Privatization, restructuring and its effects on performance: A comparison between German and British airports

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Paper No. 16., Date: 04/2009

Working Paper of the

German Airport Performance

a joint research project of

University of Applied Sciences Bremen,
Berlin School of Economics and Law (HWR),
International University of Applied Sciences in Bad Honnef, Bonn

WWW.GAP-PROJEKT.DE

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ABSTRACT

This paper encompasses a comparative analysis of the economic and technical performance of thirteen airports from 1998 to 2005. Methods used are Partial Factor Productivity (PFP), Data Envelopment Analysis (DEA), Stochastic Frontier Analysis (SFA) and Second Stage Tobit Regressions, which are applied to identify the characteristics of British and German airports and compare two different ownership structures: privatized and partially privatised with residual public ownership. The analysis aims to identify to what degree privatization contributes to or enhances the performance of the airports. Our results give support to the fact that the British (fully privatized) airports outperform the German ones. This paper improves the existing literature under two points of view. Firstly, it provides more detailed evidence on transnational productivity and performance comparisons of airports. Secondly, it uses a variety of methodologies to obtain consistent overall efficiency measures.

Keywords: Airport industry, productivity analysis, financial performance, privatization

GERMAN **A**IRPORT **P**ERFORMANCE

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1. INTRODUCTION[2]

With the liberalization of air transportation, airports have found themselves operating in an increasingly competitive environment, which is leading to significant organizational changes. Some of the publicly owned airports of the past have, over the last two decades, been partially or fully privatized. Privatization and commercialization have turned the airports into more profit oriented businesses that focus on higher returns to shareholders (Vogel, 2006). Whether this new organizational structure is giving a comparative advantage to the privatized airports in the fast-paced world of the aviation industry is one of the central issues discussed in the literature. The other crucial issue, differences in the financial performance of the privatized airports in comparison to the government owned ones, in the United Kingdom and Germany, is also addressed in this paper.

With the rise in air travel and the need to add capacity to existing airports, the importance of financing further infrastructure network has come to the fore. But this need for significant infrastructure investments has been constrained through limited state financial resources, causing governments to turn to the private sector and consideration of privatization, both in the UK and in Germany. The resulting sale of state-owned airports not only leads to flows of money to the public sector, but also to private sector, which management of operations is driven by profit maximization and efficiency over public welfare and political economy risks.

This study emerged out of need for more effective benchmarking analysis[3]. The question of comparison of airports with different structures remains attractive to the researchers since it helps identify the organizational structures that lead to the most efficiency and best performance. This paper follows in the tradition of an earlier paper "Privatization, Corporatization, Ownership Forms and their Effects on the Performance of the World's Major Airports" by Oum, Adler, and Yu (2006), which investigated the effects of ownership forms and management structure on the productive efficiency of a large sample of international airports with

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[2] This paper arose from Gajo Ovasapian's Diploma Thesis at the Berlin School of Economics (FHW). Several members of the Gap Team helped in the revisions and translation and further empirical estimates. We thank Gerry Abdesaken, Laura Fernández, David Gillen and Hans Martin Niemeier for providing additional comments and Ricardo Ribeiro and Tatiana Boytsova for helping in the empirical analysis.
This paper originates from the research project GAP (German Airport Performance) that is supported by the Federal Ministry of Research and Technology, see www.gap-projekt.de for further details.

[3] This, combined with the historically poor performance of German international airports, has motivated the creation of the *German Airport Performance* (GAP) research project to engage in a combined study to develop benchmarking approaches which address different aspects of airport operations, with a country specific application to Germany and neighboring EU countries.

different governance structures[4] from 2001-2003. Their analysis sheds light on the following issues:

1) Airports with government majority ownership and those owned by multi-level of government are significantly less efficient than 100% publicly owned airports.

2) There is no significant statistical evidence for the proposition that airports owned and operated by governments, independent airport authorities, or airports operated by 100% government corporations have lower operating efficiency than airports with a private majority ownership.

