PRODUCTIVITY ANALYSIS OF PUBLIC AND PRIVATE AIRPORTS: A CAUSAL INVESTIGATION

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ABSTRACT

Around the world, airports are being viewed as enterprises, rather than public services, which are expected to be managed efficiently and provide passengers with courteous customer services. Governments are, increasingly, turning to the private sectors for their efficiency in managing the operation, financing, and development, as well as providing security for airports. Operational and financial performance evaluation has become increasingly important to airport operators due to recent trends in airport privatization. Assessing performance allows the airport operators to plan for human resources and capital investment as efficiently as possible. Productivity measurements may be used as comparisons and guidelines in strategic planning, in the internal analysis of operational efficiency and effectiveness, and in assessing the competitive position of an airport in transportation industry. The primary purpose of this paper is to investigate the operational and financial efficiencies of 22 major airports in the United States and Europe. These airports are divided into three groups based on private ownership (7 British Airport Authority airports), public ownership (8 major United States airports), and a mix of private and public ownership (7 major European Union airports. The detail ownership structures of these airports are presented in Appendix A). Total factor productivity (TFP) model was utilized to measure airport performance in terms of financial and operational efficiencies and to develop a benchmarking tool to identify the areas of strength and weakness. A regression model was then employed to measure the relationship between TFP and ownership structure. Finally a Granger causality test was performed to determine whether ownership structure is a Granger cause of TFP. The results of the analysis presented in this paper demonstrate that there is not a significant relationship between airport TFP and ownership structure. Airport productivity and efficiency is, however, dependent upon the level of competition, choice of the market, and regulatory control.

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INTRODUCTION

Airport privatization was pioneered by Great Britain under the Thatcher Government as a result of its initial public offering of 100 percent of the shares in the former British Airports Authority (BAA) in 1987. Thus the prevailing model for airport privatization in Europe is outright sale as initiated by the British Government with its sale of BAA. BAA is now the largest airport operator in the world, with ownership of 7 airports in the United Kingdom (UK) and management of 11 airports outside of the UK, serving more than 230 million passengers a year (BAA, 2006).[1] Global airport privatization continues to be the predominant trend worldwide. Governments around the world are turning to private enterprises for airport management and development. More than 100 large and medium-size airports are being privatized in Europe, Asia, Australia, Africa, Latin America and the Caribbean, and North America.

Bijan Vasigh (cont'd.) aviation industry. The articles have been published in numerous academic journals such as the *Journal of Economics and Finance, Journal of Transportation Management, National Aeronautics and Space Administration (NASA) Scientific and Technical Aerospace Reports, Transportation Quarterly, Airport Business, Journal of Business and Economics*, and *Journal of Travel Research*, and quoted in major newspapers and magazines around the world. He was a consultant with the International Civil Aviation Organization (ICAO) and provided assistance on the evolution of aeronautical charge structure for the Brazilian Institute of Civil Aviation (IAC). He is currently a member of the international faculty at the International Air Transport Association (IATA) Learning Center and instructs Airline Finance and Accounting Management course at IATA training centers around the world. He is a member of the editorial board of Journal of Air Transport Management and Journal of Air Transportation World Wide. He worked on a NASA Research Grant on "Determination of Statewide Economic Benefits of the Small Aircraft Transportation System (SATS)." He is also a member of the Air Transport Research Society (ATRS) Global Airport Benchmarking Task Force.

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[1] On June 6, 2006, Spanish construction consortium, Grupo Ferrovial officially acquired the entire capital of the BAA for $19.30 billion. The Company manages airports in Australia (Sydney), the UK (Bristol and Belfast) and Chile; and more than 230,000 parking spaces, mainly in Spain.

Proponents of airport privatization believe the benefits of airport privatization include increases in operating efficiency through the transfer of ownership and management of public assets to private sectors, improvement of airport amenities, and increases in financial efficiencies in the form of increased revenues, increased profits, and reduced risks in undertaking unprofitable projects. Those who benefit from private management of airports are passengers, commercial airlines, private owners of airplanes, state and local government units through new revenue streams, and taxpayers.

Airport privatization can occur in many ways, including contract management, long-term lease, and sale. There are different objectives associated with each method of privatization. Contract management is often used for existing airports that are losing money, and the objective of contract management is usually to reduce costs and increase revenues to eliminate the deficit and potentially create a profitable airport operation. Long-term leases are often used for existing airports where a significant airport development is anticipated. The objective of a long-term lease is to shift a significant portion of the risk of new development from taxpayers to a private lessee. The term of the lease is primarily related to the length of time needed by the private lessee to recover its investment in new development and potentially make some profit.

