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Evaluating airport and seaport privatization: a synthesis of the effects of the forms of ownership on performance

[Avaliação de privatizações de aeroportos e portos:
uma síntese dos efeitos dos tipos de propriedades no desempenho]

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Abstract

Assessing the effects of ownership structure on efficiency has received considerable attention in the aviation management literature. Commercialization has been widely employed both in developing and developed countries as a means of increasing operational efficiency. Since airports and seaports are operationally similar, this paper examines the literature and methods used to assess the effects of privatization in both types of infrastructure. We observe that the impact of privatization on performance depends not only on the degree of privatization but on the competition in the market. Following a 4-level specification commonly employed in the seaport literature that captures degrees of privatization, we estimate a stochastic frontier model for airport efficiency as a function of ownership. We conclude that airport authorities in the United States are equally as efficient as fully privatized airports elsewhere, due to a high degree of competition and fiscal independence from the other governmental entities. Additionally, while privatization may be an effective mechanism of introducing corporatization into infrastructures that are characterized by poor competition and direct government control, the airport authority appears to achieve the benefits of privatization in operation without actual transfer of ownership.

Key words: airport; seaport; privatization; ownership; performance; stochastic frontier.

Resumo

A avaliação dos efeitos da estrutura de propriedade sobre a eficiência tem recebido considerável atenção na literatura de gestão do transporte aéreo. Concessões privadas têm sido amplamente utilizadas tanto em países desenvolvidos e em desenvolvimento, como meio de aumentar a eficiência operacional. Uma vez que os aeroportos e portos marítimos são operacionalmente similares, este trabalho examina a literatura e os métodos utilizados para avaliar os efeitos da privatização em ambos os tipos de infraestrutura. Observa-se que o impacto da privatização sobre o desempenho depende não só do grau da privatização, mas da competição no mercado. Usando uma especificação de 4-níveis comumente empregada na literatura de portos, e que controla os graus de privatização, estimamos um modelo de fronteira estocástica para a eficiência do aeroporto em função da propriedade. Concluímos que as autoridades aeroportuárias nos Estados Unidos são tão eficientes quanto os aeroportos totalmente privatizados em outros lugares, devido a um elevado grau de competição e independência fiscal de outras entidades governamentais. Além disso, embora a privatização possa ser um mecanismo eficaz de introduzir corporativização em infraestruturas que se caracterizam pela concorrência pobres e controle direto do governo, a autoridade aeroportuária parece alcançar os benefícios da privatização em operação sem a transferência real de propriedade.

Palavras-Chave: aeroportos; portos; privatização; propriedade; desempenho; fronteira estocástica.

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1. Introduction

Privatization of state owned enterprises (SOE), especially in the field of transportation, has been popular trend in Europe, Asia, Australia, Africa and Latin America. The trend was initiated in the United Kingdom by the Thatcher Administration with the Transport Act of 1981. The Act established the framework for privatizing British ports by creating a holding company (Associated British Ports or ABP) for 19 ports and offering 49% of the company for sale to investors (Bassett, 1993.) This set the stage for the privatization of other major SOEs, including airlines, roads, telecommunication, railways and airports.

Following in the footsteps of seaport privatization, airport privatization was also initiated in Britain by the Thatcher administration with the sale of 7 commercial airports to the public via the British Airport Authority (BAA)[1]. Since that time, privatization of general transportation infrastructure has been increasing across the globe, particularly in emerging economies like Asia and Latin America. About eighty eight of the world's top 100 seaports have already been privatized (Juhel, 2001), and in the period 2000-2008, a further 74 ports were privatized . In contrast, the privatization of airports has lagged far behind port privatization (Graham, 2008). Only 14% of the 91 busiest airports in the world have majority private ownership, with 24% having some form of private ownership, and 51% with some form of corporatization (ATRS Airport Benchmarking Report 2009)[2] . There are multiple reasons that could account for this uneven pace of privatization, including the historical strategic importance of airports to governments, the monopoly role played by airports in a traditional hub-and-spoke network, and the relatively higher infrastructure expenditure typically required in airports. There have been several papers that have examined airport performance in terms of efficiency, consumer surplus, quality of service and safety – Parker (1999); Oum, Adler and Yu (2005); Vasigh and Haririan (2003); Oum, Yan and Yu (2008). There have been similar efforts examining port privatization:

[1] They include: London Heathrow, Gatwick, Stanstead, Southhampton and three major Scottish airports.

[2] Air Transport Research Society (ATRS).

Culliane, Song and Gray (2002); Tongzon and Heng (2005); Cheon, Dowall and Song (2009); Gonzalez and Trujillo (2008); Hung, Lu and Wang (2010) among others. However, there have been far fewer papers that have specifically considered airport ownership as a major factor in their analyses.

Studies conducted on airports have shown different results as to whether privatization increased efficiency, productivity and/or consumer welfare. The results show, that a mixture of private and public ownership, with strong intra-port competition, leads to the best results. The presence of strong regional effects, the relatively short history of privatization, the necessity for regulation given natural monopoly tendencies, and the impact of external factors such as economic downturns, the 2009 H1N1 flu pandemic, and the financial crisis of 2007, have significantly complicated the analysis. Further complications are added by the long-term nature of capital investments. For example, construction of a new runway may take several years, and the presence of very high capital expenditures during this period, complicate operational inefficiency.[3]

Studies on seaports have also found generally mixed results. Some analyses have found no relationship between privatization and increased efficiency (Liu, 1995; Nottebottom Coeck and van den Broeck, 2001; Coto-Millan, Banos-Pino and Rodriguez-Alvarez, 2000), while others report increasing efficiency with private involvement (Culliane, Song and Gray, 2002; Tongzon and Heng, 2005; and Estache, Gonzalez and Trujillo, 2002). However, one clear trend that does emerge in both airport and seaport studies of privatization is that the strength of the results in favor of privatization appear to depend on the parameterization of the ownership variable. Studies that used dichotomous variables (or even three-point scales) to distinguish between forms of privatization had much weaker results as compared to studies that used a more finely graduated scale incorporating 4-6 levels of privatization. Drawing from the literature on seaport privatization, this study defines a four-point scale for airport privatization, setting totally government owned enterprises at one extreme, and full private ownership at the other. Following Baird's (1995) classification of seaports, this paper adopts a similar scale. Our results support

[3] The construction of the 9,000 feet long Fifth Runway at Hartsfield-Jackson International Airport, cost about $1.25 and took about 5 years to complete.

previous airport privatization literature, finding that increased private involvement generally leads to increased efficiency, while American Airport Authorities are equally efficient to fully privatized airports and present an example of a state-owned enterprise that is managed with a high degree of corporatization.

