reluctant to establish hub service at AITN if commercial traffic were divided between two airports. In addition, attempting to maintain two commercial airports, by spreading demand over two capital-intensive facilities, will have an adverse financial impact on both airports, but especially AITN which must generate revenues for future expansion if its full economic impact potential is to be achieved.

By siphoning air traffic from AITN, renewed commercial jet service at Pampulha Airport would likely preclude AITN from ever becoming a successful industrial airport and driver of airport city and broader aerotropolis commercial development. The Belo Horizonte metropolitan region and, indeed, the State of Minas Gerais would miss out on this remarkable opportunity.

Because of the above and due to Pampulha's facility and infrastructure constraints, safety issues, and image problems, it is recommended that all commercial airline service for Belo Horizonte be exclusively concentrated at AITN. It is further recommended that Pampulha serve as a general aviation airport for corporate and other private aircraft (including air taxis and very light jets) providing a second aviation asset for Belo Horizonte that complements rather than duplicates AITN.

Background of Study

The debate over maintaining two or more commercial airports to serve a metropolitan region has taken place around the world with airlines, communities, business and local, state, and federal governments all expressing strong views. This is no different in Belo Horizonte, where the debate centers not just around convenience of airport access and efficient commercial air service, but also how best to leverage its airport assets for economic development.

Apropos the latter, Aeroporto Internacional Tancredo Neves (AITN) has long been counted upon by both Infraero and the government of the State of Minas Gerais to be a key node in Brazil's aviation network and driver of economic development throughout the Belo Horizonte region and , indeed, the entire State. The airport opened in 1984 at a cost of US$400 million on an expansive site in Confins, 40km north of downtown Belo Horizonte. Its original design called for two long-range runways and four modern (300,000m^2) passenger terminals capable of handling up to 20 million passenger, along with cargo facilities with an ultimate capacity of 147,000 tonnes of cargo annually.

Twenty years later (2004), despite its superb infrastructure and facilities, AITN handled just 388,580 passenger in a single terminal (designed for a capacity of 5 million passengers annually) along with only 8,882 tonnes (8,882,371 kg) of cargo. During the period form 1997 to 2004, passengers at AITN had actually declined by 64 percent (from 1,091,544 to 388,580) and cargo by 62 percent (23,684,541 kg to 8,882,371 kg), a great disappointment to many.

In sharp contrast, passengers at more conveniently located Pampulha Airport tripled between 1996 and 2004 (1,090,818 to 3,194,715) while air cargo there almost doubled between those dates. With Pampulha dangerously congested (operating at twice its intended capacity with outdated facilities and physically constrained infrastructure), Infraero (in consultation with state and local government officials) agreed to transfer all commercial flights (with the exception of early morning and and early evening flight to and from São Paulo) to AITN in March 2005. The policy was later changed to no jets operating at Pampulha.

Annual data on passengers and cargo at AITN and Pampulha (PHU) through the third quarter of 2008 reveal the impact of these policies. Passengers at AITN increased more than ten-fold by 2007 (to 4,340,139) while cargo doubled (to 16,422,992 kg). Corresponding sharp drops in passengers and cargo were experienced at Pampulha.

As a result of (and reinforcing) passenger and cargo growth at AITN, both its domestic and international flights substantially expanded including new wide-body non-stop service to Lisbon via TAP and Miami via American Airlines. This dramatically improved AITN's air service connectivity nationally and globally, with one-stop service to virtually every major market in the world via Lisbon and Miami.

Because of its closer location to downtown Belo Horizonte, there are requests by some airlines and some in the business community to recommence commercial jet service to Pampulha which would have major implications for AITN's future growth and economic impact. It is in that context that the State of Minas Gerais Secretariat for Economic Development commissioned this study to document multiple commercial airports serving metropolitan regions around the world, the reasons for these metropolitan regions having two (or more) commercial airports, and their financial and service consequences.[1] Based on this

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[1] Richard de Neufville (de Neufville, Richard and Amedeo Odoni, 2003, *Airport Systems: Planning, Design, and Management*, New York: McGraw-Hill; de Neufville, Richard, 2000, "Planning Multi-Airport Systems in Metropolitan Regions in the 1990s," Report prepared for the U.S. Federal Aviation Administration, Procurement Order DTFA01-92-P-01243) has a long stream of research establishing the basic framework for the study of multiple airport regions. Behavioral models of airline and passenger airport choice have increased understanding of the factors responsible for the patterns of airport use.

analysis, that of others, and my own work at AITN, Belo Horizonte and around the world, the implications (benefits and costs) to Belo Horizonte, Minas Gerais and AITN of reintroducing and expanding commercial air service at Pampulha Airport will be drawn. I will also make recommendations for future air service at AITN and Pampulha Airport focusing on synergies between the two airports. Recommendations will take into consideration the economic development needs of Belo Horizonte and Minas Gerais, as well as requirements for AITN to attract additional domestic and international air service and become a prosperous hub. Rather than close Pampulha, a potentially valuable air service strategy will be proposed for this airport that could meet local business needs and complement AITN's future hub status to enhance aviation's overall economic impact on Belo Horizonte and Minas Gerais.

Cataloguing metropolitan airport systems

To catalogue secondary airports around the world and assess the reasons for then as well as their consequences, 2006-based data from *Airports Council International (ACI)* and aviation surveys were used. Focus is on the busiest 125 air travel regions since this is where the most complete data could be obtained.[2] In order to form these regions we relied on information on the metropolitan area in which airports are located supplied by *ACI*, information garnered from other surveys, from the research literature, and professional judgment. In some regions, such as New York, multiple major airports are fairly close to one another, requiring careful route demarcations in order to keep traffic from the various airports separate. In other cases, the airports are quite distant from one another.

Catchment areas for some large airports can be expansive. To illustrate, Figure 1 maps the immediate points of origin for a sample of San Francisco International Airport passengers. Some are origin passengers beginning their journey at home, their office, or another location. Others are destination passengers returning home. The airport is on the east side of the peninsula, just as the land turns to the southeast. Although concentrated in San Francisco and near the airport itself, many passengers begin their journeys from quite far south past San Jose Airport, the East Bay Area surrounding Oakland Airport and inland. In addition to those seen in the figure, a small concentration of passengers began their journey with a drive from as far as Sacramento and even a few from near Lake Tahoe on the Nevada border, hours away.

Among the largest metropolitan multiple airport regions studied, several also cover an extensive ground area. London, New York, and Los Angeles include significant geographic areas with their far-flung airports sometimes

[2] I would like to acknowledge the substantial input of my Kenan Institute colleague, Dr. Stephen J. Appold in the assembly of this extensive database.

operated by a single regional authority. Stewart Airport, managed by the Port Authority of New York and New Jersey, is 130 kilometers from New York's flagship airport, John F. Kennedy. Palmdale Airport, operated by Los Angeles World Airports, is 115 kilometers from LAX, the region's busiest airport. The smaller, more distant commercial airports do not offer viable alternatives for most travelers but, because their existence affects passenger flows and prices in the larger airports, they are included in the airport regions considered.

It should be noted that *Airports Council International*, the primary data source for this study, is a voluntary membership trade association. Analysis is limited to the airports reporting data. With a few exceptions, however, most commercial airports do join *ACI* and report on their passengers, cargo, and aircraft movements.

The major metropolitan airport regions: a global overview

ACI data show that approximately 4.4 billion passengers passed through over 1,100 airports in 2006.[3] This was an increase of 61 percent since 1996. Approximately 3.4 billion, 77 percent, of those passengers traveled through the 209 commercial airports in the busiest 125 metropolitan regions identified. Half travel through the busiest 63 airports worldwide. One-third of all passengers travel through the busiest 32 airports and one-quarter go through the top 21 airports.

Table 2 lists the 125 busiest air passenger metropolitan regions in rank-size order. The number of airports, total number of recorded aircraft movements, and total number of passengers are included. Fifty-three of the 125 busiest metropolitan regions contain multiple airports offering commercial service. Thirty-seven of the fifty busiest regions contain multiple airports with

[3] Passengers are counted each time they pass through an airport, so that there were just over two billion one-way trips taken in 2006.

commercial service. Seventy-two of the 125 regions are able to provide service with a single commercial airport; 13 of the top fifty do so.

Table 3 presents the frequency distribution of numbers of commercial airports in the largest 125 and top 50 metropolitan regions, respectively. The numbers of airports in a single region ranges from one up to seven. Seventeen percent, 21, of the metropolitan regions contain three or more commercial airports. Almost all of those regions, 18, are among the busiest 50 air passenger regions.

Table 4 shows the average number of commercial airports for each group of five regions, from the busiest to the least busy, along with the average number of passengers served. The regions in this study are grouped to reduce the statistical effects of a single outlying region. All of the groups containing the top 50 regions, each with over 22 million passengers, average 1.5 or more airports. All of the groups containing the top 25 regions, each with over 36 million passengers, average two or more airports. The very largest regions have, on average, more airports. Note that the number of air passengers declines rapidly after the first group of regions.

A careful examination of Table 2 shows that passenger flow is not the only determinant of the emergence of regional multi-airport systems. Regions as small as Tel Aviv, Israel, with less than ten million passengers annually, support multiple commercial airports. Yet Atlanta, the sixth-largest air travel market globally, functions effectively with just one airport.

Figure 2 contains a scatterplot graphing the rank size order of airport regions against the number of regional airports. Consistent with the information in Table 4, the average number of airports drops off sharply after the first several largest regions.

Table 5 includes all the metropolitan regions examined and all airports for which passenger and aircraft movement data were available. Two of Brazil's metropolitan regions (São Paulo, ranked 43rd, and Rio de Janeiro, ranked 83rd) and three of the country's airports (Congonhas, ranked 67th, Galão, ranked 131st, and Guarulhos, ranked 133rd) fall in our global study sample. Belo Horizonte is not large enough to be in the study sample. However, since I wish to draw implications for Belo Horizonte from elsewhere in the world, it is advantageous to be excluded.

In the U.S. and much of Europe and Asia, well-developed ground transportation systems – highways and trains – mean that travelers often have a choice among airports. Therefore, the demarcation of regions is not always cut and dry.

All travelers value air service frequency and convenient ground access. Especially leisure travelers will often use a larger airport that is further from their home to get a better price or more convenient flight, however. Business travelers often prefer the larger airports with more frequent service.

Germany, in cooperation with Lufthansa and the national railway, has a long history of providing rapid rail service to funnel passengers throughout the middle Rhine Valley area to Frankfurt International Airport, effectively enlarging the airport's catchment area. The airport now has one of the busiest train stations in the country. Service area leakage is an issue especially for the smaller airports, which funnels passengers and cargo to better connected airports in larger metropolitan regions.[4]

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[4] Suzuki (Suzuki, Yoshinori, (2007), "Modeling and Testing the 'Two-Step' Decision Process of Travelers in Airport and Airline Choices," *Transportation Research: Part E: Logistics and Transportation Review* 43: 1-20) reports that as many as 30 percent of all air passengers in a small metropolitan area, Des Moines IA, drive two hours or more in search of better service and lower fares. My earlier study of air cargo leakage from the Belo Horizonte area showed a huge proportion trucked to airports in São Paulo and Rio.

The historical factors leading to the emergence of multiple metropolitan airports

The previous section provided a global overview of multiple commercial airports in the busiest metropolitan regions. Here, the critical factors in the development of multiple metropolitan airports from the complex histories of regions are distilled. While idiosyncratic factors play a large role, two systematic factors account for much of the emergence of multiple metropolitan airports. A strong increase in the demand for air transport is the main prerequisite for multiple metropolitan airports.[5] The second is a constraint on capacity at established airports, which was the original impetus for AITN.

Consistent with the above, the emergence of multiple airports boils down to two basic historical patterns: 1) addressing inadequate capacity at the initial commercial airport by serially building airports to relax capacity constraints and 2) the combined geographic expansion of metropolitan regions and of airport catchment areas. The two systematic factors mentioned above are responsible for the first pattern. Metropolitan expansion is a contributing factor to the second, less common, pattern.

Despite some potential economic advantages of multiple airports (discussed below), none of the regions surveyed explicitly planned from the outset to operate more than one commercial airport. Moscow may be a partial exception in that multiple airports were planned for military and security reasons.

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[5] Despite a strong overall rise in demand, there are U.S. and European cities that have been able to supply the needed air transport without expanding the stock of runways, which are the critical capital investment, because the increase in local demand has been minimal.

Serial primary airports: The most common path to multiple metropolitan airports

As noted above, growth in passenger demand combined with capacity constraints at existing airports are the primary factor driving the construction of additional commercial airports. Faced with rising local demand for air transport, planners and officials generally can choose between a) expanding in place, b) building a new airport and closing the old one, and c) building a new airport and not closing the old one. The first two options result in a single regional airport. In almost all regions where the last option emerges, it is the result of intending – but failing – to close the older airport.

Figure 3 summarizes the *de facto* decision tree in regional air capacity planning. The first consideration is an increase in air passenger traffic. Without a sufficient increase in air traffic support for additional capital investment will probably receive little support from regulatory, financial, or political actors. If traffic is increasing, the next consideration is the ability to expand in place. Space allowing, expansion in place allows greater investment efficiency and flexibility than building a new airport. That is, expansion in place allows for incremental additions which result in a closer match between capacity and demand over time while avoiding the huge capital outlays and social and environmental impacts of building a new greenfield airport.

Managing capital investments are a major concern for airport management. Newer major greenfield airports have initially cost between $1.6 billion for Shanghai's Pudong (1999) to $12.1 billion for Hong Kong's new airport (1998). The new Munich airport (1992) holds an intermediate position at $7.1 billion. The investments needed for ground access adds considerably to these costs. In contrast, Paris' Charles de Gaulle Airport added two new parallel runways in the 1990s at a cost of $270 million. Major new international passenger terminals have cost $1 billion to $2 billion, recently. An individual concourse costs significantly less. Expansion in place allows capital investment to be incremental, hence significantly less "lumpy."

Despite the economic advantages of passenger-driven, incremental additions to the capital stock, some airports, like Pampulha, cannot be expanded in place due to a lack of land. The limited possibilities for lengthening and adding runways are major factors in the decision to open a second regional airport. Of the two, runway length is the most decisive because short runways often preclude long-distance service, as well as pose safety hazards. Several airports, including Gatwick and, for much of its history, Narita, have been able to process large numbers of passengers with only a single runway.

Three classes of runway length are important in determining the destinations that can be served from particular airports. Runways of approximately 2,000 meters are often adequate for contemporary narrow-body aircraft such as regional jets, Boeing 737s, and Airbus 320s.[6] Longer runways (approximately 2,500-3,000 meters) may be sufficient for most commercial aircraft on moderate-length routes. International wide-body flights sometimes require runways of over 3,700 meters when fully loaded. These runway lengths will increase with altitude, temperature, and other local conditions.

In the era of propeller aircraft, when many of the older commercial airports were established, a runway of 1,000 meters was typically sufficient. At the dawn of the jet age, runway needs were doubled to over 2,000 meters for a Boeing 707. Major upgrades to airports were immediately required in order for cities to participate in the jet age. Kennedy Airport's signature building, Eero Saarinen's TWA terminal, was ill-suited to mass jet travel and therefore outmoded the day it opened for operation.

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6 Some regional jets can land at London City Airport with a runway of 1,500 meters.

The adoption of widebody jets repeated the process. Longer runways, larger passenger terminals, and higher capacity ground access were once again needed. The Airbus 380 serving major long-haul hubs will require terminal and ground access improvements to cope with the larger peaks in the flow of passengers but, at the present time, it seems unlikely that commercial aircraft will be developed that require longer runways than those at most major international airports.

When runway length is the constraining capacity issue, an airport with long runways and larger passenger capacity is generally built. When the number of runways limits passenger-processing capacity, a smaller reliever airport could be chosen. If a larger airport is built, its predecessor could be closed. Allowing the predecessor airport to remain open after capacity has been added is the main route to multiple airports in a single region. We review prominent examples of each development path.

Atlanta is the most prominent example of airport expansion in place. Atlanta's airport was established in 1926 and has remained as the primary airport for the region ever since. Serving nearly 90 million passengers in 2007, it is the busiest passenger airport in the world today. The airport has been reconstructed several times in order to cope with the increasing traffic load. The airport took on its present parallel runway/mid-field terminal form in the early 1980s. Recent and continuing expansions are increasing capacity further, including a new fifth runway opening soon.

Sydney's airport, though not as large, has been serving all of that region's air transport needs since 1920. Sydney's Kingsford Smith International Airport is the oldest commercial airport now operating in the world. A second airport has been under consideration for decades, though not built. Frankfurt and Amsterdam's Schiphol also have long histories as primary airports. A comparative examination of the available evidence suggests that expansion in place for single airports is the most-preferred and cost-effective airport infrastructure option.

Atlanta's Hartsfield Airport, despite being an older airfield, had sufficient space available for its runways to be lengthened to a maximum of 3,600 meters making it suitable for almost all flights. The option of expanding in place was not open to all airports, however. Few airports have been able to successfully make transitions across the generations of commercial aircraft which have required transitions across corresponding generations of airports – from (1) grassy field to hardened runways to (2) an ability to handle jet aircraft to the capacity to (3) handle large jumbo jets on systems of parallel runways. Some were hemmed in by natural barriers such as water (New York La Guardia) or urban development (Chicago Midway). Berlin Tempelhof, opened in 1923, is still in use but, surrounded by the city from its initial construction, has been unable to make the transition to today's largest commercial aircraft.

Hong Kong, Denver CO, Munich, Austin TX, and Singapore are prominent metropolitan regions that have followed the second option of closing the older airport. With passenger scale similar to Belo Horizonte, both Bangalore and Hyderabad in India opened new airports this year following this second option as well. All have built new larger airports, usually significantly more distant from the city they serve than the airport they replace, and closed the old more centrally located airport. Orly replaced Le Bourget, which is now used for business aviation, in 1962. Earlier, La Guardia Airport replaced two other closer-in New York City airports which were then also closed to commercial traffic.

