OWNERSHIP FORMS AND THEIR EFFECTS ON AIRPORT PERFORMANCE*

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1. Introduction

This paper examines how various ownership forms and institutional structures affect the performance of airports in terms of their productive efficiency, operating profits and user charges. The general framework of this paper for measuring the efficiency and profitability effects of airport ownership form and governance structure is presented in Section 3. The data sources, sample airport characteristics and details on variable construction are given in Section 4. Section 5 presents empirical results and a discussion of the findings. Finally, Section 6 presents a summary, conclusions and further research needs.

2. Model Formulation

Airport ownership/governance models can be classified into: (a) government agency or department operating an airport directly; (b) mixed private-government ownership with a private majority; (c) mixed government-private ownership with a government majority ; (d) government ownership but contracted out to a management authority under a long term lease; (e) multi-level governments form an authority to own/operate one or more airports in the region; (e) 100% government corporation ownership/operation. Since most of the previous studies have used specific continental or country- specific airport data, rather than relying on the worldwide privatization experiences and have not attempted t distinguish economic performance among the six categories of airport ownership/governance categories, this paper introduces a new analysis to the existing empirical literature. Furthermore, among the limited studies that attempted to measure the difference between privatized airports (without distinguishing the extent of privatization) and the publicly owned/operated airports, there is no consensus in their findings. Finally, almost all of the studies used a partial measure of outputs (aircraft movements and/or passengers/cargo traffic only) ignoring non-aviation service outputs (including commercial services such as concessions) that all airports produce. Given that non-aviation outputs can account for as much as 70 % of total revenues an airport generates, the productivity measures ignoring the non-aviation service outputs would be seriously biased against airports that generate a high proportion of their total revenues from commercial services.

In order to test the hypotheses concerning varying degrees of privatization, other ownership forms and governance structures on the performance of airports, we propose the following framework of analysis. We will study productivity levels as a function of: a) Ownership and Governance Form ; b) Management Strategy Variables; c) Airport Characteristics and Business Environment; and d) Technical (residual) Efficiency.

A Variable Factor Productivity (VFP) measure will be developed to measure the level of productivity. VFP is simply the ratio of total aggregate output over aggregate variable input. Variable inputs include labor, purchased goods and materials and purchased services including outsourcing/contracting out. VFP is used as the airport performance indicator in this research for several reasons. First, it is nearly impossible to obtain consistent capital input measures comparable across airports due to the different ownership and governance structures. Second, there is no standardized accounting or reporting system across airports worldwide. Third, airport capacity expansion and other capital projects are often subsidized to varying degrees at various levels of government, which would distort the measurement of total factor productivity (TFP). On the other hand, data on variable input factors can be compiled with reasonable accuracy. In addition, long term investment decisions with regard which would distort the measurement of total factor productivity (TFP). On the other hand, data on variable input factors can be compiled with reasonable accuracy. In addition, long term investment decisions with regard decisions with regard to capacity expansion are generally beyond airport managerial control, even at private airports.

Ownership/Governance Variables: Each airport in our sample is classified into one of the following six ownership/governance types: (a) government agency or department operating an airport; (b) mixed private-government ownership with private sector owning a majority share; (c) mixed government-private ownership with government owning

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a majority share; (d) government ownership but contracted out to an airport authority under a long term lease; (e) multi-level governments form an authority to own/operate airports in the region; (f) 100% government corporation ownership/operation;

Table 1 provides a list of airports included in the sample and their ownership and governance structure. A closer examination of the airport authorities/administrations operating outside North America indicates that they operate in a manner similar to government corporations, rather different from the airport authorities in North America. Therefore, we reclassified the airport authorities/administrations in Asia and Europe into the group of government corporations.

Management Strategy variables describe an airport's management and operational strategies. Some airports focus on the traditional airport business, thus derive most of their revenue from aeronautical activities. Others have vigorously expanded into the commercial business sector. In this research, the share of non-aeronautical revenue out of total airport revenue is used as an indicator of the degree of airport business diversification.