2. Does privatization improve efficiency?

We strongly believe, analyzing the effects of ownership on airport and seaport operation is challenging due to the subjectivity of input and output variables used. The relatively short history of airport privatization, the long-term nature of capital investment, and the variations in government regulations in privatized institutions also complicate the evaluation. There are several methods to analyze the effects of airport and seaport productivity such as: total factor productivity (TFP), variable factor productivity (VFP), data envelopment analysis (DEA) and stochastic frontiers analysis (SFA). Gonzalez and Trujillo (2009) provide a comprehensive literature review of seaport benchmarking. However, the majority of these studies have focused on generic airport-seaport benchmarking and efficiency without explicitly considering the effects of airport-seaport ownership on efficiency. In the studies that have performed this comparison, the results have not been conclusive (Gonzalez and Trujillo, 2009). A number of studies claim a positive relationship between the degree of privatization and operational efficiency. Others find an inverted-U-shaped relationship with 100% private and 100% state owned-operated on each extreme and the optimal ownership form somewhere in between. Finally, other studies have found no relationship between ownership structure and performance.

3. Airport Privatization

Parker (1999) explicitly examines the impact of privatization on airport performance, using a DEA model.[4] The study examined the performance of 22 airports in the United Kingdom before and after the creation of BAA. The ownership is divided between full privatization and full public ownership, and DEA analysis is applied to assess Technical Efficiency of the airports. Technical efficiency is defined as an airport's success in producing maximum output from a given set of inputs.[5] Parker (1999) concludes that there were no clear differences in airport performance before and after privatization. A subsequent study by Vasigh and Haririan (2003) uses a similar dichotomous ownership indicator, and conducts a cross-sectional analysis of 7 airports the U.K., and 8 airports in the United States. They use a series of efficiency ratios (revenues cost ratio, revenue per passenger, passenger per runway, and cost per runway) to assess performance, and conclude that while the fully private airports experience a greater level of profitability, the cost per landing and cost per passenger are higher at private airports.[6] Therefore, while private airports may be efficient from an operational standpoint, they compare less well in terms of consumer surplus. Generally, in the absence of regulation, monopoly pricing would result in fees above the levels that would prevail in a competitive market and could also lead to super normal profits.

Subsequent studies that have incorporated a three-tier ownership system (100% public, mixed private-public, or 100% private) have found similarly results. Among these, are Oum, Yu and Fu (2003) and Lin and Hong (2006). Oum et al. (2003) analyze 50 airports in the Asian Pacific, European and North American regions using a three-tier ownership system. Outputs include the number of passengers, cargo movements and non-aeronautical revenue. The results show no significant difference between airport ownership categories. Lin and Hing (2006) use a sample of

[4] The DEA technique was formally developed by Charnes, Cooper and Rhodes (1978).

[5] Farrell M. (1957). The measurement of productive efficiency. Journal of the Royal Statistical Society Series A,120(3):253-90.

[6] Other variables used include number of passengers, number of aircraft operations, number of gates, runways, airport revenues and costs.

20 airports and a three level ownership structure (private, mixed private-public, and public) to analyze the effects of ownership on performance.[7] The methodology is based on DEA, with the number of passengers and the volume of cargo movements as output. The result show that private airports are no more efficient than mixed private-public or full publicly owned.

Oum, Adler and Yu (2005) was the first study to present empirical evidence in favor of privatization, through their analysis of 116 airports worldwide and the use of the six-tier ownership structure given in Table 1. Log-Linear regression with Variable Factor Productivity as a dependent variable was used, and the independent variables included country and continental dummy variables, non-aeronautical revenue, Output Scale (Economies of Scale), runway utilization, aircraft size, aircraft transport movement (ATM) per runway, and passenger per ATM.

Table 1 - Port Ownership Classification

Function	Regulator	Landowner	Operator
0/3	Public	Public	Public
1/3	Public	Public	Private
2/3	Public	Private	Private
3/3	Private	Private	Private

Source: Baird (1995)

The results show a private-majority ownership to be significantly more efficient than a government majority and a multi-government ownership. Private majority was more efficient than a public corporation or a government department, but the difference was not statistically significant. Furthermore, private majority airports were slightly less efficient than North American Airports, but the difference was also not statistically significant. Finally, the results show that a 100% publically owned and operated airport is more efficient than a government-majority owned airport. One of the drivers of this result was the increased non-aeronautical revenue in private majority airports, which implied that these airports earned the greater portion

[7] They include: ten airports from the United States, five airports from Europe, four airports from Asia and one from Australia.

of their revenues from non aviation-related activities. Airports across the world are becoming more dependent on non-aeronautical revenue sources, such as parking, restaurants, rental car facilities, advertising and retail, besides aeronautical revenue. Oum et al. (2005) conclude that privatization has a U-shaped return, where majority private ownership is more efficient than majority-government ownership, and statistically equivalent to 100% publically owned or North American Airport Authority operated airports. This U-shaped return may help explain the lack of evidence in favor of privatization in the earlier studies. A strong possibility is that the use of a two or three-tier ownership structure in the study will fail to adequately capture the effects of degrees of privatization, operation and ownership on performance.

Table 2 - Airport Ownership Classification

Ownership	Definition
North American Airport Authorities	Government ownership but contracted out to an airport authority under a long term tease
Public corporation	100% government corporation ownership/operation
Government majority	Mixed government–private ownership with government owning a majority share
Private-majority	Mixed private–government ownership with private sector owning a majority share;
Multi-government.	Multi-level governments form an authority to own/operate airports in the region
US Government Department	Government Agency or Department Operating an airport

Source: Oum, Adler and Yu (2006)

Another study by Oum, Yan and Yu (2008) investigates 109 airports for the effects of ownership on efficiency. Outputs include the number of passengers, the number of aircraft movements and non-aeronautical revenue. They use Bayesian inference to estimate the stochastic cost frontier, and include a series of inputs such as number of employees, non-variable labor costs, number of runways, terminal size, international passengers, cargo movements, and regional characteristics. One of the differences in input variables is the inclusion of a seventh ownership category, the U.S. Port Authority which jointly runs airports and seaports. Their findings are consistent with their previous paper in that private majority airport are generally more efficient than government majority, government departments and multi-government entities. The result also finds that U.S.