Metropolitan spatial expansion has generally accompanied growing population and the rising demand for air travel. Therefore, when capacity was constrained at existing airports by an inability to extend or add runways or by a lack of space for needed terminal expansion, available sites for new airports were often significantly more distant from established population and employment centers than the existing airports. In those cases, the pressure to keep the original airport was sometimes overwhelming.

Many of the metropolitan areas with multiple airports fall into this category. O'Hare's much smaller predecessor, Midway, is now open after being closed for decades. Chicago's Midway Airport has runways that only reach 1,988 meters, which is too short for most widebody jets. Moreover, Midway is surrounded by urban development and flights are restricted in order to limit residential noise.

Safety is also a problem at Midway. In 2007 a B737 jet overran the runway and crashed through the airport fence striking a car on a highway and killing its occupants.

O'Hare's maximum runway length is 3,963 meters which means it can handle much larger aircraft and higher loads. O'Hare is, however, 14 miles from Chicago's Loop while Midway is only 9 miles. Dallas-Fort Worth (20 miles) and Love Field (6 miles), Dulles (25 miles) and Washington National (4 miles), Bush Intercontinental (18 miles) and Hobby (10 miles) – the second airport in each pair being the smaller predecessor more proximate to the city center – are all used. In nearly all these cases, though, growing passenger demand and limited capacity at the newer airport to absorb full demand was a key reason for maintaining commercial air service at the older airport.

Charles de Gaulle and Orly are both still in service. Pudong and Hongqia, Suvarnabhumi and Don Muang, Incheon and Gimpo, and KLIA and Subang are only a few of the more recent examples of dual airports resulting from the recent strong expansion in Asian air traffic. Capacity issues arose at Pudong and Suvarnabhumi leading to the predecessor airports remaining open. Buenos Aires, Taipei, Rio de Janeiro, and São Paulo also needed to build new airports because existing runways were too short for international service and extensions were impractical. In each case, a combination of capacity needs and the distance to the newer airport resulted in successful pressure to maintain service at the original airport, despite runway safety hazards.

Some exceptional histories

In most cases where capacity constraints led to multiple metropolitan airports being in operation, the newer airport was the intended primary airport. Only in a very few cases, with London being the main example, were the newer commercial airports planned to absorb traffic overflow. In these cases, runway length was not a constraint at the established airport. Gatwick, in operation since the 1920s, was re-developed in the 1950s to serve as a reliever airport for Heathrow. The process was repeated with the development of Stansted. Despite crowding, high prices, and poor service, Heathrow has remained London's primary airport for long distance flights. Heathrow's proximity to the city center, long runways, and convenience to large residential areas most prized by business people and other frequent fliers may help explain its continued pre-eminence. A major new terminal (Terminal 5) recently opened and efforts to add a third runway are pushing ahead, despite environmentalists' opposition.

Frankfurt Airport, Europe's third-busiest, is another exception. Runway length is not a limitation but the expansion of traffic at the airport is constrained by the surrounding nature preserve and public sentiment which has also resulted in a partial ban on night flights. Extra capacity is needed. Lufthansa, the primary German airline, has shifted some of its hub operations to Munich airport in response. Munich Airport, although in a different metropolitan region, acts as a partial reliever airport for Frankfurt. With Frankfurt operating at full capacity, Lufthansa has also shifted some cargo operations to Frankfurt-Hahn airport, a former military base 120 km from Frankfurt.[7]

The New York area may be the only example of multiple airports being developed in competition for the same passenger market. Up until La Guardia Airport opened in late 1939, someone flying to New York might very well have landed in Newark. Fiorello La Guardia famously once demanded that, since he had a ticket to "New York," he be flown from Newark to Floyd Bennett Field in Brooklyn. As mayor he championed the airport which later came to bear his name. The primary New York region airports were later joined under the common management of the Port Authority of New York and New Jersey.

Metropolitan expansion and the accumulation of airports

The intertwined expansion of metropolitan regions and airport catchment areas is the second main factor partially explaining the presence of multiple airports in several regions. The geographically combined airports rarely substitute for the region's primary airport. The peripheral airports do absorb passengers from the periphery of the primary airport's catchment area, however.

New York has gained new airports as those in Westchester (33 miles away), Islip (51 miles), and now at Stewart (65 miles), recently taken under Port Authority control, are increasingly surrounded by population and employment centers. LAX is Los Angeles' premier airport but as the region has expanded, it has encompassed an increasing number of airports. John Wayne Airport in Orange County and Ontario Airport near Riverside (which is owned and operated by the City of Los Angeles along with Los Angeles International (LAX),

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[7] It is unclear why Cologne-Bonn Airport, which is only 40 km further from Frankfurt than Hahn, closer to major cargo and passenger markets, and better served by ground access infrastructure, was not chosen for that function. Cologne-Bonn Airport's runways are comparable to Hahn's and the airport, which serves as a UPS hub, does not have a night flight ban.

Van Nuys (VNY), and LA/Palmdale Regional (PMD) Airports) have been engulfed by the LA region's growth.

Hong Kong may now be affected by a similar process as China's nearby Pearl River Delta grows and becomes increasingly integrated. The Washington D.C. area now effectively encompasses Baltimore and much of Northern Virginia, adding another airport to the region's total. (Reagan National and Dulles Airports are now under the management of Metropolitan Washington Airports Authority.) The San Francisco region has three airports (San Francisco International, Oakland, and San Jose) that were each originally oriented towards separate markets. Those markets have largely grown together, as was illustrated in Figure 1.

Dallas-Fort Worth Airport is possibly the prime example of a large airport being the product of regional metropolitan expansion. As the two independent cities, Dallas and Fort Worth, continued to grow outward and towards each other, the U.S. Federal Aviation Administration became increasingly reluctant to continue investing in separate airports in each city that undermined service quality and financial economies by duplicating each other. A new, larger airport sited midway between the two metropolitan areas that could create route and financial economies of scale was the result. Additional cases can be found in the U.K. Midlands where some airports serve multiple metropolitan areas.

Probably all major metropolitan regions are, strictly speaking, multiple airport regions. Most have multiple airports even if only one has commercial air service. In Detroit, for example, all three of the region's serial primary airports, Detroit City, Willow Run, and Detroit Metro Wayne, are still in operation. Only the last attracts measurable passenger service, however. Kansas City's close-in former primary airport (now a general aviation airport), despite having the runway capacity to land wide-body aircraft, does not provide any commercial service even though its newer replacement airport is quite distant from the city.

And a number of metropolitan regions could potentially operate more airports than they do.

The need for some airports is sufficiently low that they have been decommissioned. Several of New York's and Chicago's former airports, for example, are now the sites of shopping centers and parks. Denver's Stapleton International Airport, which as closed when the new Denver International Airport opened in 1993, has become a highly successful mixed-use residential/commercial development.

Military conversions, in the U.K., Germany, and, to some extent, the U.S. have added to the supply of metropolitan airports. Because of prior infrastructure investment, these airports are sometimes economically viable whereas a new greenfield airport (one built from scratch) would not be, allowing a multiple airport metropolitan region that would otherwise not exist. While a completely new airport would require investment in land acquisition and runways, in military conversions the major capital investment is a sunk cost. The upgrading and expansion of a limited subset of existing general aviation airports has also added to the supply of metropolitan airports. Sometimes local development boosters have championed the airport. In many cases, no airline can be attracted. Table 6 summarizes the regional evolution of several major existing airport systems.

Classifying metropolitan multiple airport systems

In order to develop a typology of metropolitan airport systems a set of airports in major metropolitan areas were examined. This assessment relies on three data sources. First, data are examined on the busiest 50 metropolitan regions globally to obtain a broad comparative picture of multiple airport regions. As documented above, multiple airports are less common in the smaller regions. Then, a more detailed picture is presented using multiple airport systems in the U.S. Finally, case study data are used to provide illustrative evidence of the costs and benefits of having multiple commercial airports in operation.

The uneven distribution of traffic

Table 7 summarizes the information on passenger distribution among the multiple airports in the fifty busiest metropolitan regions. In the 37 regions where multiple commercial airports are present, the busiest airport accounts for an average of 77 percent of all metropolitan air passengers. The second-busiest airport accounts for 19 percent of metropolitan regional traffic. In other words, when multiple airports are in operation, the second-busiest airport accounts for, on average, less than one-third of the traffic of the primary airport. Multiple airport systems are generally very lop-sided.

In only four of the fifty busiest regions, New York, Washington D.C., Osaka, and Moscow, does the second airport carry three-fourths as many passengers as the primary airport and in only five additional regions, London, Tokyo, Miami, Shanghai, and the Rhine-Ruhr Valley in Germany, does the proportion of passengers reach half the number of the primary airport. The inclusion of some rather small secondary airports in the dataset may skew results somewhat but excluding the outliers does not change the main findings of the analysis.

The effect of capacity and range on traffic distribution

In most multiple airport regions, the primary airport (measured in terms of passenger numbers) serves the greatest number and range of destinations including most long distance travel while the secondary airport(s) handle regional traffic. In a few cases, however, a secondary airport specializes in long distance and international traffic. That occurs in Tokyo and Osaka where domestically-focused Haneda and Itami, respectively, are the busiest airports. That also occurred in Washington where Dulles was less used than Reagan National for many years. In Orlando a much smaller airport has a disproportionate share of international travel. Thus, the relationship between the number of passengers and an ability to handle long-distance flights is a major differentiating factor in metropolitan airport systems.

The basic bottom line is that regional airport capacity constraints, and especially those at the primary airport, are an important factor affecting the distribution of passengers among airports. Without capacity constraints at the primary airport the distribution of passengers among airports in New York, Washington, and London would certainly be more uneven, as they are in many metropolitan regions. Figure 4 presents a typology of airport types across these dimensions. As is discussed further below, relative distance from established employment and population centers is an additional factor is determining passenger distribution among airports.

Low-cost carriers do not generally separate out

In order to further characterize the nature of regional airport systems, data were used from the U.S. Bureau of Transportation Statistics to examine the characteristics of the users of airports. Therefore this detailed analysis includes only U.S. airports. The total number of passengers at each airport were tracked along with the number using low-cost carriers and the number traveling internationally. The number of destinations and the average distance flown were also measured. Results are presented for major U.S. multi-airport regions.

There are several different types of regional multi-airport systems in the U.S. Nevertheless, each boils down to a primary airport and one or more clearly secondary airports that opportunistically fill market niches. No secondary U.S. airports specialize in long-distance and international travel at present.

With higher costs and capacity constraints at their primary airports, the secondary airports in Chicago, Dallas-Fort Worth, and Houston specialize in serving low-cost carriers.[8] There is, however, no consistent airport division of labor with respect to legacy and low-cost carriers. In some regions, the primary airport serves low-cost carriers – in a few, such as New York, Los Angeles, and Boston, serving the plurality, and sometimes the majority, of regional low-cost carrier passengers. For example, in 2006, both La Guardia and Kennedy handled a much larger number of low-cost carrier passengers than Newark.

In each case where there is a division, however, the low-cost carrier uses the less attractive airport. In the first three regions just cited, shorter runways and on-airport space limitations long ago resulting in the construction of larger airports, more distant from population and business centers. Low-cost carriers, which so far do not offer inter-continental service, eventually took over the former primary airport. In other regions, the airport used by low-cost carriers is less convenient for the higher-income population that flies frequently.[9]

Most of the preceding discussion of multiple airport metropolitan regions concerns the variations on the pattern of serial primary airports discussed in the previous section. In addition, U.S. regions have spread out sufficiently that some airports grow on the basis of serving a subset of the region. Much of the

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[8] The low-cost carriers in the U.S. include AirTran Airways, ExpressJet, Frontier Airlines, JetBlue Airways, Skybus Airlines, Southwest Airlines, Spirit Airlines, Sun Country Airlines, and US Airways.

[9] Recent research suggests that in order to make significant inroads in regional passenger traffic, low-cost carriers may need to locate at the primary airports (Blackstone, Erwin A., Andrew J. Buck, and Simon Hakim, (2006), "Determinants of Airport Choice in a Multi-airport Region," *Atlantic Economic Journal* 34: 313-326).

apparent low-cost carrier/secondary airport division of labor may actually be geographic in origin, which is not the case for Belo Horizonte.

Low-cost carriers have often specialized in serving under-served sub-markets. For example, Islip Airport, in the New York region clearly draws travelers away from the major regional airports which are increasingly difficult to reach for suburban-based passengers. Yet few traveling to New York City from other U.S. regions would consider using this airport. Similarly, residents of the periphery of the Los Angeles region may have been very willing to drive to LAX a few decades ago but now, as traffic congestion mounts and population spreads ever further, outlying markets for multiple airports have evolved. The secondary airports incorporated into the primary metropolitan region, such as John Wayne Airport which is 65 kilometers southeast of LAX, are not necessarily dominated by low-cost carriers.

In only a few cases, do the multiple airports in a region appear to have a relationship in which each builds on a specific strength and none is under-utilized. New York's major airports and those in the Washington D.C. may be in this category. In both cases, a smaller airport close in to the center city specializes in shorter flights with frequent service. It should be noted, however, that such relationships evolve slowly over time. As noted above, Newark was for decades, under-utilized. The same held for Washington Dulles in northern Virginia, 35 miles from Washington D.C., which, like AITN, was considered an expensive "white elephant" for decades. London, Paris, Tokyo, and Osaka are also regions where multiple airports now co-exist. Although not treated in this analysis, Hamilton and Ft. Worth Alliance airports both specialize in servicing integrated air cargo handlers in the Toronto and Dallas-Fort Worth regions, respectively. As in the evolution of viable secondary airports elsewhere, metropolitan region airport capacity constraints are again the critical factor in the emergence of efficient divisions of labor among multiple metropolitan airports.

Factors favoring the concentration of traffic in a single metropolitan airport

The previous two sections of this study have documented the historical reasons and benefits for the emergence of multiple airport regions and outlined the types of airport regions that develop. Let us now turn our attention to the financial and operational reasons favoring a single metropolitan airport.

Managing capacity and capital investment

As noted above, managing capital investment is a central management problem for airports. Costs are minimized when expensive capital investments – runways, terminals, and ground access systems – are employed at or near capacity with little peaking of passenger flows. Savings can be passed on to users or back to the government.

Even with only a single regional airport, capacity planning is fraught with risks. The extremely large initial investments in runways, terminals and ground access infrastructure needs to be repaid over long periods of time. Accurate projections of long-term demand are therefore needed in order to make informed investment decisions and, because those investments are often repaid by landing fees, gate leases, terminal rentals, and passenger service charges, accurate projections are critical to pricing decisions.

Experience with past passenger and cargo demand forecasts suggests that forecast accuracy is relatively low. For example, when Denver was planning its new airport in the mid-1980s, the Federal Aviation Administration predicted that the airport would serve 56 million passengers by 1995. Several professional projections were even more optimistic. The actual number of passengers in 1995 was 31 million, less than Denver Stapleton's mid-1980s peak of 34.7 million. The new airport did not exceed Stapleton's peak passenger numbers until 1997. As of 2006, the airport had not yet reached the 56 million that was expected by 1995.[10] Figure 5 shows the trajectory of passengers in Denver's airport from 1981 to 2006. The new, much enlarged airport opened in 1993 at which point, as I noted previously, Denver's original major commercial airport, Stapleton International, closed.

Operational factors leading to concentration

Analysis of passenger traffic suggests that the multiple commercial airports sometimes found in metropolitan regions are arranged in a preference order queue. In most regions, there is a strong preference for the use of one airport over the other(s). Passengers, airlines, and, although not discussed here, shippers often share the same airport preference. Fare, frequency of service, range of destinations, and, not at all least, ground access time influence passenger preferences.[11] Passengers attempt to maximize their travel utility. Minimizing total expected travel time, that is, maximizing air schedule frequency and flexibility while minimizing ground access time, are important factors for all travelers and appear to be even more salient for frequent fliers.

As discussed above, when capacity exceeds demand in multi-airport metropolitan regions, airlines and passengers almost always concentrates in one airport over the others. In order to understand the preference of passengers and airlines for one airport over another, a simplified model of regional airport

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[10] Similar high projections were initially made for AITN.

[11] Air service frequency and ground access time have been found to be the most consistent factors in airport choice (Hess, Stephane and John W. Polak, (2006), "Exploring the Potential for Cross-Nesting Structures in Airport-Choice Analysis: A Case-Study of the Greater London Area," *Transportation Research: Part E: Logistics and Transportation Review* 42: 63-81). Fares, although potentially a critical choice factor, are endogenously set and appear not to vary sufficiently among metropolitan airports to be salient. Fares within airports – and indeed within individual airplanes – may have a higher variability higher than among airports.

activity is shown in Figure 6. Airport activity is a function of two feedback loops: one positive and the other negative.

There are several reasons for the concentration of traffic in one airport. Airline competition accounts for some of the concentration. Airlines, similar to Hotelling's beach vendors, tend to move towards each other in an attempt to win as many passengers as possible.[12] This "head-to-head" strategy leads airlines to frequently choose to operate in the same airports as their immediate competitors, though there are exceptions.

The "returns to frequency" are another reason for the concentration of passenger traffic in one airport. We trace the positive loop in Figure 6. As suggested above, passengers value the frequency of service which affords scheduling flexibility. Therefore, the airline (or airport) which offers more frequent service than its competitors often gains a disproportionate share of the passengers. One consequence is higher load factors for aircraft and therefore higher profits. Figure 7 schematically illustrates the relationship between airline service frequency and market share that has been found by several researchers.[13] Past a point, small improvements in service result in large market share gains.

Service frequency is often tied to airline hubbing decisions.[14] Many of the airports discussed in this report serve as airline transfer hubs.[15] The volume of transfer passengers is tied to the number of origin and destination passengers, however. The two types of passengers cross-subsidize each other, more easily

[12] Hotelling (Hotelling, Harold, (1929), "Stability in Competition," *The Economic Journal* 39: 41-57) used snack vendors on a beach as a metaphor for duopoly competition. His model, validated by scores of empirical studies, predicts that competitors will attempt to match each others offerings and price.