3) Airports with a private majority ownership generate higher profit margins than airports with different ownership structures while offering significantly lower aeronautical charges.

This aim in our study is to analyze and compare the German and British airports and assess their performance with respect to their ownership structure. The UK aviation industry has gone through a drastic change over the last two decades, replacing public ownership with the private sector. Following the *Airport Act 1986*, the BAA group went public in 1987 and over time the rising value of its share prices has become a symbol for the successful privatization programmes and a role model for other European airports. Even though the European governments were initially reluctant to privatization of their airports, the first trends towards privatizations were seen in Austria, the Netherlands, Italy, Greece and Germany throughout 1990s. Nevertheless, the privatization process within Continental Europe has still not been as rapid as in the UK, with very few airports placed fully into the private hands.

Our analysis therefore differentiates between fully privatized, partially privatized and public airports. We have used Partial Factor Productivity (PFP) indicators to measure how the effects of privatization influence labor and capital productivity of a sample of seven English and six German airports, exposed to similar market and economic conditions. After measuring relative efficiencies by using partial indicators, a frontier check comparing the overall efficiency of German and British airports will be presented using Data Envelopment Analysis (DEA) and Stochastic Frontier Analysis (SFA).

This paper is organized as follows. In the next section we explain how the performance measures in airport sector have been treated in the literature. Section 3 describes the dataset, outlines privatization processes in two countries and discusses the comparability issues. Section 4 presents the empirical results based on PFP, DEA, SFA and second stage Tobit regression. In the final Section some concluding remarks are made.

[4] Owned and operated by government departments; 100% government-owned corporations; mixed enterprises with government majority ownership; mixed enterprises with private majority ownership; and independent airport authorities.

2. REVIEW OF THE LITERATURE PERFORMANCE MEASUREMENT IN THE AIRPORT SECTOR

The methods of efficiency analysis in the context of airports include linear approaches, such as partial factor comparison (PFP), and more complex non-parametric and parametric statistical methods, e.g. DEA, SFA, Malmquist index and therefore these methodologies will be used to assess the effects of privatization on the performance. Furthermore, for a comparison of the airports in Germany and the UK, one must look at the institutional and regulatory differences between two countries and see what different outcomes are likely under these institutional arrangements.

Parker (1999) aimed at identifying the differences in performance that were supposed to be realized after the privatization of British Airport Authority (BAA) by applying DEA. At the first stage he measured technical efficiency of BAA airports for each year in the period of 1979/80-1995/96, whereby each year is regarded as a separate decision making unit (DMU). The findings of the study revealed no strong evidence of a considerate improvement in performance of BAA after the privatization. However, at the second stage he found that single BAA airport made better use of its capacity when its efficiency was compared against the efficiency of 17 other British airports from 1988/89-1996/9. Heathrow was the best performer over the period of analysis, whereas Glasgow and Edinburgh reached almost full efficiency towards the end of period. Stansted and Aberdeen were less technically efficient. Several non-BAA airports achieved very good performance. When two stages are put together, Parker (1998) concluded that the BAA represents are "*composite of varying performances across different airports operated by the company over time*." Yokomi (2005) used Malmquist index to measure pure technical efficiency of six BAA airports by removing the technical change from efficiency score. He found that the average scores were higher after the privatization than before it. He emphasized the non-aeronautical activities have achieved high growth after the privatization and contributed significantly to the productivity of the airport. In line with this is that management in a privatized company seeks out new ways (e.g. product diversification) to generate revenues.

Vasigh and Haririan (2003) measured operational and financial efficiency of privatized and non-privatized airports on a sample of British and American airports. Public airports had better operational and financial efficiency than their private counterparts. The higher revenues per PAX and per landing for the privatized airports in the UK indicate possibly the monopoly power of airports and undermine the merits of privatization for an average customer.