Port Authorities are the most inefficient form of airport governance, and that Airport Authorities are equivalently efficient as public corporations and private majority airports. In addition, the result indicates a significant increase in the probability that a private airport will be efficient if there is competition in the airport region; i.e., airlines and customers have other alternative airports to choose from in a feasible traveling radius.

4. Seaport privatization

A conceptual approach to privatization and seaport ownership classification may be found in Baird (1995). The author examines trends toward privatization in the world's top 100 ranked container ports, and finds that while privatization was a growing trend at the majority of these ports, the degree of public sector influence remains high. One of the contributions of Baird (2005) to subsequent study was the establishment of a four-point scale classifying seaport ownership. Table 1 outlines this classification, which was subsequently employed extensively in the literature analyzing the efficiency of seaports.

Since privatization is often partial, with ownership, operation and regulatory functions falling to either public or private control, most studies analyzing the effects of privatization set up a multi-tier categorical system. Ownership, operation and regulatory functions are separated, and four measures of privatization are identified. This scale is treated as an interval measurement, to better capture linear and nonlinear effects of privatization on seaport productivity.

Liu (1995) provides an empirical analysis for 28 seaports in Britain, using a stochastic productivity frontier model on 10 years of panel data. The author dichotomizes privatization into a three-level variable (*Private, Trust and Municipal*) and uses annual port revenues as an output variable, with labor and capital as inputs. Additionally, port location, hinterland area, capital intensity and size are used as influences on efficiency. The result finds no systematic relationship between privatization and operational efficiency in Britain. Culliane, Ping, and Wang (2005) utilize the 4-level seaport classification system introduced by Baird (1995), and analyze a sample of 30 seaports throughout the world. The DEA methodology is used to measure input-output efficiency and to investigate the hypothesis of a positive relationship between the degree of

privatization and efficiency. The inputs used in the model are: terminal length, terminal area, quayside gantry, yard gantry and straddle carriers. The results show no systematic correlation between the degree of private involvement in port ownership and port efficiency. However, it must be noted that the results show a distinct inverse U-shaped relationship between the two variables, where purely private, public majority and purely public ports function less efficiently than private majority ports. Moreover, fully public ports are more efficient than public majority ports.

Therefore, it could be argued that the relationship between privatization and port efficiency is nonlinear, and that the optimal form is majority private ownership with government regulatory power. Nevertheless, it must be recognized that the small sample size associated with majority-private ports may render this result tenuous. The much larger sample sizes associated with public and majority-public ports make a comparison between those two ownership forms groups more suitable. Consequently, the authors conclude that privatization has no effect on efficiency, since 100 percent public seaports are more efficient than majority-public seaports.

Coto-Millan and Rodrıguez-Alvarez (2000), conduct a stochastic frontier analysis with a sample of 27 seaports in Spain, using a dichotomous privatization variable over 4 years (1985-1989.) The results show that increased privatization has no effect on seaport efficiency. In fact, the results show that port privatization has a negative impact on efficiency for Spanish seaports, with more centralized ports found to be more efficient than ports with greater autonomy of management.

Applying the Baird (1995) four-level privatization variable, Culliane, Gray and Song (2002) conduct a stochastic production frontier analysis for a sample of 15 container ports in Asia to analyze annual container throughput. The results show a positive relationship between privatization and port operating efficiency among container ports. Similarly, a translog and Cobb-Douglas stochastic frontier model with a dichotomized privatization variable, used by Estache and Gonzalez (2002), supports a positive relationship between privatization and port operating

efficiency[8]. In this model a sample of 11 seaports in Mexico is selected to assess the impact of port reform, and it found a positive relationship between privatization and port productivity.

Tongzon and Heng (2005) use a stochastic production function with the same four-level seaport classification. The results show an inverted U-shaped return to privatization, with entirely private or entirely public owned seaports faring poorly in comparison to a majority-private ownership with public involvement.

Cheong, Dowall and Song (2010, In Press) conduct an analysis using a 6-level nominal privatization scale, which closely mirrors the privatization categories used by Oum et al. (2005). Their classification is presented below in Table 3.

Table 3 - Seaport Privatization Categories

Category	Definition
Public Operating Port	Service Ports and Tool Ports: Main objective of Port authority is to be involved in terminal operations or cargo handling.
Mixed Ownership Port	Port Authorities act as landlords. Part of container terminals is leased out. Port Authority still actively involved in terminal operations
Public Landlord Port	Port Authorities act as landlords and are not directly involved in terminal operations.
Non-government port	Private or Quasi-Public Port Authorities are legally and institutionally separate from governments.

Source: Cheong, Dowall and Song (2010); Cheong (2007)

Cheong et al. (2010) find a positive effect of privatization on productivity and efficiency. They used a Malmquist productivity index (a disaggregated ratio of TFP growth) using 1991 and 2004 as their two reference years. The sample consists of 94 seaports, 39 of which had undergone a

[8] The Cobb-Douglas production function has been used frequently in the research on production economics.

change of ownership from 1991-2004, and 55 of which had retained their original ownership structure. The finding indicates the seaports that had undergone a change in ownership structure exhibited a higher gain in efficiency to the control group.

Synthesis

The consensus of literature regarding seaports appears to be the majority private ownership is more efficient than majority-public ownership, but also that public corporations and Airport Authorities are equivalently efficient. In contrast, the consensus in airport privatization analysis seems to be ambiguous – empirical studies have not shown overwhelming evidence to support privatization. Some of this ambiguity can be explained by structural factors which will weaken all empirical analyses; these factors include the following:

Short history of airport privatization: The majority of airports have been privatized in the last fifteen years (ATRS 2009.) Given that capital investment in airports, and capacity expansions take considerable time (the average construction and approval time for new runways averaging 5-7 years), benefits to privatization might not yet be apparent.

Government Regulation: Most airports, even after privatization, are regarded as strategic national assets. Further, airports constitute geographic monopolies, since in a given airport region air traffic has few alternatives. Therefore, they are subject to the same levels of regulation as public utilities. This could restrict their ability to realize gains from privatization.[9]

[9] Several regulatory agencies in UK, such as the Competition Commission, the Civil Aviation Authority (CAA), and the Department for Transport, are responsible for regulating some aspect of BAA's business practices.

Degree of privatization: Some government-owned airports operate in an extremely privatized environment, especially in the United States. U.S. Airport authorities are technically public corporations created by the state, but they engage in active revenue enhancement through concessions and non-aeronautical revenue. They have access to financial markets to fund expansion, airside services are often provided by private FBOs, and the airport is operationally self-sufficient at a state and local level (although federal funding is still utilized for large projects). In contrast, other government-owned airports are also largely government-operated, with little to no private involvement. The benefits of privatization depend on the extent of prior privatization. In an already-efficient enterprise, merely changing ownership structures from public to private hands will likely cause little change in operations.