The sale of an airport to the private sector is the most common method of global airport privatization. In full divestiture, the government generally sells entire airports as part of an overall program of divesting itself of a non-core business. This was the motivation for the British government in the 1987 sale of BAA. In some cases, governments only sell a majority or minority portion of the ownership and maintain the rest of the business interest for direct influence in airport management or for using the sale proceeds to finance airport expansion.

In an attempt to address the relative productivity and efficiency of commercial airports, both private and public, the authors utilize Total Factor Productivity (TFP) to develop a benchmarking tool to identify the areas of strength and weakness. The results shall enable airport managers to assess their competitive positions through operational and service comparisons.

AIRPORT OWNERSHIP, PRIVATIZATION, AND PERFORMANCE ANALYSIS

Airports are the backbone of the worldwide commercial transportation system. Air transportation of passengers and cargo is a dominant element of the transportation industry. Increasing passenger demand, escalating cargo expansion, increasing operating costs, and liability exposure have placed tremendous capital demands on government and state airport owners. As a result, governments recognize that private investment capital is needed to meet airport expansion and commercialized management is needed to meet airports' operating efficiency and customer services, and therefore governments began to look into airport privatization.

While the trend of airport privatization is heating up around the world, in the United States (US) the airport privatization process is marching at a slower pace. Proponents argue that privatization would inject much needed capital into the aviation infrastructure. Opponents claim that local governments favor privatization as a way to divert airport revenue intended for developing aviation infrastructure to other municipal purposes, resulting in higher costs for airlines and passengers.

The privatization of the Stewart Airport in Newburgh, New York, is the very first airport privatization in the US under the 1996 Federal Aviation Administration (FAA) five-airport pilot program. Stewart Airport was leased for 99 years to National Express, a British company, in 2000. In five years, the airport managed to increase its passenger count by 33 percent and to attract new tenants who provided aviation services. The application for privatization of the New Orleans Lakefront Airport for a long-term lease to American Airport Corporation was submitted to the FAA in 2002 and as of June 27, 2005, the application required additional information for FAA final review (Bennett, 2005). In 2005, a new application was submitted to the FAA for approval of construction of a new airport, Abraham Lincoln National Airport, in Peotone about 40 miles south of downtown Chicago. The South Suburban Airport Commission held a competition and selected a team led by LVOR and SNC-Lavalin to finance, build, and operate the airport as a public-private partnership in which the government owns the land and the private contractor owns and operates the facilities (Sander 2004).

Other examples of successful airport privatization efforts in the US include the management contract awarded to BAA by the Indianapolis Airport Authority. In October of 1995, the BAA took over the management of Indianapolis International Airport promising to raise non-airline revenues by $32 million within the 10-year period of the contract. The contract was renegotiated in 1998 and extended until 2008. Between 1995 and 1999, costs per passenger were reduced from $6.70 to $3.70 and have increased very little since then. In spite of a moderate passenger annual growth rate of 3.5 percent, non-airline revenue per passenger more than doubled by 2003 (Vasigh & Haririan, 2003).

While over 100 airports around the world are either privatized or are in the process of being transferred to private enterprises, there are few studies that have been conducted to address the relative productivity of private versus public airports in terms of operational and financial efficiencies. With the privatization wave on the horizon, one surmises that privately owned airports should outperform public airports in terms of TFP. However the latest research on this subject by Vasigh and Haririan (2003) could not document superiority of private airports over public airports. This study used 8 US airports as the only public airports and 7 British airports owned by BAA as the only private airports. Vasigh and Haririan observed that countries having privatized airports generally impose some form of price regulation or landing fees. In the UK, for example, landing fees are market-based pricing, indicating that landing fees are higher for peak travel times, and therefore private airports showed higher revenues from landing fees. They also concluded that privatization advocates point to labor productivity growth at airports in the UK as evidence of efficiency in private airports.

The results of other studies by Oum, Yu, and Fu (2003) and Oum, Zhang, and Zhang (2004) indicate that the airports owned by mixed enterprises with a private sector majority ownership are more efficient than airports owned by government branches or 100% public corporation.