Airport Characteristics affecting productivity performance include: a) airport size (scale of output); b) average size of aircraft using the airport; c) composition of airport traffic; and d) extent of capacity constraint.

Airport size is represented by an aggregate output index as constructed in the ATRS global airport benchmarking reports (2003, 2004 and 2005). Airport size can vary significantly only in the very long run, through managerial design and effort. Since managers cannot alter the airport size variable significantly in the medium and short run, we regard the effect of airport size as being beyond managerial control. Average aircraft size is measured by the average number of passengers per aircraft movement and is dependent on the length of the runway(s), geographical location of the airports (intercontinental gateway airports tend to handle larger aircraft) etc. The composition of airport traffic is measured by the percentage of international traffic and the percentage of cargo traffic, both of which depend largely on the geographic location of the airport. Capacity constraints exist both with respect to runway and terminal capacity and are imposed by regulatory, environmental and investment funding concerns. They are generally beyond managerial control, however runway and terminal capacity shortages affect productivity and quality of service to users of airport services, resulting in delays and inconvenience to airlines, passengers and shippers. Finally, service quality is another factor that may affect airport performance, a preliminary investigation by ATRS (2003) did not indicate any significant effect on the VFP, and thus was excluded from the present study.

3. Sample Airports and Variable Construction

(1) Sources of Data and Construction of Variables

The sample includes up to 116 airports as listed in Table 1. These airports represent different sizes and ownership and governance structures. The data is compiled from various sources including the International Civil Aviation Organization (ICAO), Airport Council International (ACI), the U.S. Federal Aviation Authority (FAA), International Air Transport Association (IATA), airport annual reports and direct communication with airports. Details on the data are provided in the ATRS Global Airport Benchmarking Report (2003, 2004, and 2005).

To measure the Variable Factor Productivity (VFP), one must first identify outputs that an airport produces and the inputs it uses in producing these outputs. The most commonly used output measures for airports are the number of passengers, the volume of air cargo, and the number of aircraft movements. Airports typically impose direct (separate) charges for their services related to aircraft movements and the handling of passengers. However, air cargo services are generally handled by airlines, third party cargo handling companies, and others that lease space and facilities from airports. Air cargo services are not considered as a separate output in this research, as airports derive a very small percentage of their income from direct services related to air cargo. In addition to passenger traffic, cargo traffic and aircraft movements, airports also derive revenues from concessions, car parking, and numerous other services. These services are not directly related to aeronautical activities in a traditional sense, but they are becoming increasingly more important for airports around the world and account for over 60% of the total revenues for many airports such as Brisbane, Tampa, Munich, etc. Thus, we consider a third output that consists of revenues from non- aeronautical services. A non-aeronautical output index is constructed by deflating the non- aeronautical revenues by Purchasing Power Parity (PPP). For most airports, aeronautical and non- aviation inputs are not separable, thus any productivity or efficiency measure computed without including the non-aviation service output would lead to severely biased results. Inclusion of the non-aeronautical services output not only removes such bias in productivity measurement, but also allows us to examine the efficiency implications of airport business diversification strategies. An overall output index is constructed by aggregating the three output measures (passengers, aircraft movement and non-aeronautical output) using the widely accepted translog multilateral index procedure developed by Caves, Christensen, and Diewert (1982).

On the input side, we initially considered three variable input categories: (1) labor, measured by the number of employees (full time equivalent) who work directly for an airport operator; (2) purchased goods and materials; and (3) purchased services including outsourcing/contracting out. In practice, however, few airports provide separate expense accounts for the purchased (outsourced) services and purchased goods and materials. Thus, we decided to combine (2) and (3) to form a so-called 'soft cost' input. The soft cost input includes all expenses not directly related to capital or

labor input costs. As the soft-cost input is measured in monetary terms, and airports operate in countries with very different price levels, purchasing power parity (PPP) is used as a deflator to derive a consistent soft cost input index.. Exclusion of the soft cost input would bias productivity comparisons significantly in favor of the airports that outsource much of their services such as passenger terminal operations, ground handling services, fire fighting, police and security services, etc. A variable input index is constructed by aggregating labor and soft cost input using the CCD index procedure.