Relatively few privatized airports. 88% out of the top 100 ranked seaports have some degree of private influence, while only 24% of the top 91 airports have any degree of private influence. This may bias the results of any studies conducted on airports.

However, there might also be an analytical explanation that accounts for the ambiguous findings regarding the benefits of privatization. For both airports and seaports, studies that find no evidence of privatization tend to use a smaller average sample size, and utilize fewer levels to distinguish degrees of private ownership. In other words, studies that use larger sample sizes, span more regions and use a finer scale for measuring privatization tend to report positive effects of privatization on efficiency.

Table 4 summarizes the studies on airport and seaport privatization. The table provides the average survey size, and the average number of levels used to distinguish privatization.

Table 4 - Summary of Airport and Seaport Literature

Author and Title	Type	Sample Size	Sample Region	Methodology / Model	Privatization Scale Levels	Finding (a)
Craig, Airola, & Tipu (2005): The Effect of Institutional form on Airport Governance Efficiency	Airport	100	United States	Techical Efficiency Cost Frontier	2	0
Vasigh and Haririan (2003): An Empirical Investigation of Financial and Operational Efficiency of Private vs. Public Airports	Airport	15	United States and U.K.	Linear Regression, TFP, DEA	2	0
Lin & Hong (2006): Operational performance evaluation of international major airports: An application of data envelopment analysis	Airport	20	World	Stochastic Cost Frontier	3	0
Oum, Yu & Fu (2003): A comparative analysis of productivity performance of the world's major airports: summary report of the ATRS global airport benchmarking research report—2002	Airport	50	World	TFP	3	0
Average: No evidence of Privatization Benefits	**Airport**	**46.25**			**2.5**	
Oum, Adler & Yu (2005): Privatization, corporatization, ownership forms and their effects on the performance of the world's major airports	Airport	116	World	VFP	6	1
Oum, Yan & Yu (2008): Ownership forms matter for airport efficiency: A stochastic frontier investigation of worldwide airports	Airport	109	World	Stochastic Cost Frontier, estimated by Bayesian Inference	7	1
Average: Positive Privatization Benefits	**Airport**	**112.5**			**6.5**	
Parker (1999): The performance of BAA before and after privatization. Journal of Transport Economics and Policy	Seaport	22	U.K.	DEA	2	0
Culliane, Ping, & Wang (2005): The relationship between privatization and DEA estimates of efficiency in the container port industry	Seaport	30	World	DEA Panel Data	4	0
Liu (1995): The comparative performance of public and private enterprises: the case of British ports	Seaport	28	Britain	Stochastic Frontier Model, Panel Data	3	0
Coto-Millan, Banos-Pino & Rodrıguez-Alvarez (2000): Economic efficiency in Spanish ports: some empirical evidence	Seaport	27	Spain	Stochastic Frontier Model, Panel Data	2	0
Average: No evidence of Privatization Benefits	**Seaport**	**26.75**			**2.75**	
Tongzon, J & Heng (2005): Port privatization, efficiency and competitiveness: Some empirical evidence from container ports	Seaport	25	World	Stochastic Frontier Model, Linear Regression, TFP	4	1
Cheon, Dowall, & Song (2010) Evaluating impacts of institutional reforms on port efficiency changes: Ownership, corporate structure, and total factor productivity changes of world container ports	Seaport	98	World	Malmquist TFP	6	1
Estache & Gonzalez (2002): Efficiency Gains from Port Reform and the Potential for Yardstick Competition: Lessons from Mexico	Seaport	11	Mexico	Cobb-Douglas and Translog Production Function	2	1
Culliane, Song, & Gray (2002): A stochastic frontier model of the efficiency of major container terminals in Asia: assessing the influence of administrative and ownership structures	Seaport	15	Asia	Stochastic Frontier Model, Panel Data	4	1
Average: Positive Privatization Benefits	**Seaport**	**37.25**			**4**	
(a) Finding: 1 = Gains from privatization, 0 = No Gains						

5. Empirical methodology

Airports and seaports are operationally and functionally similar. They have the same purpose; that is, an aggregation point for transportation, and they have relatively similar inputs and outputs. Output variables are comparable and include: passengers, operating revenues, cargo shipments, and revenues for both airports and seaports.[10] Input variables in terms of physical infrastructure are similar as well – quays, gates and gantry infrastructure for seaports, and runways, gates and terminal areas for airports. Both airports and seaports use labor as an input, and their efficiency is measured in the literature in similar ways. Thus, techniques that have been used to analyze seaports can be reapplied to airports to enhance the understanding of the outcomes and effects of privatization. As mentioned, an analysis of the literature indicates that the larger the sample size and the more finely graduated the scale of privatization, the more likely the study is to pick up the effects of privatization on efficiency.

Further, since the literature on seaports also indicates the presence of a U-shaped curve for privatization (Tongzon & Heng, 2005, Culliane, Ping, & Wang, 2005), developing and implementing an interval scale measurement for privatization will likely contribute to the literature analyzing the outcomes of airport privatization. Thus far, papers analyzing airport privatization have made use of nominal (or at best, ordinal) measurement scales to measure the effects of privatization. We propose an interval scale that uses the scale built on thirds from Baird (1995), and integrates the observations on airport ownership made by Oum et al. (2005). Table 5 provides the categories and the definitions.

[10] Note that cargo typically forms a small part of an airport's total operations, and passengers form a small part of a seaport's operations. They are therefore not analyzed in this study.

Table 5 - Airport Classification Categories

Category	Definition
Fully State Owned (100%)	National/State/Local government department ownership and operation. Funded by Government at any level (i.e., Federal Airport Funds). Non Corporate structure.
Fully Public Corporations (100%)	Government owned, but corporatized structure. Independent of government in operation. Financially Self Sufficient without reliance on government funding.
Public Corporation: Majority government (Some Private Involvement)	Partially privatized airport with private sector minority ownership
Private corporation/Private Majority Ownership	Private Company Owned, or Minority Government Stake.

Source: Compiled by Authors from Baird (1995), Oum et al. (2005).