The paper by Vogel (2006) assesses the impact of the degree of privatization on the financial performance of 35 European airports in the period between 1990 and 2000. Privatized airports are more cost-efficient, and on average, they are ranked higher in terms of operating margins, the revenue/expenditure ratio and the ratio of cash flow to revenues. However, their increased operating efficiency does not affect the returns on shareholders' funds significantly. Contrary to the study of Oum, Adler and Yu(2006), Vogel found that partial privatization deals have also demonstrated synergies since they realized better cost efficiency, revenue generation and return on equity in comparison to the public and fully privatized airports. Publicly owned airports generate comparatively higher ratios of unit revenues and work load units to total assets. Their capital expenditure to total revenue ratio is lower and the asset turnover is higher. Their capital structure seems to bear more debt relative to their respective equity, which results in considerably higher gearing and financial leverage, compensating for the comparatively low rate of return on assets. Pels et al. (2003) applied both DEA and SFA to investigate the performance and the effects of economies of scale of 33 large European airports over the period 1995-1997. They concluded that average airports smaller operate under increasing returns to scale when processing PAX (passengers), whereas they operate under constant returns to scale when handling ATM (air transport movements). Furthermore, the relationship between airport size and efficiency scores was insignificant. The comparisons using DEA emerged on the national levels: Australia-Abbott and Wu (2002), Germany- Abdesaken and Cullmann (2006), Italy- Malighetti et al. (2007), Japan-Yoshida and Fujimoto (2004), Spain-Martin and Roman (2001).

In addition to this recent academic literature, long term airport benchmarking projects, such as ATRS[5] and TRL[6], have been also initiated with the goal to develop effective cross sectional benchmarking methodologies and to rank the world's top airport hubs in different categories such as labor productivity and technical efficiency. These studies often contradict one another due to their different approaches towards airport benchmarking[7]. To illustrate the results of this, Table 1 provides a comparison of the reported labor productivity estimations between ATRS and TRL in 2000. Even though they start with the same data base, a higher efficiency score is shown by TRL for Munich and Vienna Airports; however efficiency scores for Frankfurt remained consistent. Such unresolved issues stress the increased need to pursue further research in the area, and to consider additional methodologies to unchanged samples of study.

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[5] ATRS, the Airport Transport Research Society is an NGO that organizes academic conferences, but their biannual productivity comparisons and airport benchmarking are marketed commercially and they give out Airport Efficiency Excellence Award every year.

[6] TRL, the Transport Research Laboratory, is a commercial UK company, which carries out such studies related to airport performance indicators, airport charges, and airline performance indicators.

[7] While ATRS works with the unadjusted data, and therefore compares airports with different degrees of vertical integration, TRL tries to look only at the core business by subtracting (often quite arbitrarily) non core activities like ground handling and commercial services.

		ATRS 2000	TRL 2000		
1	ARN	26.352	26.241	ARN	1
2	OSL	22.955	23.531	AMS	2
3	ZRH	22.249	22.627	ZRH	3
4	AMS	20.270	22.447	OSL	4
5	LGW	17.814	19.066	LHR	5
6	LHR	17.002	18.092	LGW	6
7	GVA	16.008	18.032	MUC	7
8	CPH	12.617	17.979	GVA	8
9	MAN	7.067	14.632	VIE	9
10	MUC	5.714	13.174	CPH	10
11	VIE	4.879	10.692	MAN	11
12	FRA	3.459	8.050	FRA	12

Table 1: Ranking Discrepancies: Labor Productivity in Passengers per Employee (Kamp et al. 2005)

3. A LOOK AT THE EMPIRICAL EVIDENCE

3.1. DATA AND METHODOLOGY

This study is conducted with a small sample of 7 British and 6 German airports; from the UK we have used Aberdeen (ABZ), Glasgow (GLA), London City (LCY), London Heathrow (LHR), London Gatwick (LGW), London Stansted (STN) and Manchester (MAN); from Germany we included Düsseldorf (DUS), Frankfurt (FRA), Hamburg (HAM), Hanover (HAJ), Munich (MUC), Stuttgart (STR). Some background about the dimensions of the airports in the investigation is given by Figure 1.