Performance can be assessed based on financial efficiency or operational efficiency. Efficiency has several dimensions, two of which are economic efficiency and technological efficiency: economic efficiency means that the firm is using resources in such combinations that the cost per unit of output for that rate of output is the least; technological efficiency means that it must not be possible to produce the same rate of output with lesser amount of any resource.

In the airport industry, creation of a set of uniform performance measures has been essential not only to airport management but to airlines as well. Apart from measures of an airport's economic efficiency, managers need to be able to assess the input/output relationship in considering alternative investments or future developments.

The authors used 3 groups of airports consisting of 8 US public airports, 7 BAA private airports, and 7 European Union (EU) airports, both private and public.[2] They utilized financial and operational data such as landing fees, total assets, aircraft movements, number of airport gates, the annual number of enplaned passengers, and runway capacity. Initially, the authors adopted TFP to analyze the efficiency and performance measures of airports within each group by comparing and cross-referencing them with each other. They assessed and evaluated the performance of commercial airport(s) by developing a benchmarking tool to identify the areas of strength and weakness. This analysis led to identifying those airports that are not efficient and are thus dominated by other efficient airports.

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[2] These airports represent different sizes and ownership structure and located across EU and US. Availability of data was a major factor in our selection.

There are specific applications of this study. The report will allow the airport manager to:

1. Improve airport organizational quality;
2. Lower cost position;
3. Expose airport employees to new ideas;
4. Broaden the airport organization's operating perspective;
5. Create a culture open to new ideas; and
6. Raise the airport's level of maximum potential performance.

DATA AND METHODOLOGY

Data

The airport data reflected in this research are for five years from 2000 through 2004 and include a total of 22 airports in the following three groups:

1. US commercial airports (8 public airports),
2. BAA, (7 private airports), and
3. EU (the 7 busiest airports, both private and public).

The selected airports are shown in Table 1.

Table 1. Airports Selected for the Total Factor Productivity Analysis

BAA Airports[3] (Group 1)	US Airports[4] (Group 2)	EU Airports[5] (Group 3)
Aberdeen (ABZ)	Atlanta (ATL)	Amsterdam (AMS)
Edinburgh (EDI)	Chicago (ORD)	Frankfurt (FRA)
Glasgow (GLA)	Dallas-Fort Worth (DFW)	Munich (MUC)
London Gatwick (LGW)	Denver (DEN)	Paris Charles de Gaulle (CDG)
London Heathrow (LHR)	Detroit (DTW)	Paris Orly (ORY)
London Stansted (STN)	Los Angeles (LAX)	Rome Fiumicino (FCO)
Southampton (SOU)	Newark (EWR)	Zurich (ZRH)
	San Francisco (SFO)	

The authors selected 3 input factors and 5 output measures that are relevant in assessing airport productivity. Of the three input factors selected in this paper, two are financial and one is non-financial. The financial input factors are operation cost and net total assets. For European and British airports, operation cost was measured as total revenue minus earnings before interest and tax (EBIT). Appendix A shows ownership structure of non-UK

[3] BAA owns and operates seven major airport facilities in England as well as other countries.

[4] The financial data for both input and output factors were obtained from the FAA and AirNav.com for all US airports.

[5] The financial data for both input and output factors were obtained from the respective annual reports for the non-US airports.

European airports. The non-financial factor, runway area, was measured as the sum of all active runways' area (length x width) given in square meters.

Of the 5 output measures selected, 2 are financial and 3 are non-financial. The financial output measures are operational and non-operational revenues. Researchers must distinguish between operational and non-operational revenues, because an airport's primary purpose is getting passengers airborne, but many airports still earn a majority of their revenue on land-side operations, in areas ranging from parking and concession to direct retail. The non-financial measures are total terminal passengers, total airport movements, and aircraft landing fees. Total terminal passengers, measured on an annual basis, is indicative of an airport's ability to create demand and serve customers. Total airport movements measure the output of airside operations.

Input and output data are based on the total annual number of operations including air carriers, general aviation, air taxis, and military. These data are common among all the airports and contain financial and operational figures.

Methodology

A constant challenge in measuring productivity is deciding on precisely which measures to use. While not unique to airports, this problem requires using measures which can be applied to most airports and measures which can be obtained for airports under study. The primary objective of this study is to investigate the relationship between airport productivity and ownership and management structure.