Hundred percent State Owned refers to any airport owned and operated by any local, state, national or federal governments. The key definitions of this category are (a) Funding and (b) Non-Corporatized Structure. This immediately brings up the issue of U.S. Airport Authorities, which would fit into this category but are unique in their relationship to the local government. We categorized these airports as 100% state-owned, but control for airport authority effects with an indicator variable. This decision was made because of the fact that while Airport Authorities are created by the government as separate entities, they are still tightly linked to the local government. These airports are also eligible for federal funding, even if they are financially self-sufficient. Further, there are airports in the United States (Minneapolis St. Paul, for instance) that are not structured as airport authorities but exhibit a greater degree of government control[11]. Therefore, we classified them as 100% State Owned.

Hundred percent public corporations are extra-governmental bodies owned by the government, but entirely fiscally and operationally independent. Public Majority and Private Majority airports are determined by the shares held by the private sector.

[11] The Minneapolis-Saint Paul Metropolitan Airports Commission (MAC) is the owner and operator of Minneapolis-Saint Paul International Airport (MSP). The MAC is a governmental agency of the State of Minnesota.

To test our hypotheses about the relationship between ownership and performance, we chose to follow the seaport privatization assessment specification used by Tongzon & Heng (2005). They use a stochastic frontier translog model, proposed by Battese and Coelli (1995). The basic functional form is:

$$Y_{it} = e^{(x_{jt}\beta + V_{it} - U_{it})}$$

Where:

Y_{it} is a $[N \times 1]$ vector of output quantities,

s.t.= $(y_{1t} \dots y_{Nt}) \in R^{+}$

x_{it} is a $[N \times M]$ matrix of input quantities,

s.t. $x_{jt} \in R^{+}$for ∀i,j

β is a $[M \times 1]$ vector of unknown parameters

s.t. $\beta \in R^{+}$

V_{it} are random errors, i.i.d $N(0, \sigma_v^2)$ for ∀i,j

i= outputsj= inputs

t= time

U_{it} = *are* non-negative random variable representing technical inefficiency in production (output falls short of its potential output for the given technology)[12].

$$U_{it} = z_{it}\theta + \varepsilon_{it}$$

[12] $U_{it} \geq 0$ is technical inefficiency.

Where:

z_{it} is a $[N \times P]$ vector that captures technical inefficiency.

θ is a $[P \times 1]$ vector of coefficients (parameter)

ε_{it} is a systematic error, defined by the truncation of the normal distribution with mean 0 and variance σ_u^2, with $-z_{it}\theta$ being the point of truncation.

Therefore, U_{it} are random variables from a non-negative truncation of $N(z_{it}\theta, \sigma_v^2)$. (Tongzon and Heng, 2005). The stochastic frontier models have been extensively evaluated by Atkinson, Primont (2002); and Battese, Coelli (1995).

By implementing this model with pure cross-sectional data, we can bypass problems regarding the serial correlation between the error terms V_{it} that arise from panel data sources. Cross section data are more useful in order to verify different functional relationships which are supposed to be invariant over time. This production function is estimated using the Method of Maximum Likelihood, and the technical inefficiency of the production can be expressed as follows:

$$TE_i = \frac{y_i}{\exp(x_j\beta + V_i)}$$

$$TE_i = \frac{e^{x_j\beta + V_i - U_i}}{e^{x_j\beta + V_i}}$$

$$TE_i = e^{-U_i}$$

$$TE_i = e^{-z_i\theta - \varepsilon_i}$$

Therefore, the technical inefficiency of output when compared to inputs can be estimated by the conditional expectation of the error distribution. In other words, the error term explains the contribution of each Z_{it} to the technical efficiency.

Statistical data

Based on the ownership classification defined above, we selected and coded 91 commercial airports throughout the world. Appendix 1 lists these airports and their classification. The data was compiled from the ATRS Annual Airport benchmarking Report 2009. Details on ownership and management are provided in Part III of the report, and we combined and cross-referenced the information therein with data from the Airport Council International (ACI), International Civil Aviation Organization (ICAO) and individual airport websites to code the airports according to the previously defined scheme. These classifications are treated like an interval scale, as previously described.

The outputs included in the model are: Passenger throughput, aircraft movements and total operating revenue. The inputs are: terminal area, number of employees, soft cost index, number of runways, and number of gates.

In this study, the infrastructure utilization is measured by the number of runways rather than runway space. We did not include runway area, since all of the airports in our sample (91) are major airports with passenger throughput of two million or more per year. These airports have more than 10,000 feet for their runways, and these are capable of handling large aircraft.

Soft cost index is defined as an index of non-labor, non-capital costs that form the remainder of airport operating costs. Categories included are airport supplies, transportation vehicle depreciation, concession administration costs, and so forth. This is an important input, since labor and capital inputs form only part of an airport's operating costs. Inclusion of the soft cost input allows the investigators directly to take into account of the effects of airports' strategy and management on productivity. This index is compiled by the ATRS Benchmarking Report for the 91 airports in our sample. Note that the ATRS Report benchmarks soft costs in each region against a reference airport. In North America, the Soft Cost Index is benchmarked against Vancouver International Airport (YVR), in Europe it is benchmarked against Copenhagen Kastrup Airport (CPH), and in the Asia-Pacific it is benchmarked against Hong Kong Airport (HKG). We control for this benchmarking by including indicator variables for each airport in our frontier estimation.

Due to the almost monopolistic position enjoyed by most commercial airports a question of allocative efficiency versus technical efficiency arises. Allocative efficiency occurs when an airport chooses a mix of the revenue maximizing outputs. Technical efficiency is concerned with the combination of inputs to produce the greatest output.

We analyzed the technical efficiency of the airports by applying the stochastic frontier model. The pioneering work in this framework is Aigner; Lovell and Schmidt (1977); Meeusen and van den Broek (1977). The model is expressed in a translog form as follows:

$$\ln(Y_{j.i}) = \alpha + \sum_{j=1}^{6} \beta_j \ln(S_{m,i}) + \omega \ln(L_i) + \lambda \ln(C_i) + \sum_{k=1}^{6} \lambda_j I_{k,i} + V_i - U_i$$

Where U_i effects are defined by:

$$U_i = \gamma_0 + \gamma_1 Z_{1i} + \gamma_2 Z_{1i}^2 + \epsilon_i$$

i = Airports (total of 91 airports)

$Y_{j,i}$= Output j for airport i.

j =1: passengers

j=2: aircraft movements

j=3: revenues per passenger

α = Constant

$S_{m,i}$ = Capital inputs for a given airport i:

m = 1: Terminal area (m^2)

m = 2: Number of runways at the given airport i

m = 3: Number of gates at the given airport i

L_i = Number of employees at airport *i*

ω= Parameter or the coefficient for labor input

C_i = Soft cost index for airport *i*

λ Parameter for soft cost index

φ_j = Parameters for indicator variables

$I_{k,i}$= Indicator *k* for airport *i*

k=Number of indicators

1= Europe

2= Asia-Pacific

3= Vancouver Airport Authority (YVR)

4= Copenhagen Kastrup International Airport (CPH)

5= Hong Kong International Airport (HKG)

6= Indicator variable for passenger throughput over 25 million. Indicates a large airport, which may influence efficiency

V_i = Error term (defined in the previous section)

Z_{1i} = Ownership variable (defined in the previous section)

ϵ_i = Error, i.i.d $N(0, \sigma_u^2)$

The coefficients of the technical efficiency provide evidence of the effect of ownership on airport performance. Once the regression model has been estimated, we can calculate technical efficiency (TE) as follows:

$$TE_i = E(U_i)$$

Where:

U_i=Residual from stochastic frontier mode. This score is a measure of relative efficiency, and the higher the score, the more efficient are the airports.