[13] After de Neufville and Odoni (2003).

[14] Hubbing is a core airline competitive strategy that decreases costs but would likely be followed even if it did not (Oum, Tae Hoon, Anming Zhang, and Yimin Zhang, (1995), "Airline network rivalry," *Canadian Journal of Economics* 28: 836-857).

[15] The location of airline hubs appears to be dominated by the size of the local market (Huston, John H. and Richard V. Butler, (1991), "The location of airline hubs," *Atlantic Economic Journal* 57: 975-981). The minimization of aggregate distance traveled must play a role but does spear to have a decisive impact within some national contexts.

raising demand above threshold levels allowing more destinations to be served and more frequent service, further winning both local and transfer market share.[16] Moreover, each additional route increases the value of the existing routes because routes feed transfer passengers into each of the others. At many busy hub airports, a majority of the passengers are merely changing planes.

Figure 8 graphs the number of transfer passengers against the number of origin-destination passengers for major U.S. airports in 2002. Selected busy airports are labeled. Several airports process more transfer passengers than origin and destination passengers. These points appear above the line of magenta squares. Atlanta is the largest metropolitan region to be served by a single airport. Its airport stands out as attracting the highest ratio of transfer passengers – who essentially subsidize the air travel of the origin and destination passengers and help create the extensive air service connectivity that helps the Atlanta region prosper.

The positive feedbacks will continue until markets are saturated at the feasible airfares or, as illustrated in the figure, until congestion costs begin to erode the positive economic externalities of additional routes. Comparatively few airports are operating at or near maximum capacity but busy hub airports sometimes are characterized by a significant amount of congestion. Queuing time for take-off and landing, the extra fuel used, and the extra wages have an impact on airline costs. Moreover, the implied welfare loss to passengers can be substantial and they may begin to avoid congested airports when possible. Gate availability can also be a constraint leading to higher costs. At some airports, congestion pricing can be imposed but, even if not, higher airport operating expenses will be reflected in airport charges.

[16] Wei and Hansen (Wei, Wenbin and Mark Hansen, (2006), "An aggregate demand model for air passenger traffic in hub-and-spoke network," *Transportation Research Part A* 40: 841-851) provide a recent model with empirical validation.

Operational advantages and passenger preference

Passenger preferences for frequency of service, range of destinations, and ground access ease could conceivably "aggregate up" differently in different regions depending upon the mix of travel destinations and the relative location and characteristics of the multiple airports. Unless technical considerations, such as runway length (to handle wide-body jets), runway number (to handle the volume of traffic), or, less frequently, terminal capacity (to process passengers and cargo), interfere, the older airport, which is generally closer to established population and employment centers, tends to be the most favored option, even if its facilities are dated. Relative ground accessibility appears to be the decisive factor in intra-regional airport choice, regardless of airport quality or safety.

Consistent with the model outlined in Figure 6, Reagan National was the primary Washington airport for many years because ground access to downtown and the suburbs was significantly more convenient than for Dulles and because much of the Washington D.C. air traffic was to regional destinations anyway. As population and employment diffused outward from Washington D.C. far into Northern Virginia, Dulles became a more viable air service center for regional origin and destination traffic. United Airlines consequently decided to build upon the growing critical mass and locate a hub at Dulles. Combining the growing origin-destination traffic with transfer passengers allowed the airline to achieve economies of scale to serve a growing number of routes. The growth of international traffic in the U.S. further allowed for the dispersion of inter-continental routes away from the traditional major gateway airports (e.g., JFK) also adding to Dulles' attraction. Similarly, as Silicon Valley mushroomed in population and jobs, San Jose Airport (over 65 kilometers south of San Francisco) expanded into a major airport and eventually became an American Airlines hub.

A combination of excessive distance from population and employment and the failure of international traffic to increase as projected contributed to Montreal Mirabel's failure in Montreal. A similar fate has affected São Paulo's Viracopos/Campinas International Airport which was initially replaced by São Paulo/Guarulhos Airport in 1985 and reopened in the 1990s primarily as a cargo airport. The modest increase in distance from Paris and large increase in inter-continental flights eventually contributed to the success of Charles de Gaulle airport with respect to Orly. The airport was then able to increasingly offer transfer service within Europe. Such factors have not been as strong in Milan and Malpensa appears to be suffering as a consequence.[17]

Ground access convenience and the distribution of traffic among destination markets tend to favor the original airport – and are behind the sometimes considerable political pressure to keep older airports open. Even in cases where there may be sufficient traffic to support two airports, passenger preferences will result in the more favored airport "creaming" the most desirable traffic leading to vastly different airport traffic, as happened with Pampulha "creaming" AITN's traffic in the period between 1984 and 2004.

Political regulation of passenger preference

Even when flights to some destinations are not restricted by runway length, politically-imposed restrictions can apply. Planning bodies sometimes attempt to even out traffic by restricting traffic at the favored airport. International flights are limited at Tokyo's Haneda, Osaka's Itami, and Seoul's

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[17] Airports, if sufficiently busy, can, under certain conditions, attract employment, providing an added boost to airport use. As noted in the text, distance from established employment and population centers is a key factor. Regional employment growth is the other. Airports often need to wait, perhaps indefinitely, for metropolitan areas to expand before significant development occurs. Otherwise, commuting costs would outweigh the benefits of airport access. In the absence of significant regional growth, the need for new offices, warehouses, and other facilities is minimal.

Gimpo airports. Without those restrictions, almost all domestic traffic would concentrate at those airports leaving the respective newer airports with so little traffic that their costs would become prohibitive. Under these conditions, Narita, Kansai International, and Incheon need disproportionately high landing fees to cover costs. Kansai is one of the most costly airports in the world.

Washington's Reagan National, Dallas' Love Field, and New York's La Guardia each have had restrictions imposed on the distance of flights in an effort to shift traffic to other airports in their respective metropolitan regions. For years, airlines at Reagan National Airport circumvented the distance restrictions by scheduling intermediate stops or convenient transfers. In the case of Charles de Gaulle airport, the French government ordered Air France, the national carrier, to shift to the new airport at a reportedly tremendous cost to the airline and the French government which owned the airline. The French government also invested heavily in regional rail (RER) and high-speed long-distance (TGV) train service in an effort to make the airport more attractive to passengers and airlines. In some cases, the preference for the older airport is transitional but after more than 25 years, Montreal's modern Mirabel airport failed to attract appreciable traffic and was mothballed.

In addition to the pure transport issues discussed above, evidence from U.S. and global contexts suggests that the opportunities for airport terminal retail and airport area development are severely limited by splitting air traffic. Such splits obstruct meeting the thresholds needed in order for particular goods and services to be offered, even though the total market demand is equivalent. Terminal retail beyond food and beverage and news items is dependent upon certain passenger thresholds. Likewise, airport area hotels, convention centers, logistics facilities, and office development are also limited by dividing metropolitan region air passengers among multiple airports hindering broader economic development objectives.

The consequences of multiple metropolitan airports

The co-existence of multiple airports within a region has consequences for airlines, airport operators, travelers – and, as just noted, for businesses and economic development. These issues are addressed below noting first possible benefits, then likely costs

The unfulfilled promise of competition

Commercial airports are sometimes categorized as quasi-natural monopolies. With only a single airport in a region, airports often have considerable pricing power that they can use to their advantage. The available evidence suggests that many have done so. Airports in large metropolitan regions have been the most profitable segment of the air transportation value chain. While many airlines have faced financial ruin, airports, despite being sometimes inefficiently run, have been attractive targets for investment funds and privatization.

Competing airports have the potential to diminish the pricing power of a monopoly, possibly improving air service and lowering costs for passenger and cargo shippers. Competition among regional airports may boost efficiency. Airlines should likewise benefit from the competition through lower prices and improved airport services.

In point of fact, however, experience with multiple airports within metropolitan regions suggests that the potential benefits are not often realized and that overall costs increase and service actually deteriorates. Heathrow is a case in point. Despite its multiple regional competitors, this airport has been characterized by complaints about high costs, poor service and under-investment in airport improvements, not by ever-increasing efficiency. The competitive and operational factors leading service to concentrate in a single airport, outlined in the previous section, often generates greater network and development benefits that override cost savings due to competition.

The financial consequences of multiple commercial airports

As a consequence of the lop-sided distribution of passenger traffic among multiple commercial airports within most metropolitan regions, newer, less conveniently-located airports are often pejoratively termed "white elephants" – facilities that are often architectural showcases, but of little use and great expense. Newark Airport, for example, essentially boarded up a terminal that found no users beginning in the 1970s. The same occurred at Stansted in the 1980s when its capacity of 10-15 million passengers per year was less than half used. Dulles Airport, as noted, was under-utilized until the mid-1990s. Kuala Lumpur International Airport, a magnificent facility, is just now achieving the traffic needed to justify its original cost. Despite a huge capital investment, Zhuhai International Airport, near Hong Kong in China's Pearl River Delta, stays essentially empty despite the considerable regional growth in the number of air passengers. Table 6 above indicates a number of airports that have been labeled "white elephants" at some point in their history, some of which are now highly successful.

Figure 9 schematically illustrates the relationship between air passenger demand and regional airport capacity under two scenarios when an older airport is no longer adequate. In the first, as the older airport reaches maximum capacity and space constraints preclude further expansion, a new airport, built to respond to present and anticipated future demand is commissioned. The older airport is closed. Strategic planning is in place to trigger the construction of additional capacity on increments of 10 million passengers per annum as existing capacity is reached. The added capacity is in the form of an additional runway, terminals, or concourses.

In the second scenario, the new airport is commissioned and the older airport continues to remain in service. In this second scenario, instead of having twice the needed capacity in place when the new airport opens, the region has the burden of supporting three times the needed capacity. Moreover, under the condition that passengers and airlines have – for whatever reason – a strong preference for the older airport, the number of years until the new airport reaches its first expansion trigger increases by 50 percent.

When the older airport remains open, the new airport must operate under unfavorable load levels for a longer period of time and the region as a whole needs to support additional unused capacity at lower levels of efficiency (the case of AITN). As noted previously, it is difficult to state in generalizable terms the degree of preference for the older airport, but distance from the city center of the newer airport has often been a good indicator.

These scenarios are certainly over-simplifications but they illustrate a central financial consequence of multiple metropolitan airports. The amount of unused airport capacity is substantially higher when plans are made based on one scenario (a single regional commercial airport) but another (multiple regional commercial airports) materializes. The amount of regional capacity is critical because effective airport operation for regional development depends upon the effective management of capacity and distribution of passengers between and among multiple airports, with splitting having overriding negative consequences for air network density and airport-driven commercial development.

The stylized cases of airport finance presented in Table 8 illustrate the potential impact of the two scenarios just discussed on operator net annual revenues. The illustrative cases included in the table are simplified simulations made to show certain points, not summaries of any particular airport's situation. The basic parameters of each of the cases are, however, based on an analysis of a sample of major airports in large U.S. metropolitan regions.

The "Base Case" is an airport handling five million passengers per year operating at full capacity. The analysis has been simplified by assuming that debt repayments are equal to the amortized cost of capital investments. The grants and the passenger charges that fund them have been omitted. These can be important to the finances of individual airports. The average amortized fixed cost per work load unit (WLU) is shown as a point of reference. These costs are driven by overall capacity whether or not the capacity is fully used. In the illustrative cases, the WLU's are all passengers. Cargo in not considered but including cargo would not change the basic points discussed below.

Operating costs, aeronautical revenue, and non-aeronautical revenue each vary in different ways according to the level of traffic. There are economies of scale in operating costs. This analysis uses a simplified production function. As is found in U.S. data, though not always the case internationally, aeronautical revenues per WLU increase with size while non-aeronautical revenues per WLU decrease with traffic.

"New Airport Case #1" shows the net result of a new airport, operating at full capacity using average productivity and revenue parameters. The cost of the fixed investment per WLU capacity is 60 percent higher than average because the investment is new and has not yet been paid down at all and because current prices have been paid. That cost is well within the range of U.S. variation.

Even at full capacity, the new airport is not financially viable unless, as in "New Airport Case #2," it enjoys an operational efficiency advantage. In the illustrative case, the advantage is a ten percent cost advantage per WLU over average. As in all the scenarios, the cost per WLU decreases with scale. It is likely that a new airport would be more efficient at generating non-aeronautical revenue than average but that possibility has not been considered here. In "New airport Case #2," the airport generates a modest surplus.

"New Airport Case #3" presents a more realistic scenario of a recently opened new airport that has been constructed to absorb anticipated demand. In this scenario, the airport operator must still meet the large fixed costs of a large airport but without the capacity being fully utilized. The airport operator must therefore absorb a loss for sometimes many years in anticipation of future rewards. As suggested above, the investment payback period can be substantial.

In contrast to new airports, established airports can be quite profitable. "Old Airport Case # 1" presents the revenue and cost situation of an older airport operating at average revenue and productivity parameters. The costs of fixed investment are only one quarter of the average. Again, this cost level is not meant to represent any particular airport but it is well within the variability found among major U.S. airports. Among older airports, land acquisition costs have often long been paid off. The useful life of major investments in runways partially exceeds amortization periods. Moreover, much of the capital investment is in lower prices that existed decades ago. In this hypothetical case, the airport earns a sizeable surplus.

Should a new airport be constructed and the older airport remained open, the older airport can be adversely affected. "Old Airport Case # 2" shows what would happen to the older airport if traffic was evenly split between old and new airports. This is a somewhat arbitrary division and, as discussed above, even splits are rare in the absence of severe regional capacity constraints. Even with a fifty percent decline in traffic, the older airport remains viable.

It may be more realistic, however, for an older airport to be less efficient. "Old Airport Case # 3" illustrates that situation. The airport is assumed to operate at a ten percent operating cost disadvantage due to outmoded and constrained facilities and infrastructure. It is also assumed to suffer from a 20 percent disadvantage in generating non-aeronautical revenue given facility and land constraints. The airport, in order to attract airlines, also offers a ten percent discount on aeronautical fees stemming from reduced gate leases and lowered landing charges. These adjustments are likewise arbitrary but they fall within the bounds of U.S. observations. Despite the operating disadvantages, the lower (sunk) fixed costs actually allow the older airport to be financially viable.

The financial situation is different for the newly constructed airport, however. "New Airport Case #4" presents the impact of an older airport remaining open when all planning and construction proceeded on the basis of particular capacity needs. The large fixed costs of new airports mean that the airport operator cannot adjust easily to reduced traffic. The financial effect is substantial and, as suggested above, can be long-term.

Risk has been eliminated from all of the scenarios described. As seen above in Figure 5 and the accompanying discussion, short and long-term traffic uncertainties can be substantial. The effect of increased excess capacity and the finance disadvantage would be magnified once traffic uncertainty was taken into account because newer airports tend to be less conveniently located and therefore face a disadvantage in attracting passengers.

Another key outcome of a preference for one airport over another is that the favored airport's traffic and financial returns are stabilized while the other airport absorbs a disproportionate share of traffic and revenue fluctuations. When a new airport is added to an uncertain demand environment, the fluctuations are concentrated there. In times of high demand, some passengers shift their travel to the newer airport. In times of low demand, those travelers may shift back to the older airport, decreasing revenues at the newer airport and increasing the likelihood that a certain amount of air service at the newer airport will be curtailed.

Implications for AITN and Belo Horizonte

This cross-national study of multiple airport metropolitan regions has direct implications for:

1. the need for two commercial airports in the Belo Horizonte region,
2. the effect of splitting passenger traffic between Pampulha Airport and AITN on Belo Horizonte's chances of expanding domestic and international air service and
3. the impact of operating two commercial airports on
    a. the financial prospects of each airport,
    b. the prospects of Belo Horizontes becoming a future airline transfer hub and
    c. the overall economic impact of the airport on the economies of Belo Horizonte and Minas Gerais.

The information available cross-nationally strongly indicates that Belo Horizonte does not need two commercial airports now and will not for at least the next two decades. Given its modern infrastructure and facilities and substantial capacity for expansion, AITN will be able to handle all passenger and cargo traffic growth forecasted for the region. Evidence presented from the U.S. implies, as well, that AITN can serve Belo Horizonte's air transportation needs more efficiently from a financial standpoint operating as the sole commercial airport in the region. This is because scale effects improve and per unit operating costs decline with airport size. In the longer-term, this implies lower costs and higher benefits for the region.

The study likewise implies that a single commercial airport maximizes Belo Horizonte's position in domestic and global aviation networks because it allows for the advantage of bundling traffic flows. This supports greater and more frequent air service including international direct routes as evidenced by

AITN's new non-stop flights to Lisbon and Miami. Unified metropolitan airport markets are also more attractive to transfer passengers from other parts of Minas Gerais. Even a moderate level of transfer passengers (say 20 percent), means that local demand only needs to be 80 percent of what otherwise would be needed to meet an airline route load thresholds for service. Few additional passengers at AITN are likely to result via transfers from commercial flights to Pampulha Airport.

Splitting the commercial air service market between Pampulha Airport and AITN would thus negatively impact both origin and destination traffic at AITN and passenger transfers, reducing overall air service for Belo Horizonte. With a 50-50 passenger split, for instance, between the two airports, twice as many local passengers would be needed to achieve airline load thresholds for specific flights.

And the situation could get worse for AITN. A new Brazil low cost airline (Azul) has requested that Pampulha Airport be its airport of choice. As happened when Southwest Airlines started interstate service (which was previously restricted) from older, closer to downtown Dallas Love Field, American Airlines shifted some of its DFW flights to Love Field to compete. It is not unreasonable to think that Gol, TAM and possibly other Brazil airlines critical to AITN's more recent success would do the same, undermining progress at AITN. This would seriously reduce AITN's passenger and cargo volumes and ultimately Belo Horizonte's centrality in domestic and international aviation networks by reducing the number of destinations that could be served and by reducing the frequency of service to the destinations. Such overall reduction of network service resulting from splitting traffic would, as noted, be a welfare loss for transfer passengers as well as those residing in the Belo Horizonte metropolitan region.