Variable Factor Productivity (VFP) is defined as the ratio of the aggregate output index over the variable input index. VFP measures how productively an airport utilizes variable inputs in producing outputs for a given level of capital infrastructure and facilities.

(2) Characteristics of Sample Airports

Table 2 provides some interesting statistics for selected sample airports. These statistics indicate that there are large variations among the sample airports in terms of their size, business and operating environment. For example, the annual number of airport passengers ranges from 2.3 million passengers for Penang (Malaysia) to 79 million passengers for Hartsfield-Jackson Atlanta International Airport (United States) in 2003. Some airports serve mostly international traffic, such as Amsterdam, Brussels, Singapore, and Hong Kong, whereas others serve mostly domestic passengers, such as Kansas City where international traffic accounts for less than 1% of their total passenger traffic in 2003. Some airports provide services mostly to large aircraft, whereas others serve many small aircraft. For example, the average number of passengers per aircraft movement was 156 passengers at Narita and Kansai in 2003, but only 36 passengers per aircraft at Raleigh-Durham in the same year. Some airports derive most of their revenue from aeronautical activities, whereas for others, a significant portion of revenue comes from other sources including concession, car-parks and rentals. For example, in 2003, aeronautical revenue accounts for 73% of New York JFK's total revenue, while it is only 32 % of total revenue at Brisbane (Australia). Hub carrier's market share (in terms of frequency) varies across airports as indicated in the last column of Table 2. Oum, Yu and Fu (2003) show that some of these factors are statistically significant in explaining variations in productive efficiency among the airports, yet they are beyond managerial control. Therefore, it is important to control for the effects of these variables when testing hypotheses concerning the effects of ownership and governance structure of the airports.

4. Empirical Results and Discussions

A series of regression analyses were conducted to examine the effects of ownership forms and other variables on airport productivity performance. Since the business environments within which these airports operate are very different across Asia, Oceania, Europe and North America, we decided to include continental dummy variables in our VFP regression models with North America as the benchmark. The private majority ownership is used as the base in all regressions. The regression results for three different sets of variables are reported in Table 3, and the results are discussed in the following sections.

(1) The Effects of Regional Business Environments

The regression coefficients on the regional dummy variables indicate that the overall business environments in Asia and Europe appear to have negative influences on the operating efficiency of their airports, whereas the open business systems in Australia and New Zealand appear to help enhance airports' operating efficiency, as compared to the North American airports.

(2) The Effects of Ownership Forms

The coefficient for airports owned/operated by city/state government departments in the U.S. is not statistically significant in any of the 3 models, indicating that there is no significant difference in operating efficiency performance between these U.S. airports and those with a private majority ownership. This result provides some evidence supporting the claim by de Neufville (1999) and Dillingham (1996) that the U.S. airports are among the most "privatized" in the world, as U.S. airports routinely turn to airlines for financial help in facility expansion and modernization and in return offer long-term leases that often give airlines strategic control of airports through majority-in-interest (MII) arrangements. Since U.S. carriers face a very competitive market place, they act as a pressure group continually requiring airports to improve efficiency (see Bailey, 2002; Carney and Mew, 2003). Furthermore, private companies (airlines, concessionaires and contractors) deliver most of the airports' day-to-day operations and services. In fact, the government body that owns a US airport often employs only about 10 to 20% of the workforce active at the airport (de Neufville, 1999).