There are a number of techniques that have been adopted and applied to measure airport efficiencies including ratio analysis, regression analysis, data envelopment analysis (Gillen & Lall, 1997), and TFP (Harrigan, 1997; Hooper & Hensher, 1997). This research utilizes TFP as it is proven to be the most accurate measure of productivity of all inputs involved in the production process, which allows for measuring cost efficiency and effectiveness and for distinguishing productivity differences in airport performance that arise from economies of scales and from managerial performance (Oum, Yu, and Fu, 2003; Oum, Zhang, and Zhang, 2004; Vasigh & Hamzaee, 1998; Vasigh & Harririan, 2003). This technique can also be used for investigating the impact of variations of input and output prices on an airport's performance (Gillen & Lall, 1997).

The following TFP index (model) was employed in this research which is similar to the framework introduced by Caves et al. (1982), which is also reviewed and analyzed by Hooper and Hensher (1997):

$$\ln\left(\frac{TFP_k}{TFP_b}\right) = \sum\left(R_{ki} + \overline{R_i}\right)\left(\ln Y_{ki} - \overline{\ln Y_i}\right) - \sum\left(R_{bi} + \overline{R_i}\right)\left(\ln Y_{bi} - \overline{\ln Y_i}\right)$$
$$- \sum\left(W_{kn} + \overline{W_n}\right)\left(\ln X_{kn} - \overline{\ln X_n}\right) + \sum\left(W_{bn} + \overline{W_n}\right)\left(\ln X_{bn} - \overline{\ln X_n}\right)$$

where :

k = each individual observation, $k = 1,\dots,K$

b = base observation (a particular or average observation)

i = outputs, $i = 1,\dots,I$

n = inputs, $n = 1,\dots,N$

R_i = weights for each output

$\overline{R_i}$ = arithmetic mean of output weights over all airports

W_n = weights for each input

$\overline{W_n}$ = arithmetic mean of input weights over all airports

$\ln Y_i$ = unit measure of output

$\overline{\ln Y_i}$ = geometric mean of unit measure over all airports

$\overline{lnX_n}$ = unit measure of input

$\ln X_i$ = geometric mean of unit measure over all airports

EMPIRICAL RESULTS

Total factor productivity model

Based on TFP values as presented in Table 2 for the BAA group (private ownership structure), London Heathrow achieved the highest score throughout all 5 years under study. In the US group (public ownership structure), the highest score for 2004 is observed for Chicago O'Hare Airport, followed by Newark Airport for 2001 through 2003, and Atlanta Airport for 2000. In the third group (mixed private and public ownership), consisting of EU airports excluding the UK, Frankfurt has the highest scores for the years 2000 and 2001 and Paris Charles de Gaulle for the years 2002 and 2003; the airports share the highest score in 2004.

Table 2. Total Factor Productivity Scores for Selected Airports, 2000-2004

Airport	Year 2000	2001	2002	2003	2004
Europe (excluding UK)					
Amsterdam	1.00	0.99	1.01	0.98	0.97
Frankfurt	1.08	1.06	1.04	1.04	1.06
Munich	0.94	0.96	0.96	0.96	0.97
Paris Charles de Gaulle	*	1.05	1.05	1.07	1.06
Paris Orly	*	0.98	0.98	0.98	0.98
Rome Fiumicino	1.01	0.92	0.93	0.94	0.94
Zurich	0.99	0.96	0.95	0.95	0.95
United Kingdom (BAA)					
Aberdeen	1.00	0.98	0.98	0.98	0.98
Edinburgh	0.97	0.97	0.98	0.98	0.98
Glasgow	0.96	0.98	0.98	0.98	0.98
London Gatwick	1.07	1.06	1.06	1.05	1.05
London Heathrow	1.21	1.21	1.20	1.17	1.11
London Stansted	0.95	0.96	0.96	0.97	0.97
Southampton	1.08	1.08	1.08	1.08	1.09
United States					
Atlanta	1.13	1.11	1.05	1.04	1.07
Chicago O'Hare	1.07	1.09	1.10	1.10	1.10
Dallas-Forth Worth	1.03	1.02	1.02	1.02	1.03
Denver	0.94	0.99	1.00	0.99	1.00
Detroit	1.01	1.00	1.00	1.00	1.00
Los Angeles	1.06	1.06	1.04	1.04	1.05
Newark	1.12	1.11	1.15	1.16	1.09
San Francisco	1.01	0.99	0.99	1.00	1.00

Note. For the year of 2000 no data could be obtained for Paris Charles de Gaulle and Paris Orly.