The operation of two airports would not result in any significant increase in demand from the local market. In fact, for reasons enumerated above, total air routes and traffic would likely decrease in Belo Horizonte as a result of reopening Pampulha Airport to commercial jet service. AITN would continue to be overbuilt and it would not achieve its long-sought economic development benefits.

Apropos the latter, in 2004, the Ministry of Finance and Infraero selected AITN as the first among four designated commercial airports in Brazil to become an industrial airport. Key to the success of AITN as an industrial airport is the flight density, including international non-stop service, to efficiently carry air cargo into and out of AITN. Without growing flight networks, centered at AITN, this policy will fail.

The State has invested heavily in improving highway accessibility to AITN both through major upgrades of the MG-10 expressway between Belo Horizonte City and the airport and the new northern ring expressway which, when completed, will provide excellent AITN access to major metropolitan commercial clusters more distant from the airports.

The State is also pursuing Airport City and Aerotropolis concepts with AITN serving as their multimodal functional core. During the past five years, many electronics firms have located in the AITN area to capitalize on its growing air cargo and air passenger service. New hotels, retail, and other private-sector investments are also in the planning or development stage near the airport. The future success of these investments rests, in large part, with a growing AITN aviation network.

As a specialist in airports and airport-driven development who has had experience with both Pampulha Airport and AITN in recent years, allow me to add a further important implication based on these experiences and local observations.

A region's airport is really the calling card and handshake of a metropolitan area. It is what visitors and business people arriving by air see first and last and thus sets the impression and image they have of the area. It is therefore very important that the airport make a positive impression. Pampulha Airport, despite its convenience to downtown Belo Horizonte, does not give a positive first and last impression to non-local air travelers. It is shabby in appearance, outdated in facilities, and congested. When I was there four years ago, it was congested and chaotic. I also understand its nearby streets and sidewalks sometimes flood.

Image is secondary, though, to the safety issues. With its short-runway, limited safety overruns, and built-up areas around it, Pampulha is in a similar situation to Congonhas and Chicago Midway where both experienced aviation disasters due to such problems.

I understand that nearby residents had constantly complained about large aircraft noise and the local community association is strongly opposed to reopening the Pampulha Airport for commercial jet service. ANAC has stated a view that only operational restrictions should play a role in Pampulha's reopening to commercial jet service and the market should be the ultimate determinant of this possible outcome. Such a limited view overlooks key factors noted in this report and the implications drawn for AITN and Belo Horizonte. That is, Pampulha's renewed commercial operation would not only affect safety, metropolitan image, and quality of life of nearby residents, it would undermine efficient air service at AITN and any chance for Belo Horizonte becoming a significant hub in the domestic and international aviation network.

It is therefore recommended that Pampulha remain closed to commercial jet service and that all energy and efforts be directed to building more extensive passenger and cargo service at AITN. To do otherwise will shortchange the region in the longer-term.

Pampulha could play a potentially valuable future role in Belo Horizonte's aviation arena. With the projected future growth in general aviation, very light jets (VLJs) and air taxi service, the downtown Belo Horizonte business community could be uniquely served by Pampulha Airport specializing in these smaller, lighter aircraft services. VLJs, whether they be private corporate jets or broader-air taxi passenger service, could quickly and more quietly connect those located near the downtown with distant destinations.

The expected growth in VLJs and general aviation can be safely and efficiently met by an airport of Pampulha's size while not having these small aircraft interfere with expected future expanding commercial jet capacity needs at AITN. Whereas serious capacity constraints are probably decades away for both general and commercial aviation in the Belo Horizonte metropolitan region, this division of labor between the two airports would likely have optimum long-run benefits for Belo Horizonte's air service, business competitiveness, and greater regional economic development. Duplication of commercial air service at AITN and Pampulha likely would have opposite effects.

Figure 1. Ground Origins of a Sample of San Francisco International Air Passengers

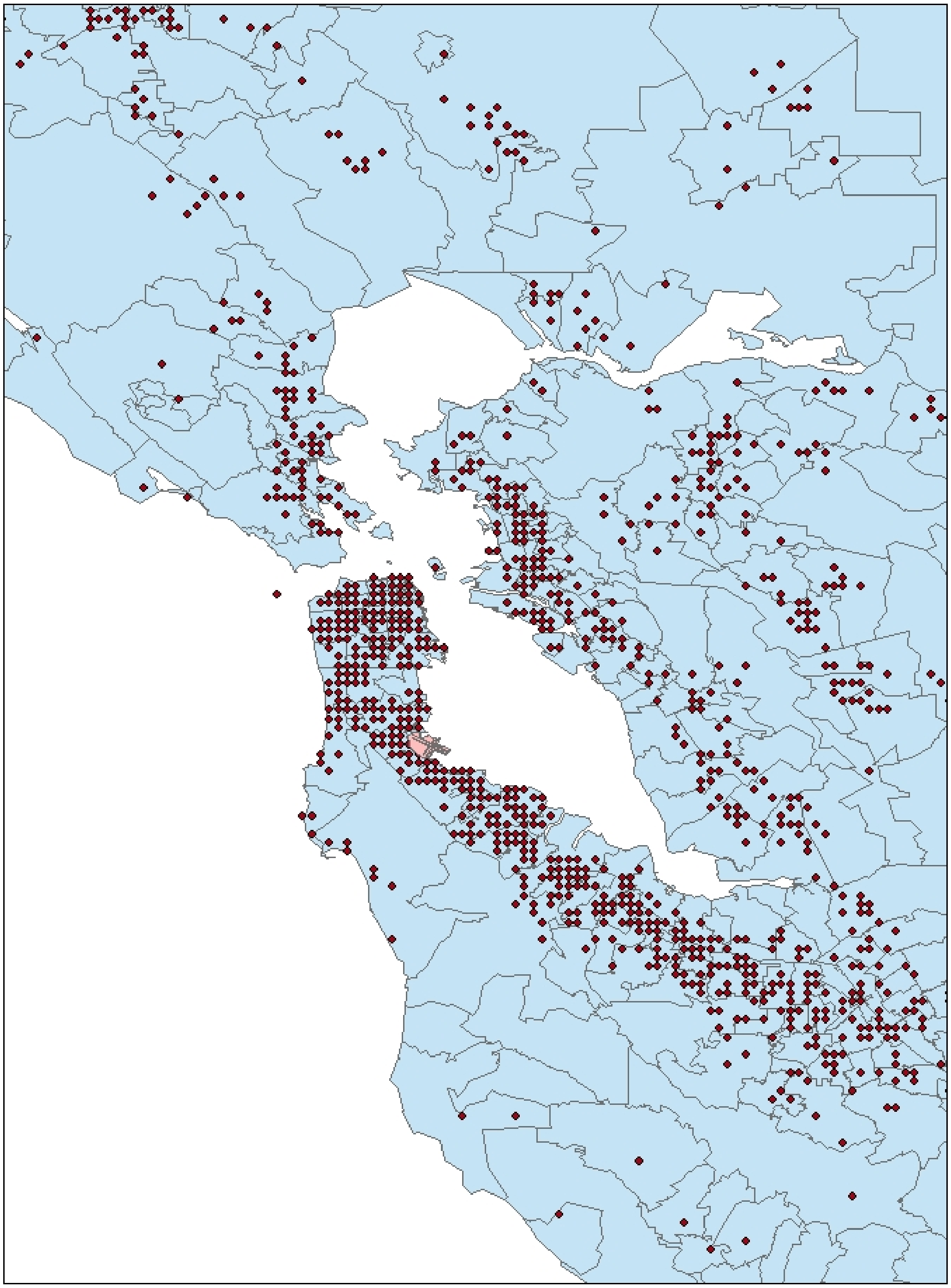


Figure 2. Rank of Metropolitan Region and Number of Airports, 2006

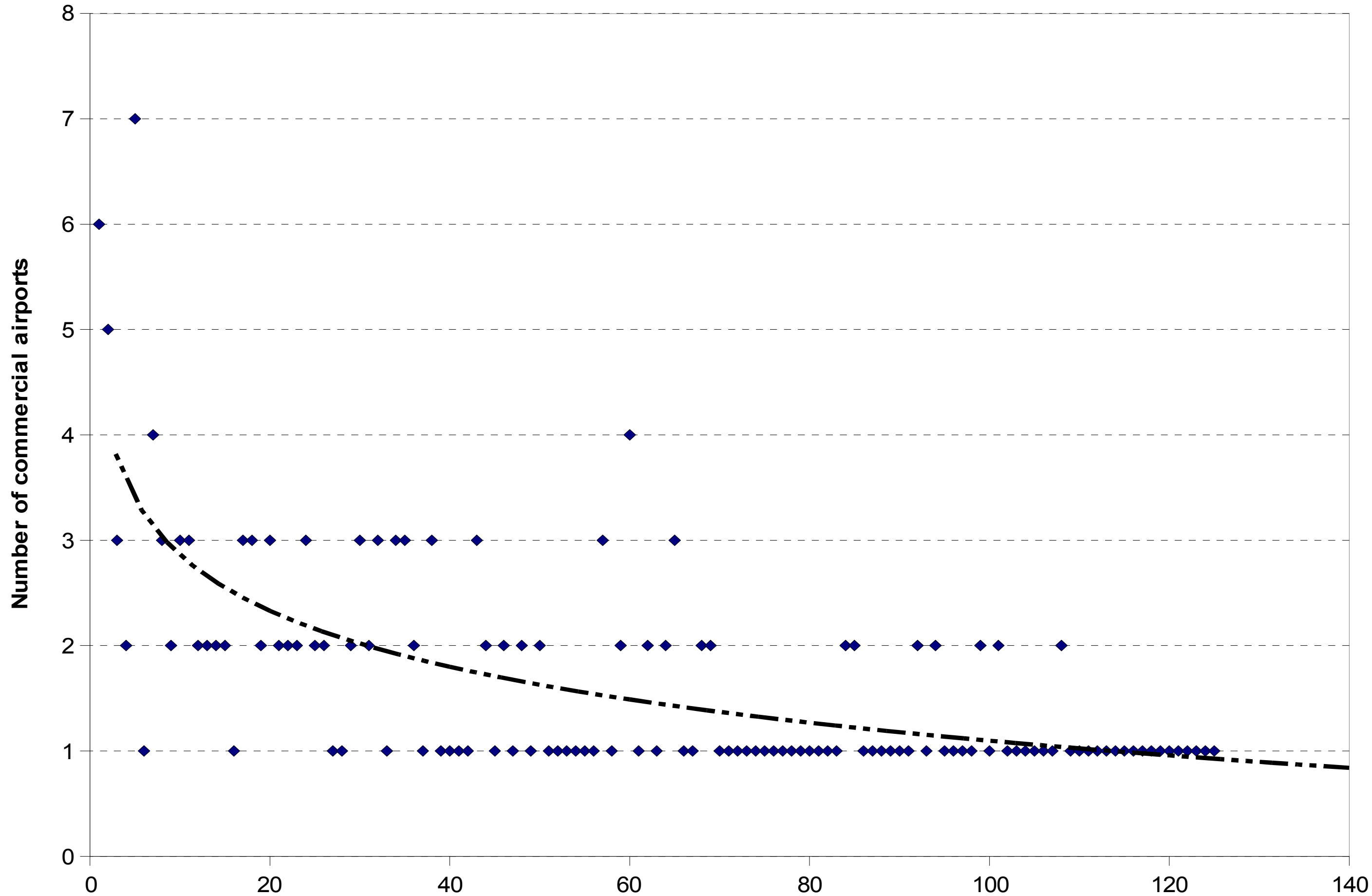


Figure 3. Decision Tree Pathway to Multiple Airports

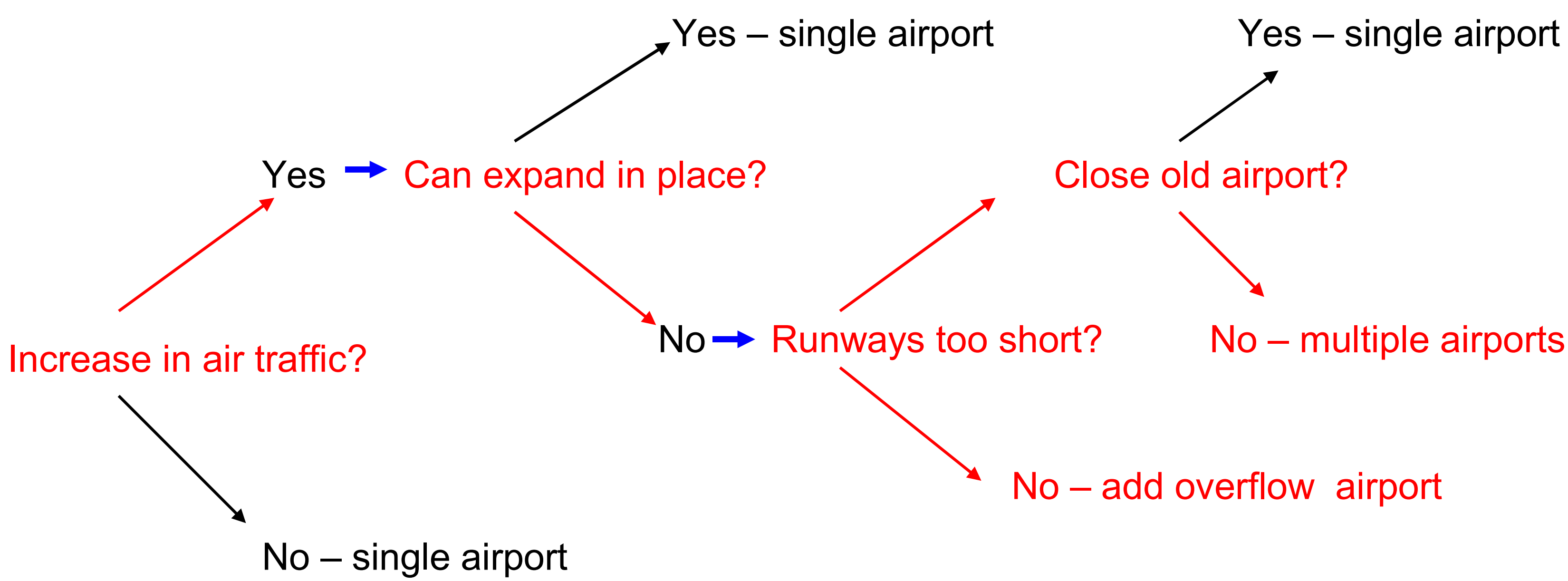


Figure 4. Typology of Multiple Airport Metropolitan Regions

<table>
<tr><td colspan="2" rowspan="2"></td><td colspan="2">Primary airport offers long-distance service?</td></tr>
<tr><td>Yes</td><td>No</td></tr>
<tr><td rowspan="2">Region is capacity-constrained?</td><td>Yes</td><td>London</td><td>Tokyo</td></tr>
<tr><td>No</td><td>Dallas-Fort Worth</td><td>Rhine-Ruhr?</td></tr>
</table>