Similarly, the coefficient for the (North American) airport authority is also not statistically significant in any of the regressions, indicating that there is no significant difference in productive efficiency between airports operated by airport authorities and those with a private majority. The airport authorities in North America appear to have sufficient freedom to operate airports in a business-like manner. Under these circumstances, ownership does not always reflect how

an airport is operated.9 This result also indicates that there is no significant efficiency difference between airports operated by North American authorities and airports owned/operated by U.S. government branches. This finding disputes those of Airola Craig (2001) who found that the authority-operated U.S. airports out-performed city- operated airports in terms of technical efficiency. It is noted, however, that their study used only one output measure, aircraft movements, as discussed in the literature review section. The coefficient for airports with a government majority is negative and statistically significant, indicating that airports with government majority are about one third less efficient than the airports with a private majority. Partial privatization that gives private sector a minority interest does not appear to work well in terms of improving operating efficiency. This result is consistent with the empirical findings of Boardman and Vining (1989) in other industries, and the theoretical and empirical results of Ehrlich et al. (1994) as discussed in the literature review section.

The dummy variable for airports with shared ownership by multiple governments has a statistically significant negative coefficient in all of the regression models in Table 3, indicating that involvement by multiple governments is likely to lead to inefficiency in airport operation. It appears that this type of airport ownership is significantly less efficient than the airports under a majority private ownership, as multiple government owners attempt to influence airport management with conflicting objectives.

The dummy variable for Government (Public) Corporation is not statistically significant. This indicates that there may not be significant differences between airports operated by a corporation under a single government ownership and those with a private majority ownership, once the differential operating environments within which these airports operate are controlled. Millward and Parker (1983) and Boyd (1986) found essentially the same results.

The most surprising result with respect to ownership is that 100% public (single government owned) airports are more efficient than the PPP (Public Private Partnership) airports, when a government has a majority ownership and control. Given that the airports operated by 100% government-owned corporations are almost as efficient as the airports with either 100% or a majority ownership in the private sector (i.e., the benchmark airports in our regression models), it is important for governments to sell a majority stake in airports when they wish to seek private sector financing or participation in ownership and management of airports. In short, the airports with a government majority and/or with multiple government involvement tend to have significantly lower operating efficiency than those with other ownership forms.

(3) Effects of Business Diversification

The % NonAviation variable is the most statistically significant variable and has a positive coefficient in all of the VFP regressions reported in Table 3. This indicates that diversifying revenue sources into commercial and other non-aeronautical business would help airports to achieve higher operating efficiency. Many airports aim to increase revenues from commercial services and other non-aeronautical activities, in order to reduce aviation user charges thus attracting more airlines. Such business diversification strategies, of course, exploit the well known demand complementarity between aeronautical services and commercial services (Oum, Zhang and Zhang (2004)) and appear to improve airport productive efficiency as well.

The result from a one-way ANOVA analysis (Table 4) shows that airports with a private majority ownership generally derive a higher percentage of their revenue from non-aeronautical activities than their counterparts under other ownership forms: e.g. 57% versus 37% for airports with a government majority. If airport privatization leads to an increase in non-aviation revenue, and in turn, an airport with proportionally higher non-aviation revenue achieves greater efficiency, then this secondary effect of privatization on efficiency over and above the effect of the privatization dummy variable should be counted as the total efficiency effect of privatization. Once we take this into account, the effect of privatization on efficiency may be larger than the result presented in this section (and in Table 3).