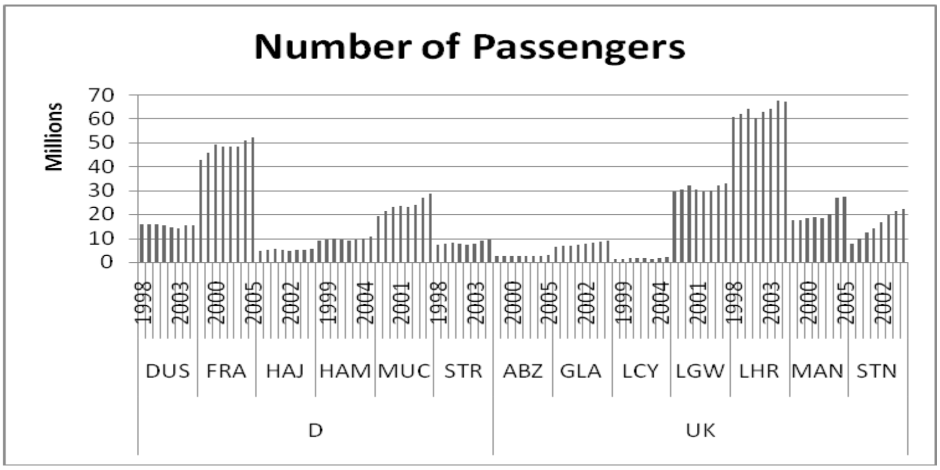

Figure 1: Size of Airports (1998-2004) measured in Passengers (millions)

Focus of Measurement		Indicator
Financial Performance		Real Costs per WLU Real Revenues per WLU Revenue-Expenses Ratio
Labor Productivity		WLU per Employee Movements per Employee
Capital Productivity	Runway Capacity	Movements / Runway Length
	Terminal Capacity	PAX(000) / Gate PAX / Terminal Area(sqm)

Table 2.:Partial factor productivity indicators

The physical and financial performance indicators of these 13 airports are observed from 1998 to 2005. The main variables used in the study can be grouped as traffic, capacity and financial variables. The main traffic data is the Work Load Unit (WLU), which is a combination of passengers and cargo (1 WLU = 1 passenger or 100 kilos of cargo), and aircraft movements. The capacity measures for capital productivity are number of gates, total length of runways and terminal size in square meters, whereas that for labor productivity is the number of employees. Financial variables are the costs and revenues of the airports.

The economic and technical performance of the airports is measured by means of PFP, DEA and SFA. PFP shows a simple ratio between different inputs and outputs, such as financial, capital and labor productivity (summarized in Table 2), to hint the productivity in different areas of airport operations. Cullinane et. al. (2006) explains the DEA and SFA briefly as follows: “DEA can be roughly defined as a non-parametric method of measuring the efficiency of a Decision Making Unit (DMU) with multiple inputs and/or multiple outputs. This is achieved by constructing a single ‘virtual’ output to a single ‘virtual’ input without pre-defining a production function. Introduced simultaneously by Aigner et al. (1977) and Meeusen and van den Broeck (1977), SFA assumes that a parametric function exists between production inputs and outputs. As an alternative approach to DEA, the great virtue of SFA is that it not only allows for technical inefficiency, but also acknowledges the fact that random shocks outside the control of producers can affect output. For this reason, the essential idea behind SFA is that the error term is composed of two parts; a one-sided component that captures the effects of inefficiency relative to the stochastic frontier, as well as a symmetric component that permits random variation of the frontier across firms, and captures the effects of measurement error, other statistical noise, and random shocks outside the firm’s control.” Before proceeding with the analyses, we will give a short overview of the development of airport privatization in these two countries.