Figure 5. Denver Passenger Traffic, 1981-2006

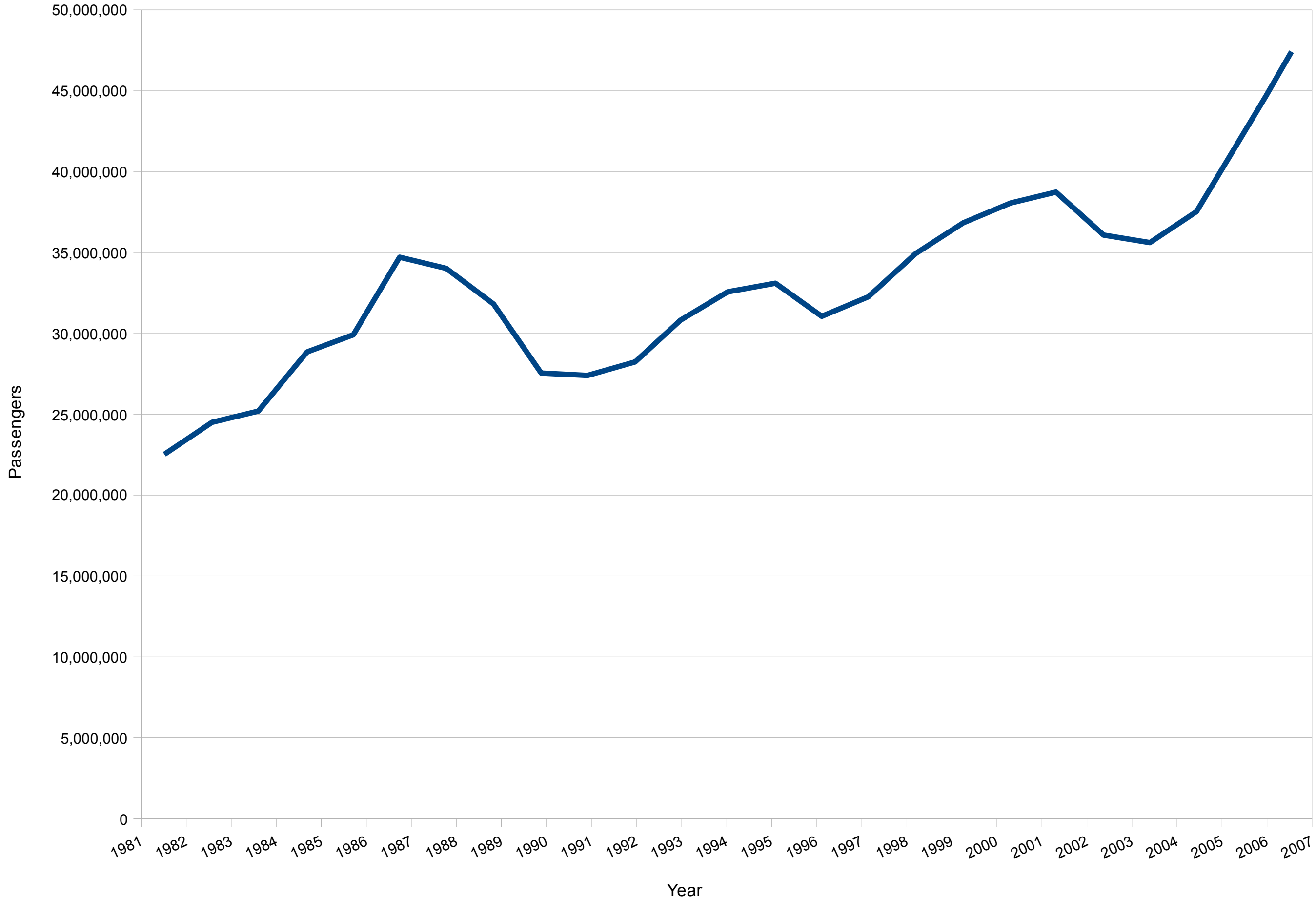
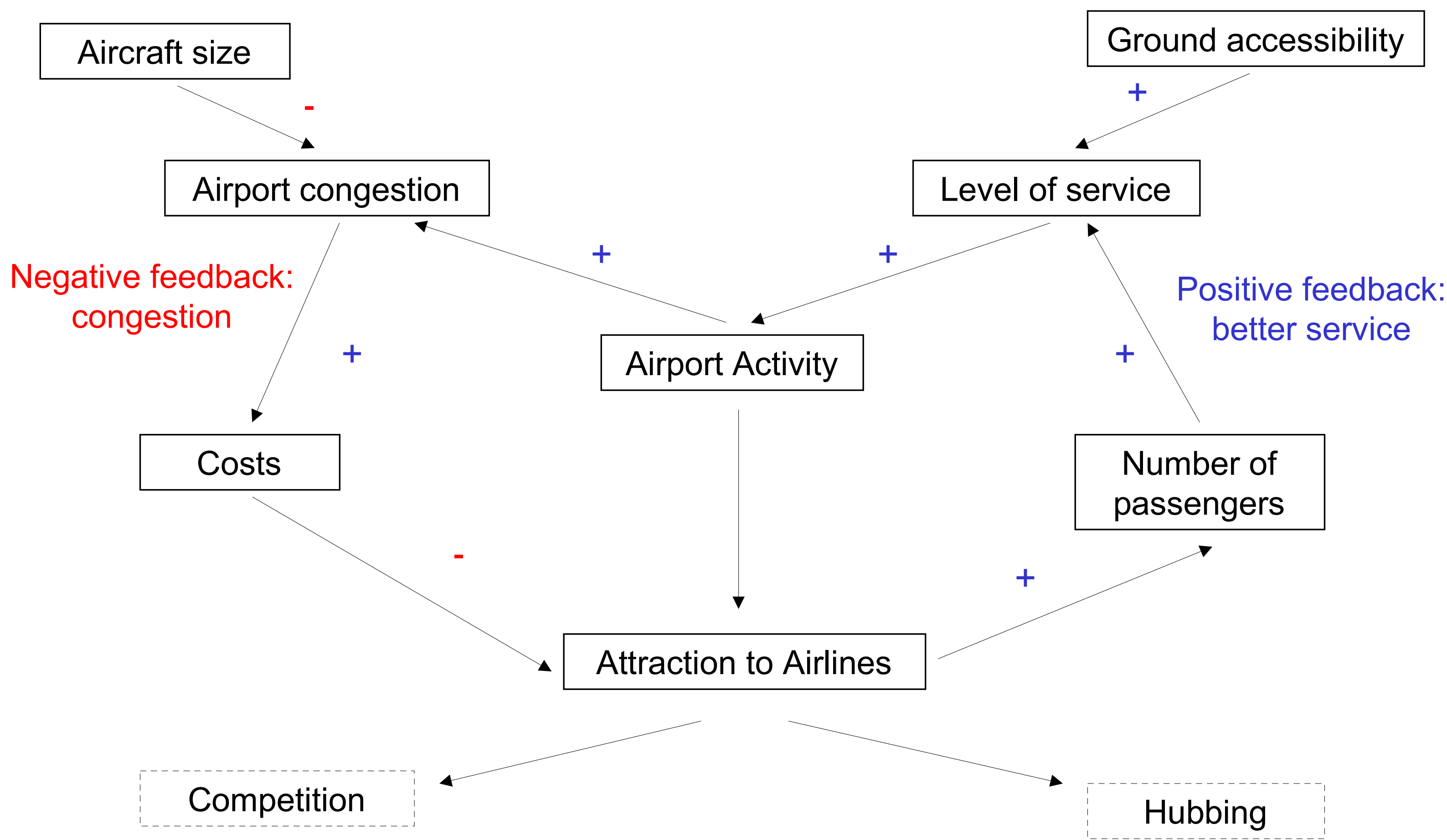


Figure 6. Model of Regional Airport Activity



Adapted from de Neufville (2000)

Figure 7. Schematic of Relationship between Service Frequency and Market Share

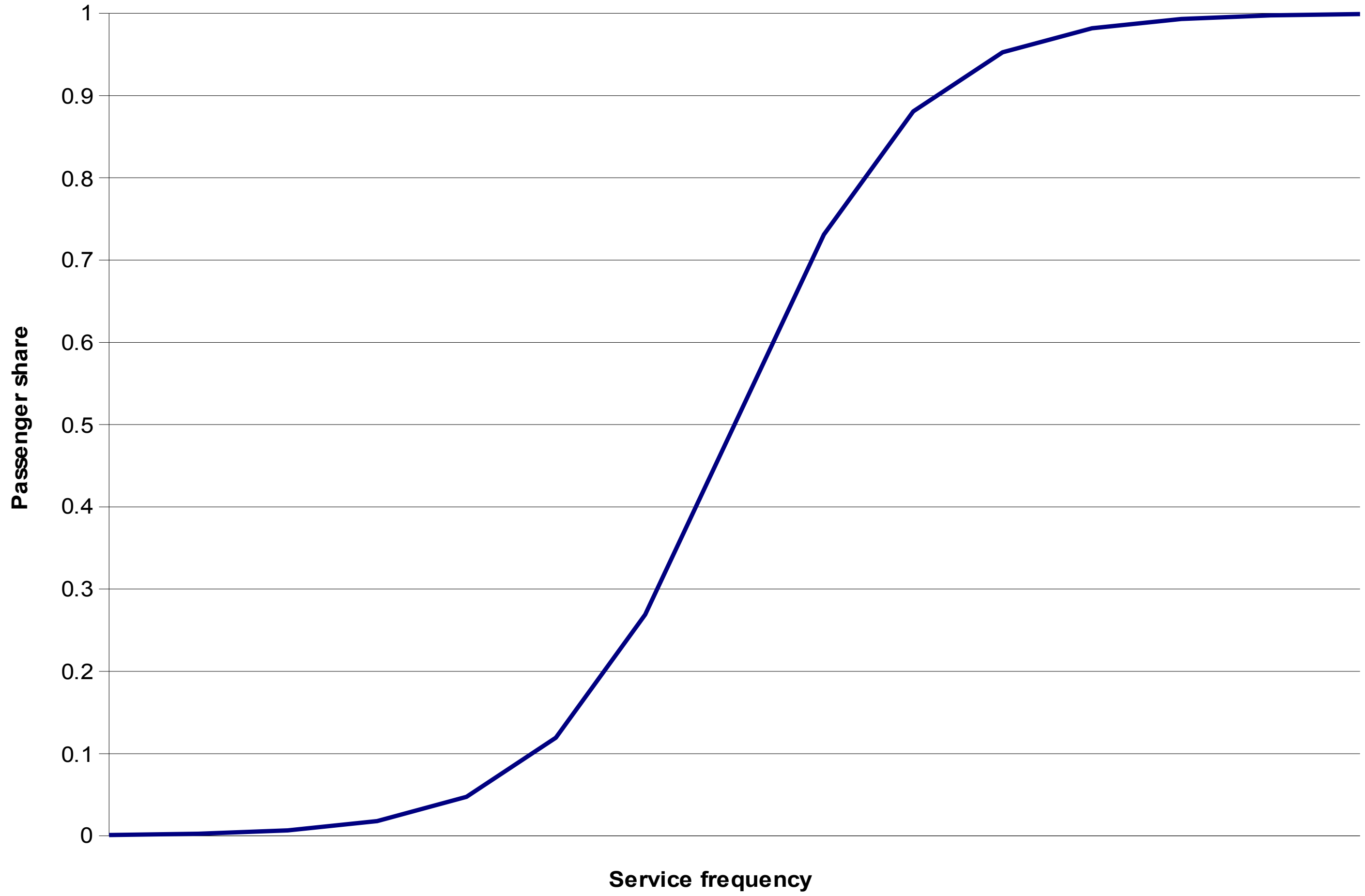


Figure 8. The Relationship between O&D and Transfer Passengers in 40 Large U.S. Airports, 2002

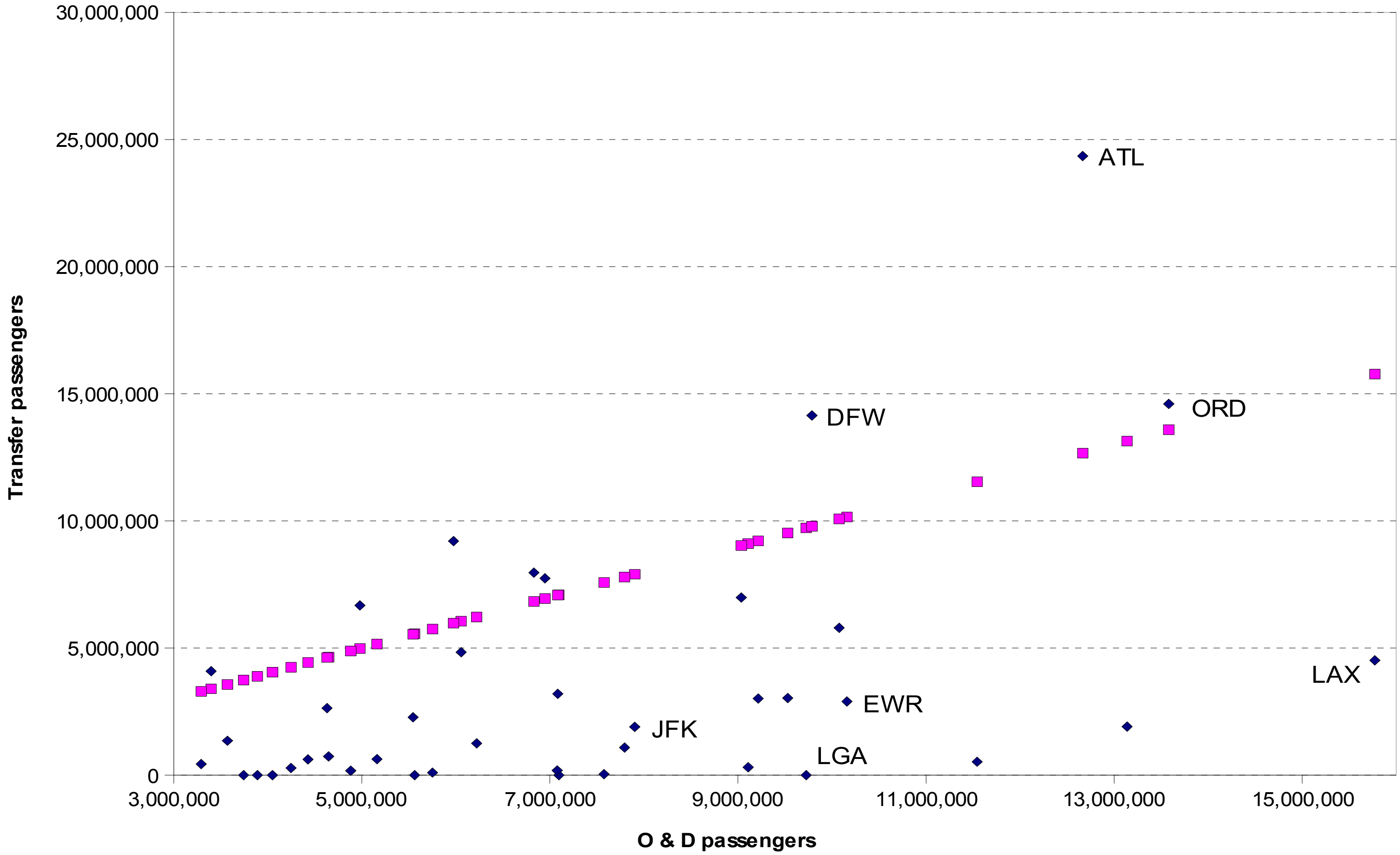


Figure 9. Schematic Relationship between Air Passenger Demand and Airport Capacity

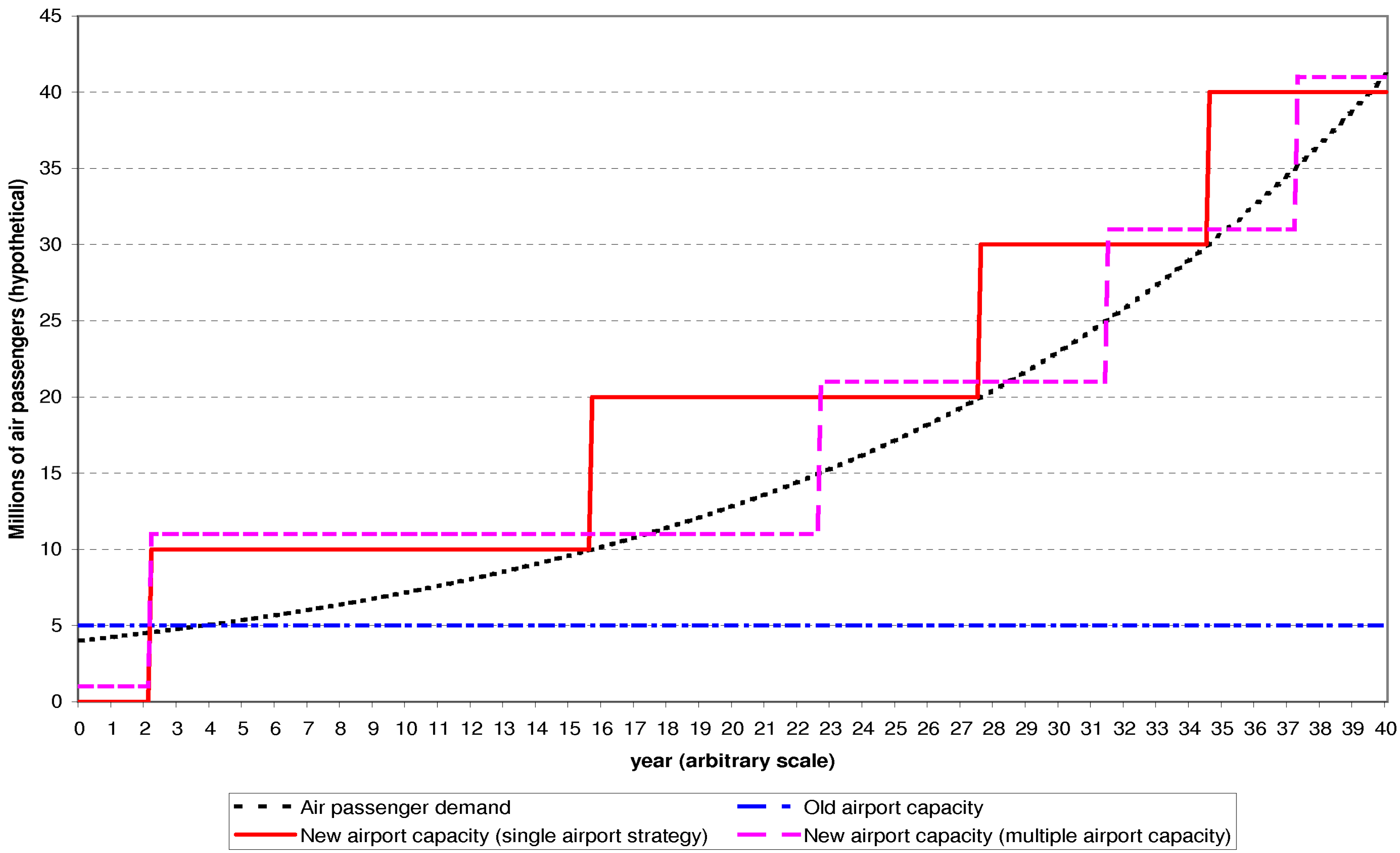


Table 1. Tancredo Neves International Airport and Pampuha Airport Traffic Statistics

	2004		2005		2006		2007		2008* (until Sep)	
	Pax	Cargo (Kg)	Pax	Cargo (Kg)	Pax	Cargo (Kg)	Pax	Cargo (Kg)	Pax	Cargo (Kg)
TNIA	388,580	8,822,371	2,893,299	14,770,288	3,727,501	16,173,319	4,340,129	16,422,992	3,688,069	14,756,491
PLU	3,194,715	8,709,565	1,281,745	2,178,152	800,940	629,378	759,824	290,069	412,940	0
Total	**3,583,295**	**17,531,936**	**4,175,044**	**16,948,440**	**4,528,441**	**16,802,697**	**5,099,953**	**16,713,061**	**4,101,009**	**14,756,491**