(4) The Effects of Airport Characteristics

All of the airports characteristic variables had the expected coefficient signs in the VFP regression. These variables are included in order to avoid bias in efficiency comparisons. The effects of these variables are as follows:

- **Airport size** (scale of output) has a positive coefficient in all three models, but is not always statistically significant. This provides some indication that the economies of output scale may have been exhausted for most of the airports included in our sample (mostly more than 3 million passengers). This is consistent with the findings of Jeong (2005).
- **Runway Utilization h**as a positive coefficient, but is not statistically significant in Model (3) and is only marginally significant in Model (2). This provides some indication that airports with congested runways tend to have higher gross VFP.
- **Average aircraft size (number of passengers per air transport movement)** has a statistically significant negative coefficient in the first order term, but statistically significant positive coefficients for the cross terms with Asia and Europe regional dummy variables in Model 3. The results indicate that in North America airports handling larger aircraft tend to have lower operating efficiency as compared to a similar airport handling smaller aircraft. This may have

been caused by the fact that arrivals and departures of larger aircraft tend to pose peaking and congestion problems at the terminal and landside operations thus reducing the efficient utilization of airports throughout the day. In Asia and Europe, however, airports serving larger aircraft tend to have higher efficiency than those serving smaller aircraft. This provides some indication that Asian and European airports are more concerned with runway congestion, and larger aircraft would release some runway congestion pressure, thus helping to improve overall productive efficiency.

• **%International** has a negative coefficient in its first order term, but is not statistically significant. However, the cross term with the European regional dummy is statistically significant with a negative coefficient, and the cross term with the Asian regional dummy is statistically significant with positive coefficient. The results provides some evidence that in North America and Europe, airports with a heavy reliance on international passengers are likely to have lower 'gross' VFP, whereas in Asia, airports with proportionately more international traffic tend to have a higher "gross" VFP.

• **%Cargo** has a positive coefficient, but is not statistically significant. This provides weak evidence that airports with a larger proportion of cargo traffic are expected to have higher VFP.

(5) Ownership Influences on Other Factors

Ownership forms are likely to influence airport pricing and profitability.. A series of one way ANOVA analysis were conducted to examine the effects of ownership form on airport profitability and airport charges.

• **Effects on Profitability:** Table 5 shows that airports with a private majority achieve significantly higher profit margins (56%) than airports under other ownership forms. In particular, their average operating margins are more than double those of airports with a government majority and/or operated by multiple governments. North American airports operated by airport authorities also achieved considerably higher profit margins than other types of government operated airports.

• **Effects on Airport Charges:** Table 6a and 6b show that airports in North America generally have lower aeronautical charges than their counterparts in other regions. Outside North America, airports with a private majority have significantly lower average aeronautical charges than other airports. The results provide some evidence that privatization has not lead to airports charging monopoly prices. Instead, privatized airports tend to enhance their profitability by diversifying their business into commercial and other non-aeronautical activities. In contrast, the airports owned/operated by multiple governments appear to rely more on aeronautical charges than the others because they are relatively inefficient.

5. Summary and Conclusions

This paper investigates the effects of ownership forms and governance structure on the performance of airports around the world, focusing on productive efficiency and operating profitability. The efficiency measure was based on a variable factor productivity (VFP) index drawing from an extensive set of unbalanced panel dataset including major airports in Asia-Pacific, Europe and North America over the period of 2001-2003.

Contrary to initial expectations, we found strong evidence that airports owned and managed by a mixed enterprise with a government-owned majority is significantly less efficient than 100% publicly owned and operated airports.

Again, contrary to common belief, there is no statistical evidence indicating that the airports owned/operated by a firm with private sector majority ownership are more efficient than the airports owned/operated by the U.S. government branches or 100% public corporations. Furthermore, no statistically significant difference in efficiency performance was found to separate airports managed by government departments/branches in the U.S. and those managed by airport authorities such as Vancouver International Airport Authority. The data also suggests that government majority ownership and ownership by multiple governments (often federal/state/local governments) are the two most inefficient ownership forms.

Airports with a private majority, all of which are based in Europe and Oceania, achieved significantly higher profit margins (56%) than airports under other ownership forms despite the fact that they charge significantly lower aeronautical tariffs than other airports. Hence, the results provide some evidence that privatization has not lead to airports charging monopoly prices. Instead, privatized airports tend to enhance their profitability by diversifying their business into commercial and other non-aeronautical activities.