Empirical analysis, results and discussion

The results of the three regressions are presented in Table 6. The results indicate terminal area and the soft cost index are significant predictors. These imply that larger airports which have a higher soft cost tend to be the more efficient and, in other words, indicate the existence of significant economies of scale in airport efficiency. The airport size indicator is also significant with the passengers output, further confirming the existence of economies of scale resulted from natural monopoly theory. That is why many privatized or privately operated airports are subject to various forms of regulation. Regulation may be the only tool available to policy maker to ensure a privatized airport achieves higher productivity and to meet the standard customer services. Airports face little competition could charge prices above the levels that would prevail in a competitive market. In the United State the competition among airports has helped to lower airport fees, improve productivity and efficiency of the airports. The indicator for North America was considered the base case, and several other indicators were included to control for the soft cost benchmarking and other regional effects. Airports in Asia are significantly lower in output as compared with airports in the United States, which could be accounted for by the pervasiveness of state-owned enterprises in Asia. Airports in Europe would appear to handle fewer passengers when compared to North America for a given level of productive inputs.

Results from the ownership residuals are shown in Table 7. There is significant evidence for a U-shaped privatization-efficiency effect, as indicated by the positive coefficient on the square of the private ownership index, but the negative coefficient on private ownership index. In other words, state-owned enterprises seem to be equally as efficient as highly privatized airports, but the airports with a mixture of ownership seem to be the least technically efficient. In other words, fully public and fully private airports operate the most efficiently but public and private combinations tend to not produce significant increases in efficiency. This is somewhat counterintuitive: until one considers that the category of state-owned airports is dominated by the United States. Consistent with findings by Vasigh and Haririan (1996), we find American airports, although state-owned, to be technically efficient on par with fully private enterprises. They operate in a highly competitive environment, with the majority of employees employed within the private sector businesses (concessionaires, parking, FBOs, Airport Hotels and so forth that are associated with the management of an airport). While American Airport Authorities are state owned, they are functionally privatized, and have high degrees of technical efficiency. The fully private airports, Zurich, Dusseldorf, London Heathrow and Brussels operate within a similarly competitive environment. Figure 1 gives the technical efficiency scores for the airports in our analysis.

Table 6 - Stochastic Frontier Regression Results

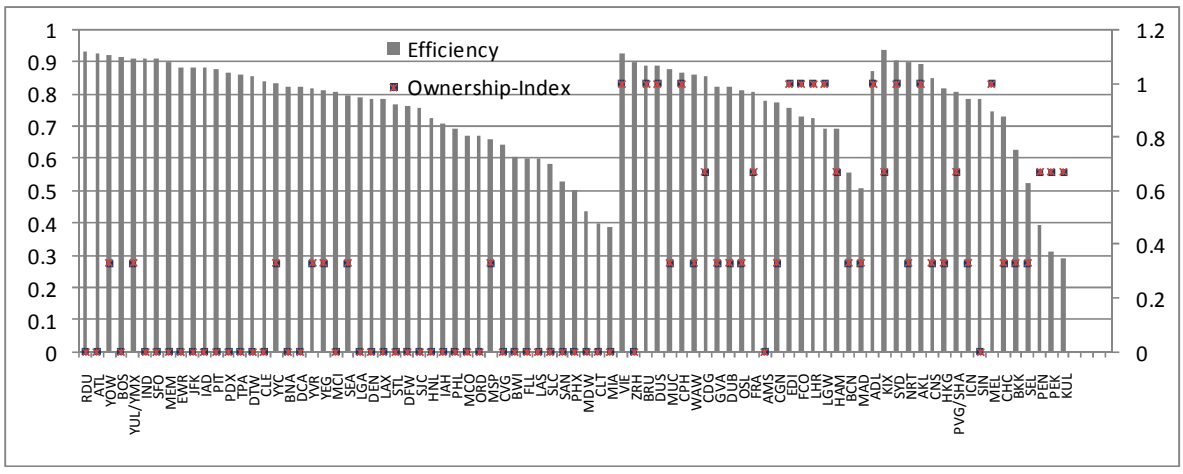
	Passengers	Aircraft Movements	Revenues
Terminal Area	0.150 (2.04)*	0.218 (2.97)**	0.077 (0.95)
Employees	0.044 (1.02)	0.014 (0.33)	0.087 (1.18)
Number of Runways	0.008 (0.013)	0.08 (0.77)	-0.162 (1.19)
Number of Gates	0.014 (0.21)	0.103 (1.61)	-0.205 (2.56)*
Soft Cost Index	0.308 (4.73)**	0.060 (0.93)	0.317 (4.01)**
Airport Size Indicator: >25,000	0.513 (5.32)**	0.322 (3.34)**	
Indicators			
Asia	0.344 (2.03)*	-0.49 (2.90)**	0.946 (5.08)**
Europe	-0.207 (1.53)*	-0.114 (0.84)	0.756 (5.13)**
YVR	0.18 (0.64)	0.30 (1.06)	0.276 (0.91)
CPH	0.49 (1.73)	0.18 (0.67)	0.327 (1.26)
HKG	0.18 (0.63)	0.18 (0.66)	-0.242 (0.77)
Constant	7.80 (0.05)	2.52 (0.01)	3.180 (3.27)**
Observations	87	87	86

Absolute value of z statistics in parentheses
* Significant at 5%
** Significant at 1%

Table 7 - Ownership Variable Coefficients

Dependent Variable	Aircraft Passengers	Movements	Revenues
	Coefficient		
Ownership Index	0.930	0.762	4.388
	(2.68)**	(2.20)*	(0.34)
Ownership Index Squared	-0.953	-0.771	-6.169
	(3.20)**	(2.59)**	(0.36)
Constant	0.239	0.214	3.083
	(0.00)	(0.00)	(0.30)

Figure 1 - Airport Technical Efficiency, by region and ownership index.