Based on average annual TFP for airport groups as presented in Table 3, the US airports group, representing public ownership structure, had the highest average annual TFP throughout the 5 years and outperformed the BAA airports group, representing private ownership structure, and the EU airports group, representing a mixture of private and public ownership structure.

Table 3. Average annual Total Factor Productivity for Airport Groups, 2000-2004

Airport	**Year 2000**	**2001**	**2002**	**2003**	**2004**
Europe (excluding UK)	1.004	0.989	0.989	0.989	0.990
United Kingdom (BAA)	1.034	1.034	1.034	1.030	1.023
United States	1.046	1.046	1.044	1.044	1.043

Table 4 exhibits the 5-year average TFP for the third group (EU airports). Based on a 5- year average TFP, Paris Charles de Gaulle Airport scored the highest followed by Frankfort, Amsterdam, Paris Orly, Zurich, Munich, and Rome.

Table 4. Five-year Average Total Factor Productivity for European Union Airports Group, 2000-2004

EU Airport	Ownership Structure	Average TFP for 2000-2004
Amsterdam	Private Management	0.991
Frankfurt	Private Management	1.056
Munich	Public	0.958
Paris Charles de Gaulle	Public	1.058
Paris Orly	Public	0.978
Rome Fiumicino	97% Private	0.948
Zurich	51% Public	0.960

Table 5 presents the ranking of all 22 airports based on a 5-year average TFP score. The leading airport is London Heathrow from the first Group (airports with a private ownership structure) with a score of 1.18, followed by Newark (1.126) and Chicago O'Hare (1.093) from the second group (airports with a public ownership structure).

Table 5. Airport Ranking Based on Five-year Average Total Factor Productivity Scores, 2000-2004

Rank	Airport	Region	Score
1	London Heathrow	UK	1.180
2	Newark	US	1.126
3	Chicago O'Hare	US	1.093
4	Southampton	UK	1.084
5	Atlanta	US	1.080
6	London Gatwick	UK	1.059
7	Paris Charles de Gaulle	EU	1.058
8	Frankfurt	EU	1.056
9	Los Angeles	US	1.050
10	Dallas-Forth Worth	US	1.024
11	Detroit	US	1.002
12	San Francisco	US	0.997
13	Amsterdam	EU	0.991
14	Denver	US	0.985
15	Aberdeen	UK	0.984
16	Glasgow	UK	0.979
17	Paris Orly	EU	0.978
18	Edinburgh	UK	0.976
19	London Stansted	UK	0.962
20	Zurich	EU	0.960
21	Munich	EU	0.958
22	Rome Fiumicino	EU	0.948

Figures 1 through 3 compare TFP within all three groups for a period of five years from 2000 through 2004. In Figure 1, EU airports group, Paris Charles de Gaulle and Frankfort airports outperform the other airports. In Figure 2, UK airports group, London Heathrow outperforms the other airport listed over the five-year period. In Figure 3, US airports group, overall

Newark outperforms other airports listed although Chicago O'Hare extended its performance ahead of Newark in 2004.