3.2 PRIVATIZATION IN GERMANY

Airport industry in Germany is dominated by three types of ownership structures. First, the public airports are owned by joint local, regional and federal governments and often managed by local governments. Stuttgart and Munich are the most important examples of this type of ownership. The second group is composed of the partially privatized airports, which, next to private ownership, are owned by local, regional and federal governments, such as Düsseldorf and Hamburg. The last group consists of mostly small fully privatized airports, such as Niederrhein (NRN), which are owned and managed by a private company.

First privatizations of airports in Germany have started in late 1990s; however, the process of the change of ownership is still happening. Düsseldorf went first private by accident after the fire, which destroyed parts of the airport in 1996. No availability of public funds for a huge investment in the reconstruction works has forced state of Nordrhein-Westphalia to sell 50 %[8] of the airport. The traditional cost-based regulation continues to be used by the state regulator of this airport. (Becker et al., 2003)

In October 2000 the Hamburg airport went partly into the private hands. Hochtief Airport GmbH and Aer Rianta International (Hamburg Airport Partners) bought 36% for approximately 270 million Euro, and later increased their stake to 49%. The original owner, the City of Hamburg, still controls 51% of the shares, but may reduce its stake further. In 2000 the traditional cost-based regulation was replaced by a (dual-till) price-cap regulation (Becker et al., 2003).

The partial privatization of Frankfurt airport occurred in 2001. 25% of shares were placed in the stock market. These are now held by diverse holders, including a 10% share by Lufthansa. The airport followed the Hamburg model and agreed in 2002 with the regulator and the airport user council to introduce price-cap regulation. Hannover is a further example of partially privatized airport. 70% is owned by the state of Lower Saxony and the city of Hannover, while 30% is in the ownership of Fraport AG. As in Hamburg and Frankfurt, Hanover airport is also subject to price-cap regulation. The remaining German airports included in our analysis continue to be owned by local or state governments. Table 3 details the ownership patterns of German airports used in our comparison analysis.

[8]Hochtief Airport GmbH and Aer Rianta International bought this stake for 180 million Euro in 1997. After the purchase the airport partners invested 389 million Euro in the reconstruction of the terminal B. The investors' intention was to enable the airport to be able to use its full capacity in the shortest time possible and to follow a growth-oriented strategy.

Airport	Operating Company	Shareholders	Share
Düsseldorf International (DUS)	Flughafen Düsseldorf GmbH	City of Düsseldorf	50%
		Airport Partners GmbH	50%
Frankfurt/Main (FRA)	Fraport AG	Federal Republic of Germany	18.38%
		Federal State of Hessen	32.13%
		Stadtwerke Frankfurt Holding	20.52%
		Portfolio Investments	28.97%
Hamburg (HAM)	Flughafen Hamburg GmbH	City of Hamburg	51%
		Hamburg Airport Partners GmbH Co KG	49%
Hanover (HAJ)	Flughafen Hannover Langenhagen GmbH	Hannoversche Beteiligung GmbH	35%
		City of Hanover	35%
		Fraport AG and NordLB	30%
Munich (MUC)	Public Airport	Federal State of Bavaria	51%
		Federal Republic of Germany	26%
		City of Munich	23%
Stuttgart (STR)	Public Airport	Federal State of Baden-Wuerttemberg	50%
		City of Stuttgart	50%

Table 3: Ownership structure of major German airports (Source: Malina, 2005)

3.3 PRIVATIZATION IN THE UNITED KINGDOM

In contrast to Germany, the airports in the UK are not owned and managed by a government entity. Indeed, the UK government policy actively promotes and encourages private ownership of airports, and the majority of British airports are either partially or fully privatized (Gillen and Niemeier, 2006). Three types of airport ownership predominate in the United Kingdom. Most of airports are managed and owned by a private company. Examples of fully privatized airports include Liverpool and the BAA airports. Partially privatized airports, such as Birmingham and Newcastle, are operated by joint local government and private companies. An example of public airport is Manchester, owned and managed by local governments. Table 4 shows the privatization structure of the airports in the UK that were used in the analyses.