Source: Infraero

Table 2. Major Metropolitan Air Passenger Regions, 2006

Regional passenger rank	Metropolitan Region	Number of airports	Metropolitan aircraft movements	Metropolitan passengers
1	LONDON	6	1,207,961	137,214,521
2	NEW YORK	5	1,486,521	108,369,778
3	CHICAGO	3	1,459,696	103,008,091
4	TOKYO	2	514,178	100,785,897
5	LOS ANGELES	7	1,768,311	87,681,227
6	ATLANTA	1	976,447	84,846,639
7	PARIS	4	825,308	84,368,532
8	HONG-KONG	3	510,649	67,190,070
9	DALLAS/FORT WOR	2	948,578	67,100,855
10	WASHINGTON/BALT	3	961,620	62,542,832
11	SAN FRANCISCO	3	878,077	58,975,747
12	FRANKFURT	2	529,016	56,514,862
13	MIAMI	2	681,565	53,903,761
14	HOUSTON/GALVEST	2	837,381	51,099,721
15	DENVER	2	739,447	49,354,425
16	BEIJING	1	376,643	48,654,770
17	AMSTERDAM	3	519,893	48,347,191
18	LAS VEGAS	3	915,846	46,938,137
19	SHANGHAI	2	409,598	46,126,079
20	MADRID	3	508,097	45,527,236
21	BANGKOK	2	302,276	42,803,709
22	SEOUL	2	288,493	42,127,246
23	PHOENIX	2	827,229	41,442,594
24	MILAN	3	439,202	36,704,599
25	SINGAPORE	2	260,718	36,341,469
26	ORLANDO	2	669,169	36,290,016
27	DETROIT	1	481,740	35,972,673
28	MINNEAPOLIS/ST.	1	475,668	35,612,133
29	ROME	2	379,542	35,002,041
30	BARCELONA	3	385,966	34,970,683
31	OSAKA	2	246,257	33,649,869
32	MOSCOW	3	403,992	33,265,248
33	PHILADELPHIA	1	515,869	31,768,272
34	BOSTON	3	538,064	31,689,135
35	TORONTO	3	535,298	31,518,827
36	JAKARTA	2	281,463	30,812,445
37	MUENICH	1	411,335	30,757,978
38	MANCHESTER UK	3	416,141	30,543,000
39	SYDNEY	1	283,636	30,375,799
40	SEATTLE	1	340,058	29,979,097
41	CHARLOTTE	1	509,559	29,693,949
42	DUBAI	1	237,258	28,788,726
43	SAO PAULO	3	398,879	27,928,424

Table 2. Major Metropolitan Air Passenger Regions, 2006

Regional passenger rank	Metropolitan Region	Number of airports	Metropolitan aircraft movements	Metropolitan passengers
44	RHINE-RHUR VALL	2	367,139	26,495,409
45	GUANGZHOU	1	232,404	26,222,037
46	ISTANBUL	2	277,363	26,178,332
47	MEXICO CITY	1	355,593	24,727,296
48	KUALA LUMPUR	2	220,495	24,213,250
49	TAIPEI	1	157,703	22,857,445
50	COPENHAGEN	2	300,414	22,737,731
51	PALMA DE MAJORC	1	190,280	22,402,257
52	MELBOURNE AUST	1	179,130	21,903,775
53	SALT LAKE CITY	1	421,436	21,557,656
54	MUMBAI	1	206,091	21,375,051
55	DUBLIN	1	196,641	21,196,382
56	HONOLULU	1	317,317	20,067,871
57	GLASGOW/EDINBUR	3	285,317	19,870,057
58	NEW DELHI	1	192,491	19,372,694
59	STOCKHOLM	2	283,722	19,330,800
60	BRUSSELS	4	422,164	19,289,515
61	ZURICH	1	260,786	19,185,989
62	OSLO	2	251,820	18,967,791
63	TAMPA	1	257,071	18,867,541
64	VIENNA	2	291,995	18,788,172
65	BERLIN	3	250,502	18,506,506
66	SAPPORO	1	100,478	18,389,322
67	FUKUOKA	1	137,632	18,205,998
68	MANILA	2	206,007	17,990,591
69	VANCOUVER	2	482,210	17,642,160
70	SAN DIEGO	1	220,839	17,481,942
71	JOHANNESBURG	1	207,624	17,344,669
72	BRISBANE	1	165,826	17,087,549
73	CHENGDU	1	156,340	16,278,700
74	CINCINNATI	1	345,754	16,244,962
75	ST. LOUIS	1	272,585	15,205,944
76	ATHENS	1	190,872	15,065,267
77	ANTALYA	1	99,146	14,767,977
78	KUNMING	1	135,523	14,448,653
79	NAHA	1	116,372	14,172,504
80	PORTLAND	1	260,510	14,043,489
81	JEDDAH	1	101,845	13,357,093
82	MALAGA	1	127,769	13,056,155
83	RIO DE JANEIRO	2	165,498	12,838,357
84	LISBON	1	137,109	12,314,314
85	BUENOS AIRES	2	142,916	12,156,670
86	HELSINKI	2	247,298	12,143,004

Table 2. Major Metropolitan Air Passenger Regions, 2006

Regional passenger rank	Metropolitan Region	Number of airports	Metropolitan aircraft movements	Metropolitan passengers
87	JEJU	1	78,611	12,109,837
88	HAMBURG	1	168,395	11,954,560
89	BOGOTA	1	216,592	11,770,339
90	NAGOYA	1	107,485	11,652,161
91	PRAGUE	1	166,346	11,567,588
92	AUCKLAND	1	160,893	11,458,553
93	MONTREAL	2	235,393	11,431,751
94	RIYADH	1	94,250	11,328,238
95	CLEVELAND	2	320,794	11,321,050
96	CALGARY, AB, CA	1	242,658	11,279,080
97	KANSAS CITY	1	178,466	11,237,480
98	MEMPHIS	1	384,823	11,176,460
99	CAIRO	1	105,999	10,778,097
100	SAN JUAN	2	196,621	10,689,445
101	BRASILIA	1	126,427	10,379,185
102	SACRAMENTO, CAL	2	251,458	10,362,800
103	GRAN CANARIA	1	114,938	10,279,594
104	STUTTGART	1	167,945	10,104,958
105	PITTSBURGH	1	235,264	9,987,310
106	NICE	1	178,861	9,948,035
107	GENEVA	1	176,709	9,856,546
108	CANCUN	1	97,228	9,852,615
109	TEL AVIV	2	108,693	9,850,440
110	NASHVILLE, TENN	1	216,617	9,663,386
111	RALEIGH-DURHAM,	1	245,099	9,422,112
112	XIAN	1	103,281	9,368,953
113	HERAKLION	1	67,602	9,355,235
114	BIRMINGHAM	1	119,532	9,153,047
115	ALICANTE	1	76,816	8,882,521
116	TENERIFE SUR	1	65,774	8,816,745
117	MADRAS	1	103,299	8,476,707
118	HO CHI MINH CIT	1	64,183	8,472,423
119	AUSTIN, TEXAS	1	209,150	8,261,310
120	BUDAPEST	1	126,947	8,248,650
121	WARSAW	1	146,066	8,101,827
122	INDIANAPOLIS, I	1	213,740	8,085,394
123	SAN ANTONIO, TE	1	218,934	8,031,405
124	FORT MYERS, FLO	1	86,170	7,643,217
125	PERTH	1	96,658	7,529,945

Source: ACI 2006 data

Table 3. Frequency Distribution of Number of Commercial Airports, 2006

All 125 regions					Top 50 regions			
Number of airports	Count of metropolitan regions	Percent of regions	Cumulative percent		Number of airports	Count of metropolitan regions	Percent of regions	Cumulative percent
1	1	73	58.4%	58.4%	1	13	26.0%	26.0%
2	2	31	24.8%	83.2%	2	19	38.0%	64.0%
3	3	16	12.8%	96.0%	3	14	28.0%	92.0%
4	4	2	1.6%	97.6%	4	1	2.0%	94.0%
5	5	1	0.8%	98.4%	5	1	2.0%	96.0%
6	6	1	0.8%	99.2%	6	1	2.0%	98.0%
7	7	1	0.8%	100.0%	7	1	2.0%	100.0%

Source: ACI 2006 data

Table 4. Mean airports by size of regional flying market, 2006

Five preceding metropolitan regions ending in rank:	Mean number of airports in group	Mean number of annual regional passengers in group	Mean number of annual passengers per airport
5	4.6	107,411,903	23,350,414
10	2.6	73,209,786	28,157,610
15	2.2	53,969,703	24,531,683
20	2.4	47,118,683	19,632,784
25	2.2	39,883,923	18,129,056
30	1.8	35,569,509	19,760,838
35	2.4	32,378,270	13,490,946
40	1.6	30,493,664	19,058,540
45	1.6	27,825,709	17,391,068
50	1.6	24,142,811	15,089,257
55	1.0	21,687,024	21,687,024
60	2.2	19,586,187	8,902,812
65	1.8	18,863,200	10,479,555
70	1.4	17,942,003	12,815,716
75	1.0	16,432,365	16,432,365
80	1.0	14,499,578	14,499,578
85	1.4	12,605,447	9,003,891
90	1.0	11,810,897	11,810,897
95	1.4	11,363,734	8,116,953
100	1.2	10,852,133	9,043,445
105	1.2	10,136,539	8,447,116
110	1.2	9,729,020	8,107,517
115	1.0	9,208,987	9,208,987
120	1.0	8,455,167	8,455,167
125	1.0	7,878,358	7,878,358

Source: ACI 2006 data

Table 5. Major World Airports, Sorted by Rank, 2006

Regional passenger rank	Metropolitan Region	Rank of airport	Airport name	Metropolitan aircraft movements	Metropolitan passengers	Metropolitan aircraft movements	Metropolitan passengers
1	LONDON			1,207,961	137,214,521	100%	100%
		3	HEATHROW	477,030	67,530,197	39%	49%
		25	GATWICK	263,347	34,172,492	22%	25%
		46	STANSTED	206,656	23,686,800	17%	17%
		127	LONDON LUTON	116,132	9,447,494	10%	7%
			LONDON CITY	79,616	2,377,318	7%	2%
			BIGGIN HILL	65,180	220	5%	0%
2	NEW YORK			1,486,521	108,369,778	100%	100%
		15	JF KENNEDY INTL	378,389	43,762,282	25%	40%
		19	NEWARK LIBERTY INTL	444,374	36,724,167	30%	34%
		41	LA GUARDIA	399,827	26,571,146	27%	25%
			WESTCHESTER COUNTY	180,798	1,003,600	12%	1%
			STEWART INTL	83,133	308,583	6%	0%
3	CHICAGO			1,459,696	103,008,091	100%	100%
		2	O'HARE INTL	958,643	77,028,134	66%	75%
		65	MIDWAY INTL	298,548	18,680,663	20%	18%
			GENERAL MITCHELL INTL	202,505	7,299,294	14%	7%
4	TOKYO			514,178	100,785,897	100%	100%
		4	TOKYO INTL (HANEDA)	324,052	65,810,672	63%	65%
		23	NEW TOKYO INTL (NARITA)	190,126	34,975,225	37%	35%
5	LOS ANGELES			1,768,311	87,681,227	100%	100%
		5	LOS ANGELES INTL	656,842	61,041,066	37%	70%
		126	JOHN WAYNE	347,194	9,613,540	20%	11%
			ONTARIO INTL	136,261	7,049,904	8%	8%
			BOB HOPE	131,214	5,689,291	7%	6%
			LONG BEACH	369,738	2,758,362	21%	3%
			PALM SPRINGS INTL	94,578	1,529,005	5%	2%
			PALMDALE	32,484	59	2%	0%
6	ATLANTA			976,447	84,846,639	100%	100%

Table 5. Major World Airports, Sorted by Rank, 2006

Regional passenger rank	Metropolitan Region	Rank of airport	Airport name	Metropolitan aircraft movements	Metropolitan passengers	Metropolitan aircraft movements	Metropolitan passengers
		1	HARTSFIELD-JACKSON ATLANTA INTL	976,447	84,846,639	100%	100%
7	PARIS			825,308	84,368,532	100%	100%
		7	CHARLES DE GAULLE	541,566	56,849,567	66%	67%
		43	ORLY	233,458	25,622,152	28%	30%
			BEAUVAIS-TILLE	35,685	1,887,971	4%	2%
			VATRY	14,599	8,842	2%	0%
8	HONG-KONG			510,649	67,190,070	100%	100%
		14	HONG KONG INTL	290,107	43,857,908	57%	65%
		69	SHENZHEN HUANGTIAN INTL	169,493	18,356,069	33%	27%
			MACAU INTL	51,049	4,976,093	10%	7%
9	DALLAS/FORT WOR			948,578	67,100,855	100%	100%
		6	DALLAS/FT WORTH INTL	699,773	60,226,138	74%	90%
			LOVE FIELD	248,805	6,874,717	26%	10%
10	WASHINGTON/BALT			961,620	62,542,832	100%	100%
		49	WASHINGTON DULLES INTL	379,571	22,813,067	39%	36%
		58	BALTIMORE/WASHINGTON INTL THURGOOD	305,630	21,184,208	32%	34%
		66	R REAGAN WASHINGTON NATIONAL	276,419	18,545,557	29%	30%
11	SAN FRANCISCO			878,077	58,975,747	100%	100%
		26	SAN FRANCISCO INTL	359,201	33,574,807	41%	57%
		89	OAKLAND INTL	330,418	14,692,875	38%	25%
		113	NORMAN MINETA SAN JOSE INTL	188,458	10,708,065	21%	18%
12	FRANKFURT			529,016	56,514,862	100%	100%
		8	FRANKFURT/MAIN	489,406	52,810,683	93%	93%
			HAHN	39,610	3,704,179	7%	7%

Table 5. Major World Airports, Sorted by Rank, 2006

Regional passenger rank	Metropolitan Region	Rank of airport	Airport name	Metropolitan aircraft movements	Metropolitan passengers	Metropolitan aircraft movements	Metropolitan passengers
13	MIAMI			681,565	53,903,761	100%	100%
		27	MIAMI INTL	384,477	32,533,974	56%	60%
		56	FT LAUDERDALE/HOLLYWOOD INTL	297,088	21,369,787	44%	40%
14	HOUSTON/GALVEST			837,381	51,099,721	100%	100%
		17	G BUSH INTERCONTINENTAL	602,672	42,550,432	72%	83%
		139	WP HOBBY	234,709	8,549,289	28%	17%
15	DENVER			739,447	49,354,425	100%	100%
		10	DENVER INTL	598,489	47,325,016	81%	96%
			COLORADO SPRINGS	140,958	2,029,409	19%	4%
16	BEIJING			376,643	48,654,770	100%	100%
		9	BEIJING CAPITAL INTL	376,643	48,654,770	100%	100%
17	AMSTERDAM			519,893	48,347,191	100%	100%
		12	SCHIPHOL	440,154	46,065,719	85%	95%
			EINDHOVEN	15,474	1,143,637	3%	2%
			ROTTERDAM	64,265	1,137,835	12%	2%
18	LAS VEGAS			915,846	46,938,137	100%	100%
		11	MCCARRAN INTL	619,486	46,193,329	68%	98%
			NORTH LAS VEGAS	229,794	707,036	25%	2%
			HENDERSON EXECUTIVE	66,566	37,772	7%	0%
19	SHANGHAI			409,598	46,126,079	100%	100%
		40	PUDONG	231,995	26,789,125	57%	58%
		62	HONGQIA INTL	177,603	19,336,954	43%	42%
20	MADRID			508,097	45,527,236	100%	100%
		13	BARAJAS	435,018	45,501,168	86%	100%
			TOREJON	15,154	25,894	3%	0%
			CUATRO VIENTOS	57,925	174	11%	0%

Table 5. Major World Airports, Sorted by Rank, 2006

Regional passenger rank	Metropolitan Region	Rank of airport	Airport name	Metropolitan aircraft movements	Metropolitan passengers	Metropolitan aircraft movements	Metropolitan passengers
21	BANGKOK			302,276	42,803,709	100%	100%
		16	BANGKOK INTL (SUVARNABHUMI)	290,916	42,799,532	96%	100%
			DON MUEANG	11,360	4,177	4%	0%
22	SEOUL			288,493	42,127,246	100%	100%
		38	INCHEON INTL	184,279	28,360,723	64%	67%
		93	GIMPO INTL	104,214	13,766,523	36%	33%
23	PHOENIX			827,229	41,442,594	100%	100%
		18	PHOENIX SKY HARBOR INTL	546,510	41,436,737	66%	100%
			WILLIAMS GATEWAY	280,719	5,857	34%	0%
24	MILAN			439,202	36,704,599	100%	100%
		53	MALPENSA	251,229	21,767,267	57%	59%
		124	LINATE	131,615	9,696,515	30%	26%
			ORIO AL SERIO	56,358	5,240,817	13%	14%
25	SINGAPORE			260,718	36,341,469	100%	100%
		22	CHANGI	217,773	35,033,083	84%	96%
			SULTAN ISMAIL	42,945	1,308,386	16%	4%
26	ORLANDO			669,169	36,290,016	100%	100%
		24	ORLANDO INTL	350,119	34,640,451	52%	95%
			ORLANDO SANFORD INTL	319,050	1,649,565	48%	5%
27	DETROIT			481,740	35,972,673	100%	100%
		20	DETROIT METRO WAYNE COUNTY	481,740	35,972,673	100%	100%
28	MINNEAPOLIS/ST.			475,668	35,612,133	100%	100%
		21	MINNEAPOLIS/ST PAUL INTL	475,668	35,612,133	100%	100%
29	ROME			379,542	35,002,041	100%	100%
		33	FIUMICINO	315,627	30,102,097	83%	86%

Table 5. Major World Airports, Sorted by Rank, 2006

Regional passenger rank	Metropolitan Region	Rank of airport	Airport name	Metropolitan aircraft movements	Metropolitan passengers	Metropolitan aircraft movements	Metropolitan passengers
			CIAMPINO	63,915	4,899,944	17%	14%
30	BARCELONA			385,966	34,970,683	100%	100%
		34	BARCELONA	327,636	30,000,601	85%	86%
			GIRONA/COSTA BRAVA	33,436	3,592,700	9%	10%
			REUS	24,894	1,377,382	6%	4%
31	OSAKA			246,257	33,649,869	100%	100%
		78	OSAKA (ITAMI) INTL	130,826	17,050,440	53%	51%
		81	KANSAI INTL	115,431	16,599,429	47%	49%
32	MOSCOW			403,992	33,265,248	100%	100%
		85	DOMODEDOVO	149,895	15,370,335	37%	46%
		96	SHEREMETYEVO	155,660	12,764,263	39%	38%
			VNUKOVO	98,437	5,130,650	24%	15%
33	PHILADELPHIA			515,869	31,768,272	100%	100%
		28	PHILADELPHIA INTL	515,869	31,768,272	100%	100%
34	BOSTON			538,064	31,689,135	100%	100%
		39	LOGAN INTL	406,119	27,725,443	75%	87%
			MANCHESTER-BOSTON REGL.	93,138	3,896,532	17%	12%
			PEASE INTL TRADEPORT	38,807	67,160	7%	0%
35	TORONTO			535,298	31,518,827	100%	100%
		29	LESTER B. PEARSON INTL	417,921	30,972,577	78%	98%
			JOHN C MUNRO HAMILTON INTL	41,878	527,133	8%	2%
			TORONTO CITY CENTRE	75,499	19,117	14%	0%
36	JAKARTA			281,463	30,812,445	100%	100%
		31	SOEKARNO HATTA INTL	247,126	30,583,957	88%	99%
			HALIM PERDANKUSUMA	34,337	228,488	12%	1%
37	MUENICH			411,335	30,757,978	100%	100%
		30	MUNICH	411,335	30,757,978	100%	100%