Figure 1. Total Factor Productivity for European Union Airports, 2000-2004

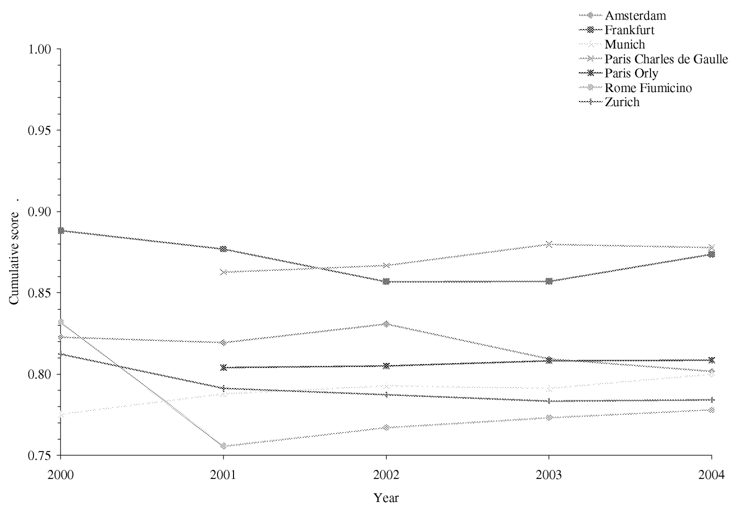


Figure 2. Total Factor Productivity for United Kingdom Airports, 2000-2004

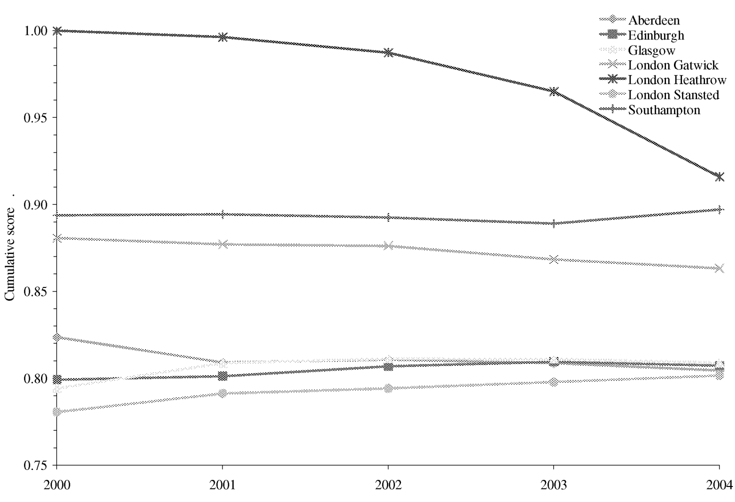


Figure 3. Total Factor Productivity for United States Airports, 2000-2004

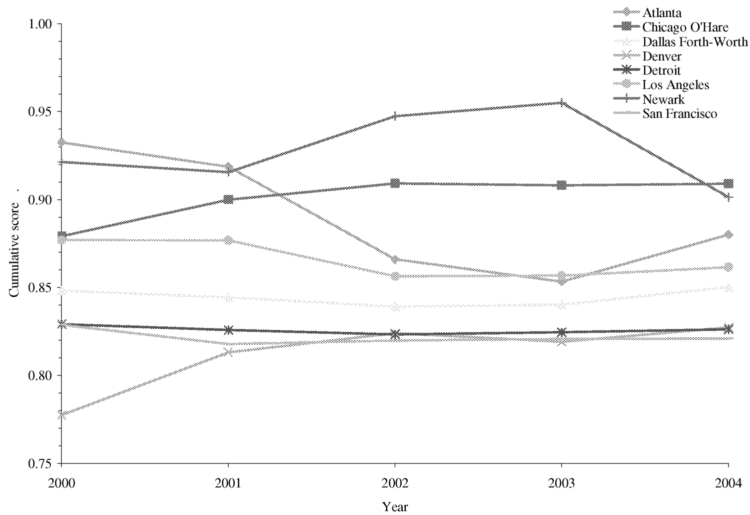
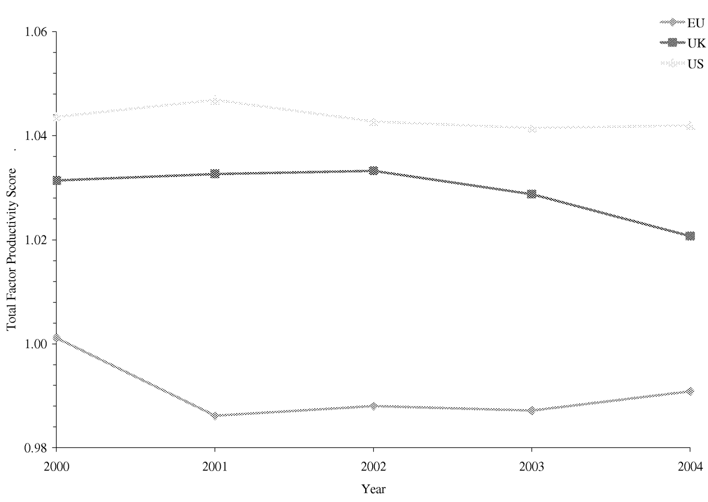


Figure 4 compares the annual average TFP for all three groups over five years (2000 – 2004). US airports consistently score higher than UK airports (BAA group), and EU airports always score lower than UK airports.