In North America, Raleigh-Durham (RDU) and Atlanta Hartsfield-Jackson International Airport (ATL) are ranked the best airports. The Raleigh-Durham Airport Authority is responsible for operation and maintenance of the airport. ATL is owned by the City of Atlanta and operated by its Department of Aviation. Among the European airports, Vienna International Airport (VIE)

and Zurich International Airport (ZRH)[13] are among the top performer. VIE is one of the publicly traded European airports in which the state holds only a minority interest. Note that three airports, Dubai International (DXB), Sofia (SOF) and Taipei Taiwan (TPE) are excluded from the efficiency score since they have missing variables that preclude estimation. Nearly all American airports, together with the highly privatized British and European airports have similar levels of technical efficiency. Note also that outside the United States, higher levels of technical efficiency are associated with lower degrees of privatization, except in a few cases such as the Amsterdam and Singapore Airports (both, government owned).[14] This indicates that the American airports are equally efficient as compared to private airports. Finally, we note that the effect grows weaker with aircraft movements as a dependent variable, and disappears entirely with revenues as a dependent variable. We believe this weakening of privatization's effect is caused by the lack of competition at the existing airports. Since over 50% of airports revenues in general are derived from aeronautical sources (ATRS 2009), we conclude that revenue does not reflect the effect of ownership on technical efficiency.

Conclusion

The results obtained in this paper indicate that ownership forms are less important than competitiveness and corporatization at the management level. In other words, ownership structures do not appear to influence airport efficiency to the same extent that management does. The same model, when implemented by Tongzon and Heng (2005) reveals an inverse U-shaped curve for privatization, with state-owned and completely privately owned seaports being systematically more inefficient than partially privatized seaports. We believe this is because the role of airport authorities in the United States is unique, and this ownership form does not exist

[13] Up to 28% of the equity capital of Unique Zurich Airport will be made available to the Swiss public and international investors in early 2011.

[14] However, this effect was not statistically significant when we ran a stochastic frontier regression with North America removed from the dataset. The model exhibited convergence difficulties, and OLS revealed no significant effect of ownership on output.

for seaports. State-owned seaports tend to behave like other state-owned infrastructure and exhibit systematic inefficiency. However, U.S. airport authorities behave more like private enterprises, with a great degree of competition, which exhibit systematic efficiency. We believe this is driven by two characteristics of airport regions in the United States The sheer number of different airports in a given airport region, and the fiscal independence of government-owned airport authorities. Due to the number commercial airports in the United States, airlines and passengers have a wide variety of feasible choices when making transportation decisions. Airport authorities are owned by local governments but are managed with the principle of fiscal independence from state government funds, which sets up profit maximizing (or at the very least, cost-covering) incentives very similar to private enterprises.

In Europe and Latin America, such competition between airports in an airport region is rare, and airports are owned as well as operated by local governments. Therefore, while private enterprises are observed to allocate resources more efficiently than state-owned enterprises, the regions which have pioneered airport privatization (Great Britain and Continental Europe) also had airports which were owned and operated by the government in non-corporatized forms in regions of low competition. While effects of privatization and the effects of increased corporatization are extremely difficult to separate, the high efficiency of U.S. Airport Authorities can be used to distinguish between the two. Airport authorities are state-owned but corporatized and operate in a competitive environment. They have efficiency scores close to or better than fully private airports.

The case of U.S. Airport Authorities makes an argument for efficient publicly-owned enterprises. One of the conclusions that can be drawn from this study is that while U.S. airports would not see enormous benefits to privatization, U.S. seaports, which are more centralized in their management, would see significant benefits through privatization. Fundamentally, these results suggest that ownership may be a less significant factor than management and competition in an airport/seaport region in determining efficiency. However, in the context of an industry without high degrees of corporatization or competition, privatization may be one method to introduce such factors into the system and thereby enhance efficiency.

References

Atkinson, S. and Primont, D. (2002). Stochastic estimation of firm technology, and productivity growth using shadow cost and distance function, *Journal of Econometrics*, 108, 203–225.

ATRS (2009). Air Transport Research Society (ATRS) Airport Benchmarking Report 2009.

Baird, A. (1997). Port privatization: an analytical framework. In: Proceedings of International Association of Maritime Economist Conference, City University, London, 22–24 September.

Bassett, K. (1993). British port privatization and its impact on the port of Bristol. *Journal of Transport Geography*, 1, (4) 255-267

Battese, E., Coelli, J. 1995. A model for technique inefficiency effects in a stochastic frontier production function for panel data. Empirical Economics 20, 325–332.

Cheon, S.-H., Dowall, D. E., Song, D. In press. Evaluating impacts of institutional reforms on port efficiency changes: ownership, corporate structure, and total factor productivity changes of world container ports. Transportation Research Part E: Logistics and Transportation Review.

Cullinane, K., and P., Wang, T. (2005). The relationship between privatization and DEA estimates of efficiency in the container port industry. Journal of Economics and Business 57 (5), 433–462.

Cullinane, K., Song, D.W., and Gray, R. (2002). A stochastic frontier model of the efficiency of major container terminals in Asia: assessing the influence of administrative and ownership structures, *Transportation Research Part A* 36 743–762

Estache, A. Gonzalez, M. and Trujillo, L. (2002). Efficiency gains from port reform and the potential for yardstick competition: Lessons from Mexico. *World Development*, 30 (4), 545-560

Graham, Anne (2008). Managing Airports: An International Perspective. Butterworth-Heinemann Ltd.

Gonzalez, M., Trujillo, L., in press. Efficiency measurement in the port industry: a survey of the empirical evidence, Journal of Transport Economics and Policy.

Hung, S-W., Lu, W. and T. Wang. (2010). Benchmarking the operating efficiency of Asia container ports. *European Journal of Operational Research, 203 (3), 706-713*

Juhel, M.H. (2001). Globalization Privatization and Restructuring of Ports. *International Journal of Maritime Economics*, 3(2), 128-138.

Lin, L.C., and Hong, C.H. (2006). Operational performance evaluation of international major airports: An application of data envelopment analysis, *Journal of Air Transport Management* 12 (6), 342–351

Liu, 1995 Z. Liu, The comparative performance of public and private enterprises: the case of British ports, *Journal of Transport Economics and Policy* 29 (3), 263–274.