Table 5. Major World Airports, Sorted by Rank, 2006

Regional passenger rank	Metropolitan Region	Rank of airport	Airport name	Metropolitan aircraft movements	Metropolitan passengers	Metropolitan aircraft movements	Metropolitan passengers
38	MANCHESTER UK			416,141	30,543,000	100%	100%
		50	MANCHESTER	229,806	22,776,337	55%	75%
			LIVERPOOL JOHN LENNON	91,474	4,971,452	22%	16%
			LEEDS/BRADFORD	94,861	2,795,211	23%	9%
39	SYDNEY			283,636	30,375,799	100%	100%
		32	KINGSFORD SMITH	283,636	30,375,799	100%	100%
40	SEATTLE			340,058	29,979,097	100%	100%
		35	SEATTLE TACOMA INTL	340,058	29,979,097	100%	100%
41	CHARLOTTE			509,559	29,693,949	100%	100%
		36	CHARLOTTE/DOUGLAS INTL	509,559	29,693,949	100%	100%
42	DUBAI			237,258	28,788,726	100%	100%
		37	DUBAI INTL	237,258	28,788,726	100%	100%
43	SAO PAULO			398,879	27,928,424	100%	100%
		67	INT DE CONGONHAS	230,995	18,542,803	58%	66%
		133	INT DO GUARULHOS	154,940	9,216,052	39%	33%
			CAMPO DE MARTE	12,944	169,569	3%	1%
44	RHINE-RHUR VALL			367,139	26,495,409	100%	100%
		82	DUSSELDORF	215,481	16,591,174	59%	63%
		121	COLOGNE BONN KONRAD ADENAUER	151,658	9,904,235	41%	37%
45	GUANGZHOU			232,404	26,222,037	100%	100%
		42	GUANGZHOU BAIYUN INTL	232,404	26,222,037	100%	100%
46	ISTANBUL			277,363	26,178,332	100%	100%
		47	ATATURK	241,375	23,261,878	87%	89%
			SABIHA GOKCEN INTL	35,988	2,916,454	13%	11%
47	MEXICO CITY			355,593	24,727,296	100%	100%
		44	MEXICO CITY	355,593	24,727,296	100%	100%
48	KUALA LUMPUR			220,495	24,213,250	100%	100%

Table 5. Major World Airports, Sorted by Rank, 2006

Regional passenger rank	Metropolitan Region	Rank of airport	Airport name	Metropolitan aircraft movements	Metropolitan passengers	Metropolitan aircraft movements	Metropolitan passengers
		45	KUALA LUMPUR INTL	183,869	24,129,748	83%	100%
			SULTAN ABDUL AZIZ SHAH, SUBANG	36,626	83,502	17%	0%
49	TAIPEI			157,703	22,857,445	100%	100%
		48	TAIWAN TAOYUAN INTL	157,703	22,857,445	100%	100%
50	COPENHAGEN			300,414	22,737,731	100%	100%
		59	COPENHAGEN	258,356	20,799,352	86%	91%
			MALMÖ/STURUP	42,058	1,938,379	14%	9%
51	PALMA DE MAJORC			190,280	22,402,257	100%	100%
		51	PALMA DE MALLORCA	190,280	22,402,257	100%	100%
52	MELBOURNE AUST			179,130	21,903,775	100%	100%
		52	TULLAMARINE	179,130	21,903,775	100%	100%
53	SALT LAKE CITY			421,436	21,557,656	100%	100%
		54	SALT LAKE CITY INTL	421,436	21,557,656	100%	100%
54	MUMBAI			206,091	21,375,051	100%	100%
		55	MUMBAI	206,091	21,375,051	100%	100%
55	DUBLIN			196,641	21,196,382	100%	100%
		57	DUBLIN	196,641	21,196,382	100%	100%
56	HONOLULU			317,317	20,067,871	100%	100%
		60	HONOLULU INTL	317,317	20,067,871	100%	100%
57	GLASGOW/EDINBUR			285,317	19,870,057	100%	100%
		136	GLASGOW	110,063	8,853,951	39%	45%
		138	EDINBURGH	126,907	8,612,881	44%	43%
			PRESTWICK	48,347	2,403,225	17%	12%
58	NEW DELHI			192,491	19,372,694	100%	100%
		61	INDIRA GANDHI INTL	192,491	19,372,694	100%	100%
59	STOCKHOLM			283,722	19,330,800	100%	100%
		73	ARLANDA	227,095	17,667,501	80%	91%
			BROMMA	56,627	1,663,299	20%	9%

Table 5. Major World Airports, Sorted by Rank, 2006

Regional passenger rank	Metropolitan Region	Rank of airport	Airport name	Metropolitan aircraft movements	Metropolitan passengers	Metropolitan aircraft movements	Metropolitan passengers
60	BRUSSELS			422,164	19,289,515	100%	100%
		80	BRUSSELS NATIONAL	254,772	16,666,522	60%	86%
			BRUSSELS SOUTH	66,480	2,166,915	16%	11%
			LIEGE-BIERSET	45,889	308,229	11%	2%
			ANTWERP-DEURNE	55,023	147,849	13%	1%
61	ZURICH			260,786	19,185,989	100%	100%
		63	ZURICH	260,786	19,185,989	100%	100%
62	OSLO			251,820	18,967,791	100%	100%
		72	OSLO INTL	214,640	17,672,179	85%	93%
			TORP	37,180	1,295,612	15%	7%
63	TAMPA			257,071	18,867,541	100%	100%
		64	TAMPA INTL	257,071	18,867,541	100%	100%
64	VIENNA			291,995	18,788,172	100%	100%
		79	VIENNA INTL	260,846	16,855,725	89%	90%
			M.R. STEFANIK/IVANKA	31,149	1,932,447	11%	10%
65	BERLIN			250,502	18,506,506	100%	100%
		101	TEGEL OTTO LILIENTHAL	140,611	11,812,625	56%	64%
			SCHOENEFELD	67,702	6,059,343	27%	33%
			TEMPELHOF	42,189	634,538	17%	3%
66	SAPPORO			100,478	18,389,322	100%	100%
		68	SAPPORO CHITOSE	100,478	18,389,322	100%	100%
67	FUKUOKA			137,632	18,205,998	100%	100%
		70	FUKUOKA INTL	137,632	18,205,998	100%	100%
68	MANILA			206,007	17,990,591	100%	100%
		71	N AQUINO INTL	171,913	17,942,465	83%	100%
			SUBIC BAY INTL	34,094	48,126	17%	0%
69	VANCOUVER			482,210	17,642,160	100%	100%
		76	VANCOUVER INTL	322,396	17,139,527	67%	97%
			ABBOTSFORD	159,814	502,633	33%	3%

Table 5. Major World Airports, Sorted by Rank, 2006

Regional passenger rank	Metropolitan Region	Rank of airport	Airport name	Metropolitan aircraft movements	Metropolitan passengers	Metropolitan aircraft movements	Metropolitan passengers
70	SAN DIEGO			220,839	17,481,942	100%	100%
		74	SAN DIEGO INTL	220,839	17,481,942	100%	100%
71	JOHANNESBURG			207,624	17,344,669	100%	100%
		75	JOHANNESBURG INTL	207,624	17,344,669	100%	100%
72	BRISBANE			165,826	17,087,549	100%	100%
		77	BRISBANE INTL	165,826	17,087,549	100%	100%
73	CHENGDU			156,340	16,278,700	100%	100%
		83	CHENGDU SHUANGLIU INTL	156,340	16,278,700	100%	100%
74	CINCINNATI			345,754	16,244,962	100%	100%
		84	CINCINNATI/NO KENTUCKY INTL	345,754	16,244,962	100%	100%
75	ST. LOUIS			272,585	15,205,944	100%	100%
		86	LAMBERT-ST LOUIS INTL	272,585	15,205,944	100%	100%
76	ATHENS			190,872	15,065,267	100%	100%
		87	ATHINAI	190,872	15,065,267	100%	100%
77	ANTALYA			99,146	14,767,977	100%	100%
		88	ANTALYA	99,146	14,767,977	100%	100%
78	KUNMING			135,523	14,448,653	100%	100%
		90	KUNMING WUJIABA INTL	135,523	14,448,653	100%	100%
79	NAHA			116,372	14,172,504	100%	100%
		91	NAHA INT'L	116,372	14,172,504	100%	100%
80	PORTLAND			260,510	14,043,489	100%	100%
		92	PORTLAND INTL	260,510	14,043,489	100%	100%
81	JEDDAH			101,845	13,357,093	100%	100%
		94	KING ABDULAZIZ INTL	101,845	13,357,093	100%	100%
82	MALAGA			127,769	13,056,155	100%	100%
		95	MALAGA	127,769	13,056,155	100%	100%
83	RIO DE JANEIRO			165,498	12,838,357	100%	100%

Table 5. Major World Airports, Sorted by Rank, 2006

Regional passenger rank	Metropolitan Region	Rank of airport	Airport name	Metropolitan aircraft movements	Metropolitan passengers	Metropolitan aircraft movements	Metropolitan passengers
		131	GALÃO	100,895	9,285,180	61%	72%
			SANTOS DUMONT	64,603	3,553,177	39%	28%
84	LISBON			137,109	12,314,314	100%	100%
		97	LISBON	137,109	12,314,314	100%	100%
85	BUENOS AIRES			142,916	12,156,670	100%	100%
			EZEIZA "MINISTRO PISTARINI"	63,693	6,867,596	45%	56%
			AEROPARQUE JORGE NEWBERY	79,223	5,289,074	55%	44%
86	HELSINKI			247,298	12,143,004	100%	100%
		98	HELSINKI VANTAA	182,226	12,142,873	74%	100%
			HELSINKI MALMI	65,072	131	26%	0%
87	JEJU			78,611	12,109,837	100%	100%
		99	JEJU	78,611	12,109,837	100%	100%
88	HAMBURG			168,395	11,954,560	100%	100%
		100	HAMBURG-FÜHLSBUTTEL	168,395	11,954,560	100%	100%
89	BOGOTA			216,592	11,770,339	100%	100%
		102	ELDORADO INTL	216,592	11,770,339	100%	100%
90	NAGOYA			107,485	11,652,161	100%	100%
		103	CHUBU CENTRAIR INTL	107,485	11,652,161	100%	100%
91	PRAGUE			166,346	11,567,588	100%	100%
		104	PRAHA-RUZYNE	166,346	11,567,588	100%	100%
92	AUCKLAND			160,893	11,458,553	100%	100%
		105	AUCKLAND INTL	160,893	11,458,553	100%	100%
93	MONTREAL			235,393	11,431,751	100%	100%
		106	PIERRE ELLIOT TRUDEAU INTL	213,468	11,431,751	91%	100%
			MIRABEL INTL	21,925	.	9%	—
94	RIYADH			94,250	11,328,238	100%	100%

Table 5. Major World Airports, Sorted by Rank, 2006

Regional passenger rank	Metropolitan Region	Rank of airport	Airport name	Metropolitan aircraft movements	Metropolitan passengers	Metropolitan aircraft movements	Metropolitan passengers
		107	KING KHALED INTL	94,250	11,328,238	100%	100%
95	CLEVELAND			320,794	11,321,050	100%	100%
		108	CLEVELAND HOPKINS INTL	249,967	11,321,050	78%	100%
			BURKE LAKEFRONT	70,827	.	22%	—
96	CALGARY, AB, CA			242,658	11,279,080	100%	100%
		109	CALGARY INTL	242,658	11,279,080	100%	100%
97	KANSAS CITY			178,466	11,237,480	100%	100%
		110	KANSAS CITY INTL	178,466	11,237,480	100%	100%
98	MEMPHIS			384,823	11,176,460	100%	100%
		111	MEMPHIS INTL	384,823	11,176,460	100%	100%
99	CAIRO			105,999	10,778,097	100%	100%
		112	CAIRO INTL	105,999	10,778,097	100%	100%
100	SAN JUAN			196,621	10,689,445	100%	100%
		114	LUIS MUÑOZ MARIN	195,369	10,621,730	99%	99%
			SAN JUAN	1,252	67,715	1%	1%
101	BRASILIA			126,427	10,379,185	100%	100%
		115	INT DE BRASILIA-PRES JUSCELINO KUB	126,427	10,379,185	100%	100%
102	SACRAMENTO, CAL			251,458	10,362,800	100%	100%
		116	SACRAMENTO INTL	172,522	10,362,800	69%	100%
			MATHER	78,936	.	31%	—
103	GRAN CANARIA			114,938	10,279,594	100%	100%
		117	GRAN CANARIA	114,938	10,279,594	100%	100%
104	STUTTGART			167,945	10,104,958	100%	100%
		118	STUTTGART	167,945	10,104,958	100%	100%
105	PITTSBURGH			235,264	9,987,310	100%	100%
		119	PITTSBURGH INTL	235,264	9,987,310	100%	100%
106	NICE			178,861	9,948,035	100%	100%
		120	NICE-COTE D'AZUR	178,861	9,948,035	100%	100%

Table 5. Major World Airports, Sorted by Rank, 2006

Regional passenger rank	Metropolitan Region	Rank of airport	Airport name	Metropolitan aircraft movements	Metropolitan passengers	Metropolitan aircraft movements	Metropolitan passengers
107	GENEVA			176,709	9,856,546	100%	100%
		122	AEROPORT INTL DE GENEVE	176,709	9,856,546	100%	100%
108	CANCUN			97,228	9,852,615	100%	100%
		123	CANCUN	97,228	9,852,615	100%	100%
109	TEL AVIV			108,693	9,850,440	100%	100%
		132	BEN GURION INTL	76,735	9,221,552	71%	94%
			SDE-DOV HOZ	31,958	628,888	29%	6%
110	NASHVILLE, TENN			216,617	9,663,386	100%	100%
		125	NASHVILLE INTL	216,617	9,663,386	100%	100%
111	RALEIGH-DURHAM,			245,099	9,422,112	100%	100%
		128	RALEIGH-DURHAM INTL	245,099	9,422,112	100%	100%
112	XIAN			103,281	9,368,953	100%	100%
		129	XIAN XIANYANG INTL	103,281	9,368,953	100%	100%
113	HERAKLION			67,602	9,355,235	100%	100%
		130	N. KAZANTZAKIS	67,602	9,355,235	100%	100%
114	BIRMINGHAM			119,532	9,153,047	100%	100%
		134	BIRMINGHAM INTL	119,532	9,153,047	100%	100%
115	ALICANTE			76,816	8,882,521	100%	100%
		135	ALICANTE	76,816	8,882,521	100%	100%
116	TENERIFE SUR			65,774	8,816,745	100%	100%
		137	TENERIFE SUR	65,774	8,816,745	100%	100%
117	MADRAS			103,299	8,476,707	100%	100%
		140	CHENNAI	103,299	8,476,707	100%	100%
118	HO CHI MINH CIT			64,183	8,472,423	100%	100%
		141	TAN SON NHAT INTL	64,183	8,472,423	100%	100%
119	AUSTIN, TEXAS			209,150	8,261,310	100%	100%
		142	AUSTIN-BERGSTROM INTL	209,150	8,261,310	100%	100%
120	BUDAPEST			126,947	8,248,650	100%	100%

Table 5. Major World Airports, Sorted by Rank, 2006

Regional passenger rank	Metropolitan Region	Rank of airport	Airport name	Metropolitan aircraft movements	Metropolitan passengers	Metropolitan aircraft movements	Metropolitan passengers
		143	FERIHEGY	126,947	8,248,650	100%	100%
121	WARSAW			146,066	8,101,827	100%	100%
		144	OKECIE	146,066	8,101,827	100%	100%
122	INDIANAPOLIS, I			213,740	8,085,394	100%	100%
		145	INDIANAPOLIS INTL	213,740	8,085,394	100%	100%
123	SAN ANTONIO, TE			218,934	8,031,405	100%	100%
		146	SAN ANTONIO INTL	218,934	8,031,405	100%	100%
124	FORT MYERS, FLO			86,170	7,643,217	100%	100%
		147	SOUTHWEST FLORIDA INTL	86,170	7,643,217	100%	100%
125	PERTH			96,658	7,529,945	100%	100%
		148	PERTH	96,658	7,529,945	100%	100%

Source: ACI 2006 data

Table 6. Overview of the Evolution of Airports in Major Regions

Regional passenger rank	Metropolitan Region	Rank of airport	Airport name	Description	Notes
1	LONDON				
		3	HEATHROW	Replaced Croyden (12 m) in 1946	Capacity constrained
		25	GATWICK	Began being (re-)developed in 1950s as an overflow airport	Capacity constrained
		46	STANSTED	Began being (re-)developed in 1980s ? as an overflow airport	White elephant
		127	LONDON LUTON		
			LONDON CITY		
			BIGGIN HILL	no airline service	
2	NEW YORK				
		15	JF KENNEDY INTL	Serial and competing airports? 1948	
		19	NEWARK LIBERTY INTL	1928	White elephant
		41	LA GUARDIA	Opened in 1939, one of the first with hard paved runways; most long distance flights (over 1,500 miles) prohibited	Capacity constrained
			WESTCHESTER COUNTY	Regional geographic expansion	
			STEWART INTL	Regional geographic expansion	
			ISLIP		
3	CHICAGO				
		2	O'HARE INTL	Replaced Midway as primary airport; now being reconfigured	
		65	MIDWAY INTL		Capacity constrained
			GENERAL MITCHELL INTL	Regional geographic expansion	
4	TOKYO				
		4	TOKYO INTL (HANEDA)	International flights disallowed	Capacity constrained
		23	NEW TOKYO INTL (NARITA)	Became primary international airport	