Probably the most surprising result of this analysis is that 100% public (single government owned) airports are more efficient than the PPP (Public Private Partnership) airports, where a government retains majority ownership and control. Given that the airports operated by 100% government- owned corporations are almost as efficient as the airports with either 100% or a majority stake in the private sector, it would appear to be important for governments to sell a majority stake in airports when they seek private sector financing or participation in ownership and management of airports. In short, the airports with a government majority and/or with multiple government involvement tend to have significantly lower operating efficiency than all other forms of ownership. Furthermore, airports with majority private ownership (including 100% private ownership) do not achieve significantly higher efficiency than the 100% government-owned airports, such as

those in the U.S.

Consequently, institutional changes along with some or all of the following measures may help improve airport's operational efficiency:

• In the long run, creation of a continental single aviation market would encourage greater competition amongst airport markets by providing airlines and passengers with greater choices.

• Removing bureaucratic control and duplication of administrative processes between the corporatized airport management and governmental administrative procedures.

• Giving airport managers complete authority to restructure operations and conduct business may improve efficiency e.g. the airport managers should be given the freedom to outsource terminal operations to specialized firms.

Researchers have pointed out that the empirical results of efficiency analysis may depend on the method of measurement used (Oum, Waters and Yu, 1999). Other methodologies, such as various forms of DEA, stochastic frontier methods, cost function methods, etc. are likely to yield different empirical results. Given that some of the findings obtained here are likely to be controversial, it is important to test different measurement methodologies before reaching a firm conclusion as to the efficiency effects of privatization, corporatization and commercialization of airports.

Table 3

Variable Factor Productivity Regression Results – Log-Linear Model

(Base ownership: airport with a private majority)

Model	1		2		3	
Dependent Variable	VFP		VFP		VFP	
	Coeff.	t-stat	Coeff.	t -stat	Coeff.	t-stat
Intercept	0.776	-	-0.531	-	0.689	-
Output Scale (Index)	0.080	1.99	0.029	0.58	0.076	1.56
Runway Utilization (ATM per Runway)	-	-	0.101	1.71	0.045	0.80
Aircraft size (Pax /ATM)	-0.161	1.94	-0.128	1.51	-0.303	3.19
* Europe	-	-	-	-	0.599	3.74
* Asia-Pacific	-	-	-	-	0.628	2.83
%International	-0.010	0.51	-0.008	0.38	-0.035	1.65
* Europe	-	-	-	-	-0.316	1.96
* Asia-Pacific	-	-	-	-	0.139	3.52
%Non Aviation	0.574	9.04	0.565	8.92	0.504	7.70
%Cargo	0.019	0.65	0.021	0.74	0.013	0.45
Asia	-0.623	4.60	-0.612	4.52	-3.403	3.17
Europe	-0.453	3.40	0.234	0.55	-2.720	3.03
Oceania	0.410	2.72	0.432	2.86	0.508	3.58
2002	-0.066	1.35	-0.060	1.22	-0.054	1.18
2003	-0.081	1.66	-0.069	1.40	-0.067	1.45
Ownership/Governance Form Dummy Variables:						
U.S. Govt Department	-0.046	0.34	-0.031	0.24	-0.056	0.44
N. America Airport Authority	0.026	0.18	0.047	0.34	0.0176	0.13
100% Public Corporation	-0.047	0.54	-0.038	0.44	-0.012	0.14
Mixed Ent. (majority-gov)	-0.341	2.95	-0.303	2.58	-0.225	1.98
Multi-Gov shareholders	-0.287	2.91	-0.264	2.65	-0.331	3.51
R^2	0.6846		0.6885		0.7336	
Adjusted R^2	0.6647		0.6674		0.7107	
Log-Likelihood Value	-57.27		-55.71		-35.84	
Observations (n)	254		254		254	

Note: All variables including the dependent variables are in logarithmic form except for dummy variables; VFP = Variable Factor Productivity index.