Notteboom, T., Croeck, C., and C. van den Broeck, J. (2000). Measuring and explaining the relative efficiency of container terminals by means of Bayesian Stochastic Frontier Models, *International Journal of Maritime Economics* 2 83–106.

Oum, T. H., J. Yan and C. Yu (2008). "Ownership Forms Matter for Airport Efficiency: A Stochastic Frontier Investigation of Worldwide Airports", *Journal of Urban Economics*, 64.

Oum, T.H., Adler, N., and Yu, C. (2006). Privatization, corporatization, ownership forms and their effects on the performance of the world's major airports (2006) *Journal of Air Transport Management*, 12 (3) 109-121

Oum, T.H., Yu, C. and Fu, X. (2003). A comparative analysis of productivity performance of the world's major airports: summary report of the ATRS global airport benchmarking research report—2002 *Journal of Air Transport Management, 9 (5), 285-297*

P. Coto-Millan, J. Banos-Pino and A. Rodrıguez-Alvarez, Economic efficiency in Spanish ports: some empirical evidence, *Maritime Policy and Management* 27 (2) (2000) 169–174.

Parker, D. (1999), "The performance of BAA before and after privatization: a DEA study", *Journal of Transport Economics and Policy*, 33 (2), 133-46.

Tongzon, J. and Heng, W. (2005). Port privatization, efficiency and competitiveness: Some empirical evidence from container ports (terminals). *Transportation Research Part A: Policy and Practice*, 39(5), 405-424

Vasigh, B. and Haririan, M. (2003). Empirical investigation of financial and operating efficiency of private versus public *airports.* Journal of Air Transport, 8(1),(2003), 91-110.

Appendix: Airport Classification

Airport	Ownership	Airport	Ownership	Airport	Ownership
Atlanta William B Hartsfield International Airport	Government Owned	Pittsburgh International Airport	Government Owned	Manchester International Airport	100% Public Corporation
Nashville International Airport	Government Owned	Raleigh–Durham International Airport	Government Owned	Munich International Airport	100% Public Corporation
Boston Logan International Airport	Government Owned	San Diego International Airport	Government Owned	Milan Malpensa International Airport	Public Corporation/Majority Government
Baltimore Washington International Airport	Government Owned	Seattle–Tacoma International Airport	100% Public Corporation	Paris Orly Airport	Public Corporation/Majority Government
Cleveland–Hopkins International Airport	Government Owned	San Francisco International Airport	Government Owned	Oslo Airport	100% Public Corporation
Charlotte Douglas International Airport	Government Owned	Norman Y. Mineta San José International Airport	Government Owned	Prague International Airport	100% Public Corporation
Cincinnati/Northern Kentucky International Airport	Government Owned	Salt Lake City International Airport	Government Owned	Sofia Airport	Government Owned
Ronald Reagan Washington National Airport	Government Owned	St. Louis–Lambert International Airport	Government Owned	Vienna International Airport	Private Corporation/Majority Private
Denver-Stapleton International Airport	Government Owned	Tampa International	Government Owned	Warsaw Frederic Chopin Airport	100% Public Corporation
Dallas/Fort Worth International Airport	Government Owned	Edmonton International Airport	100% Public Corporation	Zurich International Airport	Private Corporation/Majority Private
Detroit Metropolitan Wayne County Airport	Government Owned	Ottawa International	100% Public Corporation	Adelaide International Airport	Private Corporation/Majority Private
Newark International Airport	Government Owned	Aéroports de Montréal	100% Public Corporation	Auckland International Airport	Private Corporation/Majority Private
Fort Lauderadale Hollywood International	Government Owned	Vancouver International Airport	100% Public Corporation	Bangkok International Airport	100% Public Corporation
Honolulu International Airport	Government Owned	Calgary International Airport	100% Public Corporation	Christchurch International Airport	100% Public Corporation
Washington Dulles International Airport	Government Owned	Amsterdam Schiphol International Airport	Government Owned	Cairns International Airport	100% Public Corporation
Houston–Bush Intercontinental Airport	Government Owned	Barcelona El Prat Airport	100% Public Corporation	Dubai International Airport	Government Owned
Indianapolis International Airport	Government Owned	Brussels International Airport	Private Corporation/Majority Private	Hong Kong Chek Lap Kok International Airport	100% Public Corporation
New York-John F. Kennedy International Airport	Government Owned	Paris Charles de Gaulle International Airport	Public Corporation/Majority Government	Incheon International Airport	100% Public Corporation
Las Vegas McCarran International Airport	Government Owned	Cologne/Bonn Konrad Adenauer International Airport	100% Public Corporation	Osaka Kansai International Airport	Public Corporation/Majority Government
Los Angeles International Airport	Government Owned	Copenhagen Kastrup International Airport	Private Corporation/Majority Private	Kuala Lumpur International Airport	100% Public Corporation
LaGuardia International Airport	Government Owned	Dublin International Airport	100% Public Corporation	Melbourne Tullamarine International Airport	Private Corporation/Majority Private
Kansas City International	Government Owned	Flughafen Dusseldorf International Airport	Private Corporation/Majority Private	Tokyo Narita International Airport	100% Public Corporation
Orlando International Airport	Government Owned	Edinburgh Airpor	Private Corporation/Majority Private	Beijing Capital International Airport	Public Corporation/Majority Government
Chicago Midway Airport	Government Owned	Rome Leonardo Da Vinci/Fiumicino Airport	Private Corporation/Majority Private	Penang International Airport	Public Corporation/Majority Government
Memphis International Airport	Government Owned	Frankfurt Main International Airport	Public Corporation/Majority Government	Shanghai Airport Authority	Public Corporation/Majority Government
Miami International Airport	Government Owned	Geneva Cointrin International Airport	100% Public Corporation	Seoul Gimpo International Airport	100% Public Corporation
Minneapolis/St. Paul International Airport	100% Public Corporation	Hamburg International Airport	Public Corporation/Majority Government	Singapore Changi International Airport	Government Owned
Chicago O'Hare International Airport	Government Owned	Helsinski Vantaa International Airport	Government Owned	Taiwan Taoyuan International Airport	Government Owned
Portland International Airport	Government Owned	London Gatwick International Airport	Private Corporation/Majority Private	Sydney Kingsford Smith International Airport	Private Corporation/Majority Private
Philadelphia International Airport	Government Owned	London Heathrow International Airport	Private Corporation/Majority Private		
Phoenix Sky Harbor International Airport	Government Owned	Madrid Barajas International Airport	100% Public Corporation		