Table 6. Overview of the Evolution of Airports in Major Regions

Regional passenger rank	Metropolitan Region	Rank of airport	Airport name	Description	Notes
5	LOS ANGELES				
		5	LOS ANGELES INTL		
		126	JOHN WAYNE	Regional geographic expansion	
			ONTARIO INTL	Regional geographic expansion	
			BOB HOPE	Regional geographic expansion	
			LONG BEACH	Regional geographic expansion	
			PALM SPRINGS INTL	Regional geographic expansion	
			PALMDALE	Regional geographic expansion	
6	ATLANTA				
		1	HARTSFIELD-JACKSON ATLANTA INTL	Reconfigured and rebuilt in 1980; additional additions more recently	
	PARIS				
		7	CHARLES DE GAULLE	Replaced Orly as primary international airport in 1974; government ordered Air France to switch from Orly	White elephant
		43	ORLY	Replaced Bourget (9 m) in 1962	Capacity constrained
			BEAUVAIS-TILLE		
			VATRY		
8	HONG-KONG				
		14	HONG KONG INTL	Replaced Kai Tak (3 m) in 1998	
		69	SHENZHEN HUANGTIAN INTL	Regional geographic expansion; upgraded in 2000	
			MACAU INTL	Regional geographic expansion; upgraded in 1995	
9	DALLAS/FORT WOR				
		6	DALLAS/FT WORTH INTL	Replaced Love Field as primary airport in 1974	
			LOVE FIELD		
10	WASHINGTON/BALT				

Table 6. Overview of the Evolution of Airports in Major Regions

Regional passenger rank	Metropolitan Region	Rank of airport	Airport name	Description	Notes
		49	WASHINGTON DULLES INTL	Replace DCA in 1962	White elephant
		58	BALTIMORE/WASHINGTON INTL THURGOOD		
		66	R REAGAN WASHINGTON NATIONAL	Capacity constrained	
11	SAN FRANCISCO				
		26	SAN FRANCISCO INTL	Regional geographic expansion	
		89	OAKLAND INTL		
		113	NORMAN MINETA SAN JOSE INTL		
12	FRANKFURT				
		8	FRANKFURT/MAIN		
			HAHN	Overflow / capacity expansion	
13	MIAMI				
		27	MIAMI INTL		
		56	FT LAUDERDALE/HOLLYWOOD INTL		
14	HOUSTON/GALVEST				
		17	G BUSH INTERCONTINENTAL	Replaced Hobby as primary airport	
		139	WP HOBBY		
15	DENVER				
		10	DENVER INTL	Replaced Stapleton in 1995	
			COLORADO SPRINGS	Regional geographic expansion	
16	BEIJING				
		9	BEIJING CAPITAL INTL	Being upgraded	
17	AMSTERDAM				
		12	SCHIPHOL		
			EINDHOVEN		
			ROTTERDAM		
18	LAS VEGAS				

Table 6. Overview of the Evolution of Airports in Major Regions

Regional passenger rank	Metropolitan Region	Rank of airport	Airport name	Description	Notes
		11	MCCARRAN INTL		
			NORTH LAS VEGAS		
			HENDERSON EXECUTIVE		
19	SHANGHAI				
		40	PUDONG	Replaced Hongqia as primary airport in 1999	
		62	HONGQIA INTL		
20	MADRID				
		13	BARAJAS	Expansion in late 1990s	
			TOREJON		
			CUATRO VIENTOS		
21	BANGKOK				
		16	BANGKOK INTL (SUVARNABHUMI)	Replaced Don Muang as primary airport in 2005 ?	
			DON MUEANG		
22	SEOUL				
		38	INCHEON INTL	Replaced Gimpo as primary airport in 2001	
		93	GIMPO INTL		
23	PHOENIX				
		18	PHOENIX SKY HARBOR INTL		
			WILLIAMS GATEWAY		
24	MILAN				
		53	MALPENSA	Replaced Linate as primary airport	Alitalia moving hub operations to Rome
		124	LINATE		
			ORIO AL SERIO	LCC and charter	
25	SINGAPORE				

Table 6. Overview of the Evolution of Airports in Major Regions

Regional passenger rank	Metropolitan Region	Rank of airport	Airport name	Description	Notes
		22	CHANGI		
			SULTAN ISMAIL		
			BATAM	New in 1995 with 2 4000 m parallel runways -- equal Changi	
26	ORLANDO				
		24	ORLANDO INTL		
			ORLANDO SANFORD INTL		
27	DETROIT				
		20	DETROIT METRO WAYNE COUNTY	Replaced Willow Run (31 m) which replaced Detroit City (6 m) as primary airport in xxx	
28	MINNEAPOLIS/ST.				
		21	MINNEAPOLIS/ST PAUL INTL	Only siginficant commercial airport in region	
29	ROME				
		33	FIUMICINO	Expansion continuing	
			CIAMPINO		
30	BARCELONA				
		34	BARCELONA		
			GIRONA/COSTA BRAVA		
			REUS		
31	OSAKA				
		78	OSAKA (ITAMI) INTL	International flights disallowed; more convenient, less expensive	
		81	KANSAI INTL	Replaced Itami as primary airport in 1994; 1st 24 hr airport in Japan	
32	MOSCOW				
		85	DOMODEDOVO	Military reasons for multiple airports	
		96	SHEREMETYEVO		
			VNUKOVO		

Table 6. Overview of the Evolution of Airports in Major Regions

Regional passenger rank	Metropolitan Region	Rank of airport	Airport name	Description	Notes
33	PHILADELPHIA				
		28	PHILADELPHIA INTL	Only siginficant commercial airport in region	
34	BOSTON				
		39	LOGAN INTL		
			MANCHESTER-BOSTON REGL.		
			PEASE INTL TRADEPORT		
35	TORONTO			Malton 17 m	
		29	LESTER B. PEARSON INTL		
			JOHN C MUNRO HAMILTON INTL		
			TORONTO CITY CENTRE		
36	JAKARTA				
		31	SOEKARNO HATTA INTL		
			HALIM PERDANKUSUMA		
37	MUNICH				
		30	MUNICH	Replaced Munich-Riem (7 m) in 1992	
38	MANCHESTER UK				
		50	MANCHESTER		
			LIVERPOOL JOHN LENNON		
			LEEDS/BRADFORD		
39	SYDNEY				
		32	KINGSFORD SMITH	Only siginficant commercial airport in region	
			another Sydney airport?	not happening	
40	SEATTLE				
		35	SEATTLE TACOMA INTL	Only siginficant commercial airport in region	
41	CHARLOTTE				

Table 6. Overview of the Evolution of Airports in Major Regions

Regional passenger rank	Metropolitan Region	Rank of airport	Airport name	Description	Notes
		36	CHARLOTTE/DOUGLAS INTL	Only siginficant commercial airport in region	
42	DUBAI				
		37	DUBAI INTL	Only siginficant commercial airport in region	
43	SAO PAULO				
		67	INT DE CONGONHAS		White elephant
		133	INT DO GUARULHOS	Constrained by runway length	
			CAMPO DE MARTE		
44	RHINE-RHUR VALL				
		82	DUSSELDORF		
		121	COLOGNE BONN KONRAD ADENAUER	Former political capital / rennovations, no nightflight restrictions	
45	GUANGZHOU				
		42	GUANGZHOU BAIYUN INTL	Rplaced old Baiyun aiport in 2002; older in Huandu	
46	ISTANBUL				
		47	ATATURK		
			SABIHA GOKCEN INTL		
47	MEXICO CITY				
		44	MEXICO CITY	Only siginficant commercial airport in region	
48	KUALA LUMPUR				
		45	KUALA LUMPUR INTL	Replaced Subang as primary airport in 1998	White elephant
			SULTAN ABDUL AZIZ SHAH, SUBANG		
49	TAIPEI				
		48	TAIWAN TAOYUAN INTL		
				Runway length restricts capacity	

Table 6. Overview of the Evolution of Airports in Major Regions

Regional passenger rank	Metropolitan Region	Rank of airport	Airport name	Description	Notes
50	COPENHAGEN				
		59	COPENHAGEN		
			MALMÖ/STURUP		
57	GLASGOW/EDINBUR				
		136	GLASGOW		
		138	EDINBURGH		
			PRESTWICK		
59	STOCKHOLM				
		73	ARLANDA		
			BROMMA		
60	BRUSSELS				
		80	BRUSSELS NATIONAL	Upgraded in 1990s	
			BRUSSELS SOUTH		
			LIEGE-BIERSET	TNT in 1998	
			ANTWERP-DEURNE		
64	VIENNA				
		79	VIENNA INTL		
			M.R. STEFANIK/IVANKA		
65	BERLIN				
		101	TEGEL OTTO LILIENTHAL	To close in 2012	Divided city
			SCHOENEFELD	Former East Berlin airport; being rebuilt as Berlin-Brandenburg International (to open in 2011); now "Holiday Airport"	
			TEMPELHOF	To close in 2008; sometimes cited as the world's oldest continually operating airport (Sydney pre-dates by three years)	
84	BUENOS AIRES				
			EZEIZA "MINISTRO PISTARINI"		

Table 6. Overview of the Evolution of Airports in Major Regions

Regional passenger rank	Metropolitan Region	Rank of airport	Airport name	Description	Notes
			AEROPARQUE JORGE NEWBERY	Runway length? Possibly both replaced	
85	HELSINKI				
		98	HELSINKI VANTAA		
			HELSINKI MALMI		
92	MONTREAL				
		106	PIERRE ELLIOT TRUDEAU INTL		
			MIRABEL INTL	Opened in 1975 to replace Trudeau Intl but is too far from population centers to attract traffic	

Table 7. The Distribution of Air Passenger Traffic Among Airports in Major Flying Regions, 2006

Regional passenger rank	Metropolitan Region	Metropolitan passengers	Airport 1	Airport 2	Airport 3	Airport 4
1	LONDON	137,214,521	49.20%	24.90%	17.30%	6.89%
2	NEW YORK	108,369,778	40.40%	33.90%	24.50%	0.93%
3	CHICAGO	103,008,091	74.80%	18.10%	7.09%	
4	TOKYO	100,785,897	65.30%	34.70%		
5	LOS ANGELES	87,681,227	69.60%	11.00%	8.04%	6.49%
6	ATLANTA	84,846,639	100.00%			
7	PARIS	84,368,532	67.40%	30.40%	2.24%	
8	HONG-KONG	67,190,070	65.30%	27.30%	7.41%	
9	DALLAS/FORT WOR	67,100,855	89.80%	10.20%		
10	WASHINGTON/BALT	62,542,832	36.50%	33.90%	29.70%	
11	SAN FRANCISCO	58,975,747	56.90%	24.90%	18.20%	
12	FRANKFURT	56,514,862	93.40%	6.55%		
13	MIAMI	53,903,761	60.40%	39.60%		
14	HOUSTON/GALVEST	51,099,721	83.30%	16.70%		
15	DENVER	49,354,425	95.90%	4.11%		
16	BEIJING	48,654,770	100.00%			
17	AMSTERDAM	48,347,191	95.30%	2.37%	2.35%	
18	LAS VEGAS	46,938,137	98.40%	1.51%	0.08%	
19	SHANGHAI	46,126,079	58.10%	41.90%		
20	MADRID	45,527,236	99.90%	0.06%	0.00%	
21	BANGKOK	42,803,709	100.00%	0.01%		
22	SEOUL	42,127,246	67.30%	32.70%		
23	PHOENIX	41,442,594	100.00%	0.01%		
24	MILAN	36,704,599	59.30%	26.40%	14.30%	
25	SINGAPORE	36,341,469	96.40%	3.60%		
26	ORLANDO	36,290,016	95.50%	4.55%		
27	DETROIT	35,972,673	100.00%			
28	MINNEAPOLIS/ST.	35,612,133	100.00%			
29	ROME	35,002,041	86.00%	14.00%		
30	BARCELONA	34,970,683	85.80%	10.30%	3.94%	
31	OSAKA	33,649,869	50.70%	49.30%		
32	MOSCOW	33,265,248	46.20%	38.40%	15.40%	
33	PHILADELPHIA	31,768,272	100.00%			
34	BOSTON	31,689,135	87.50%	12.30%	0.21%	
35	TORONTO	31,518,827	98.30%	1.67%	0.06%	
36	JAKARTA	30,812,445	99.30%	0.74%		
37	MUENICH	30,757,978	100.00%			
38	MANCHESTER UK	30,543,000	74.60%	16.30%	9.15%	
39	SYDNEY	30,375,799	100.00%			
40	SEATTLE	29,979,097	100.00%			

Table 7. The Distribution of Air Passenger Traffic Among Airports in Major Flying Regions, 2006

Regional passenger rank	Metropolitan Region	Metropolitan passengers	Airport 1	Airport 2	Airport 3	Airport 4
41	CHARLOTTE	29,693,949	100.00%			
42	DUBAI	28,788,726	100.00%			
43	SAO PAULO	27,928,424	66.40%	33.00%	0.61%	
44	RHINE-RHUR VALL	26,495,409	62.60%	37.40%		
45	GUANGZHOU	26,222,037	100.00%			
46	ISTANBUL	26,178,332	88.90%	11.10%		
47	MEXICO CITY	24,727,296	100.00%			
48	KUALA LUMPUR	24,213,250	99.70%	0.34%		
49	TAIPEI	22,857,445	100.00%			
50	COPENHAGEN	22,737,731	91.50%	8.52%		
			75.88%	18.93%	8.92%	4.77%

Source: ACI 2006 data

Table 8. Airport Costs and Revenues — Illustrative Cases

	Base case	New airport Case 1	New airport Case 2	New airport Case 3	New airport Case 4	Old airport Case 1	Old airport Case 2	Old airport Case 3
	Stylized average airport; based on a sample of large U.S. airports	New airport operating at capacity without an efficiency advantage	New airport operating at capacity with an efficiency advantage	New airport operating below capacity with an efficiency advantage	New airport operating below capacity with an efficiency advantage but split traffic	Old airport operating at capacity without an operational disadvantage	Old airport operating below capacity due to split traffic without an operational disadvantage	Old airport operating below capacity due to split traffic with an operational disadvantage
Capital cost compared to average with respect to capacity	Average airport; average capital costs	New airport; 60% increased capital cost	New airport; 60% increased capital cost	New airport; 60% increased capital cost	New airport; 60% increased capital cost	Old airport; 75% capital cost decrease	Old airport; 75% capital cost decrease	Old airport; 75% capital cost decrease
Operating cost compared to average per WLU	Average operating efficiency	Average operating efficiency	10% operating efficiency advantage	10% operating efficiency advantage	10% operating efficiency advantage	Average operating efficiency	Average operating efficiency	10% operating efficiency disadvantage
Aeronautical revenue compared to average per WLU	Average aeronautical revenue	Average aeronautical revenue	Average aeronautical revenue	Average aeronautical revenue	Average aeronautical revenue	Average aeronautical revenue	Average aeronautical revenue	10% aeronautical revenue discount
Non-aeronautical revenue compared to average per passenger	Average non-aeronautical revenue	Average non-aeronautical revenue	Average non-aeronautical revenue	Average non-aeronautical revenue	Average non-aeronautical revenue	Average non-aeronautical revenue	Average non-aeronautical revenue	20% non-aeronautical revenue disadvantage
Volume compared to capacity	Full capacity	Full capacity	Full capacity	All regional traffic; built for anticpated future demand; half capacity	Traffic split evenly with an older regional airport; quarter capacity	All regional traffic; full capacity	Traffic split evenly with a new regional airport; half capacity	Traffic split evenly with a new regional airport; half capacity
Design capacity	5,000,000	10,000,000	10,000,000	10,000,000	10,000,000	5,000,000	5,000,000	5,000,000
Passengers	5,000,000	10,000,000	10,000,000	5,000,000	2,500,000	5,000,000	2,500,000	2,500,000
Cost								
Capital cost								
per WLU capacity	$2.31	$3.70	$3.70	$3.70	$3.70	$0.58	$0.58	$0.58
Total	$11,550,000	$36,960,000	$36,960,000	$36,960,000	$36,960,000	$2,887,500	$2,887,500	$2,887,500
Operating cost								
per WLU	$5.38	$5.28	$4.75	$4.84	$4.89	$5.38	$5.43	$5.97
Total	$26,900,000	$52,800,000	$47,520,000	$24,210,000	$12,217,500	$26,900,000	$13,575,000	$14,932,500
Total cost	$38,450,000	$89,760,000	$84,480,000	$61,170,000	$49,177,500	$29,787,500	$16,462,500	$17,820,000
Revenue								
Aeronautical								
per WLU	$3.78	$3.81	$3.81	$3.78	$3.76	$3.78	$3.76	$3.38
Total	$18,875,000	$38,100,000	$38,100,000	$18,875,000	$9,393,750	$18,875,000	$9,393,750	$8,454,375
Non-Aeronautical								
per passenger	$4.89	$4.74	$4.74	$4.89	$4.97	$4.89	$4.97	$3.97
Total	$24,450,000	$47,400,000	$47,400,000	$24,450,000	$12,412,500	$24,450,000	$12,412,500	$9,930,000
Total revenue	$43,325,000	$85,500,000	$85,500,000	$43,325,000	$21,806,250	$43,325,000	$21,806,250	$18,384,375
Net annual revenue	$4,875,000	-$4,260,000	$1,020,000	-$17,845,000	-$27,371,250	$13,537,500	$5,343,750	$564,375