Figure 4. Total Factor Productivity for Selected Airports Grouped by Geographical Region, 2000-2004



Stepwise-regression model

In order to evaluate and analyze the relationship between airport productivity and others factors such as airport ownership structure, management policy, and financial condition, the authors have developed the following functional relationship:[6]

TFP = *f* (RW, OC, NA, TP, MV, LF, OR, NR, D1, D2, D3, D4)

where:

RW = Airport runway area
OC = Airport operation cost
NA = Net total asset
MV = Aircraft movements
LF = Aircraft landing fee
OR = Operating revenue
NR = Non-operating revenue
D1 = Dummy variable, ownership structure
    D1 = 1 100% private
    D1 = 0 not 100% private
D2 = Dummy variable, airport location
    D2 = 1, all US airports
    D2 = 0, non-US airports
D3 = Dummy variable, multiple private entity
    D3 =1, multiple-airport operator
    D3 =0, single-airport operator
D4 = Dummy variable, multiple public entity
    D4 =1, multiple public entities owner or management
    D4 =0, single public entity owner

Stepwise-regression analysis was used to reveal whether productivity, defined as TFP, was related to runway size, airport operating cost, airport net assets, airport movements, landing fee, airport management, or ownership structure. This functional relationship was chosen because it selects the independent variable that is most predictive of the dependent variable (i.e., highest correlation with dependent variable "airport productivity") as indicated by the significance of t values.

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[6] Variance Inflation Factors (VIFs) test was conducted among aircraft movements and operational revenue to uncover the possibility of multicollinearity. Since the calculated VIF value (6) was less than 10, therefore we reject multicollinearity between these two variables. This is a simple rule of thumb, since the VIF (like R^2) is a statistic without a distribution.

As Table 6 presents, the estimated coefficients for landing fees, runway area, aircraft movements, operational revenue, net assets, and dummy variable 3 (private multiple-airport multiple operator) are significant with at least 95 percent confidence. This result indicates that these independent variables contribute significantly to the TFP of the airport. On the other hand, the t-value for dummy variables 1, 2, and 4 are statistically insignificant, indicating that ownership structure, airport location (in group 1, 2, or 3), and public multiple entity are not contributors to airport productivity. As the results show, airport productivity was positively affected by landing fee, aircraft movements, and operational revenues and negatively affected by runway area and net assets. It also indicates that airports with higher TFP ratings may have used runways more intensively and used net assets more efficiently. In addition, the significance of dummy variable 3 indicates that if an airport operator manages more than one airport it will enjoy economies of scale in several areas, such as finance and marketing. Therefore, overall productivity increases and has a positive impact on the TFP score.

Table 6. Summary of Stepwise Regression Analysis for Variables Predicting the Total Factor Productive Score (N = 108)

	Log-Linear			Linear function		
Variable	**B**	**SE B**	**B**	**B**	**SE B**	**β**
Constant	0.326 (3.813)	0.086		0.892 (93.086)	0.010	
Landing Fee	0.052 (9.680)	0.005	0.550	0.015 (18.198)	0.001	0.670
Runway Area (m^2)	-0.096 (-9.932)	0.010	-1.203	-0.000 (-10.466)	0.000	-0.570
Aircraft Movements	0.137 (13.170)	0.010	1.630	0.000 (17.810)	0.000	1.012
Dummy 3 (multiple airports)	0.037 (3.592)	0.010	0.289	0.015 (2.322)	0.007	0.123
Operational Revenues	0.027 (4.336)	0.006	0.464	0.000 (6.841)	0.000	0.335
Net Assets	-0.019 (-3.214)	0.006	-0.320	-0.000 (-0.146)	0.000	-0.007

Note. Log Values: Adjusted R^2 = .733; Durbin-Watson autocorrelation = 2.308. Non-Log Values: Adjusted R^2 = .874; Durbin-Watson autocorrelation = 2.020. Values in parentheses are t-values.

Granger causality test

The authors furthermore applied the Granger (1969) causality test between TFP and airport ownership, runway area, airport movement and operating revenue. The results of Granger causality tests are reported in Table 7. Generally, there is some evidence that TFP and runway area have Granger causality to each other.

Table 7. Granger Causality Test, for Airport Groups, 2000-2004

	US Airports		**BAA Airports**		**EU Airports**		**Aggregate**	
	No. Lags	FPE	No. Lags	FPE	No. Lags	FPE	No. Lags	FPE
RW -> TFP	2	0.00564	3	0.01023	3	0.10320	2	0.10747
MV -> TFP	3	0.00164	2	0.08322	1	0.12032	2	0.00591
NA -> TFP	1	0.10747	1	0.09210	2	0.07912	2	0.00792
OR -> TFP	2	0.01201	2	0.00003	2	0.06070	2	0.00000

-> Denotes Granger Causality

FPE is Final Prediction Error

In this section, the authors examined the causal relationship between airport landing fees, runway area, operating revenue, net assets, operating costs and airport total productivity. The relationship between airport operating cost and airport productivity is complex and the historical evidences are not clear. A large cut in airports operating expenses may reduce productivity because of diminishing returns due to more intensive use of variable resources; this is likely because large-scale and across-the-board cost cutting results in cutting productive and unproductive resources. Thus, it would seem that past values of airport operating costs may not help to predict TFP.

Furthermore, the Granger causality test indicated that there is no long-run relationship between the airport productivity and airport landing fees, operating revenue, and operating costs. However, the results for the BAA airports show that the runway area is Granger causes of airport productivity (but not for the other airport groups under the study).

CONCLUSION

The productivity and efficiency of any airport depends on the market power, regulatory control, choice of market to serve, and level of competition in the environment that it operates. In this research, the authors have assessed the performance of the 22 major international airports and utilized TFP model to measure airport performance.

This study concludes that airport operators managing more that one airport will enjoy a higher level of TFP than those that operate only one airport. Operators find this improvement through possible economies of scale in several areas that contribute to overall factor productivity of airports. This follows the reasoning of basic economics.

The study further found an inverse relationship between TFP and two of the input factors used in this model, total net assets and runway area. The negative coefficients imply that airports with higher TFP ratings may have used runways more intensively and used net assets more efficiently. It may also indicate that one airport operator may be able to produce greater outputs with the same net assets and runway area than another operator.

The positive relationships between TFP and landing fees, aircraft movements, and operational revenues, imply that these input factors contribute to increasing returns to scale. Therefore, increasing TFP may require additional units of these factors. Similarly, the increase in these input factors will result in a higher level of productivity.

The results of the analysis presented in this research paper demonstrate, among the airports under the study, that the ownership and management structure of an airport does not necessarily contribute to its productivity. These results support the prior findings of Vasigh and Harrian (2003), which found no link between ownership structure and productivity.

The quality of managerial performance, on one hand influenced by the distinct patterns of authority, responsibility, and economic incentives provided by the ownership arrangements and on the other hand depends on the market and competition conditions in which the airports operate. The US airports, although, marked as public ownership that owned by government departments or public authorities, majority of their operations are contracted to private enterprises. Since US airports operate in a competitive environment with significant private contractors of their operations, it is not unexpected to see that their performances are not significantly different as compared to the airports owned by the private enterprises under this study.

Further tests of the link between ownership structure and productivity might be most easily seen in time-series test on airports that adjusted their ownership structures. As airports worldwide privatize, there will be opportunities to measure the value of shifts in ownership structure. This could provide important observations in this critical time. With changing airports structures, one can compare the resulting change in productivity of the same airport with respect to changes in organizational structure, organizational direction, and strategic decision making. These comparisons may produce the most fruitful results.

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APPENDIX

OWNERSHIP STRUCTURE OF EUROPEAN AIRPORTS (EXCL. UK)

Airport	Ownership Structure	
Amsterdam	Managed and operated by Schiphol Group:	
	75.8%	State of Netherlands
	21.8%	City of Amsterdam
	2.4%	City of Rotterdam
Frankfurt	Managed and operated by Fraport:	
	31.7%	State of Hesse
	20.3%	Stadtwerke Frankfurt am main Holding GmbH
	6.6%	Federal Republic of Germany (exchangeable bond)
	5.4%	Julius Baer Investment Management LLC
	5.0%	Deutsche Lufthansa
	31.0%	free float
Munich	Managed and operated by Flughafen Muenchen GmbH:	
	51.0%	Free State of Bavaria
	26.0%	Federal Republic of Germany
	23.0%	City of Munich
Paris Charles de Gaulle Paris Orly	Managed and operated by Aéroports de Paris S.A., a state-owned company.	
Rome Fiumicino	Managed and operated by Aeroporti di Roma (ADR S.p.A.):	
	44.68%	Macquarie Airports Group
	51.08%	Leonardo S.r.l.
	3.00%	Local Authorities (1.33% Regione Lazio, 1.33% Comune de Roma, 0.25% Provincia, 0.1% Comune de FCO)
	1.24%	Others
Zurich	Managed and operated by Unique AG:	
	51.00%	Public sector
	13.51%	Financial Institution
	3.78%	Private individuals
	2.78%	Companies
	1.10%	Pension Funds
	27.83%	Free float