Airport	Status	Principal Owner
Aberdeen (ABZ)	Private	BAA
Glasgow (GLA)	Private	BAA
London City (LCY)	Private	AIG/GE/Credit Suisse
London Gatwick (LGW)	Private	BAA
London Heathrow (LHR)	Private	BAA
London Stansted (STN)	Private	BAA
Manchester (MAN)	Public	------------

Table 4: Ownership structure of the UK airports in the sample

The fundamental change in the airport industry occurred after the 1986 *Airports Act*[9] which was to introduce the privatization and commercialization into the sector with an aim to reduce the financial burden on the public sector through the encouragement of operations efficiency and access to private capital (Graham, 2006). When the airports were still owned by the public sector, it was difficult for them to borrow and mainly for this reason the government decided to privatize their operations. Humphrey (1999) named access to finance for expansion as the main reason for sale of most UK airports (not belonging to the BAA), which were privatized in course of 1990s. BAA, Peel Airport, Macquarie Airport and the public owned Manchester airport today own most of the regional airports. In 2006 Airport Development and Investment Limited (ADI), the investment arm of the Spanish construction firm Ferrovial, has taken over the BAA group.

3. 4 COMPARABILITY ISSUES OF AIRPORTS

The academic literature encountered a number of difficulties in attempts to benchmark the airports and identify the best performers in the airport sector, arising from differences in the following issues: accounting issues, regulatory regimes, degree of vertical integration.

a. Difference in accounting practices

Airport costs will also be affected by the accounting standards and procedures used. There are major variations in accounting practices because of the existence of different national accounting policies and regulations. Key problems associated with airport operations refer to calculating depreciation a number of the airport's assets excluded from the accounts. Because at some airports, assets owned directly by the government rather than the airport authority or those that have been financed from government grants do not appear in the balance sheet and are not depreciated (Doganis, 1992). While the majority of airports calculate depreciation on a straight line basis, some airports use the diminishing value method. There are significant

[9] The airports belonging to BAA were converted into private ownership after the Act.

differences within the decision on the life of the assets concerned. BAA lengthened the life of its assets after privatization. Between 1988 and 1990, the lives of runways, taxiways and aprons were extended from between fifteen to twenty-five years to one hundred years, thereby significantly reducing depreciation costs. These are much longer lives than used elsewhere (Doganis, 1992). These varying policies pose difficulties in making meaningful comparisons.

b. Differences in regulation regimes

The airports in two countries operate under different regulation systems. In the UK, both BAA plc London and Manchester airports have been subject to single till price cap regulation since 1987-88. The other smaller regional airports do not have direct price control as they are not considered to have sufficient market power to warrant this. (Betancor and Rendeiro, 2006)

The price cap is set at the Retail Price Index (RPI) less an adjustment for productivity. In recent years, the productivity adjustment (the X in RPI-X) has been quite large, exceeding the inflation rate. This results in a requirement for the airports to lower prices. At the five-year-review the airports are allowed special price increases to deal with new capital and other extraordinary items. Thus when a new terminal or runway is planned, the Civil Aviation Authority (CAA) allows the airport to increase its prices above RPI-X to reflect the increased cost of the new facilities. For instance, an upward adjustment in prices to compensate BAA was made when intra-Europe duty free sales were no longer allowed. A major impact of this single till regulation at the London airports has been that the commercial aspects of the business have been considerably expanded which has led to a substantial reduction in real charges to airline users. Airport charges still remained comparatively high which is one of the key reasons for the more restrictive price cap for the 1998-2003 period at Manchester airports.(Graham, 2003)

In Germany, pursuant to §43 of the Air Transport Licensing Regulation (Luftverkehrszulassungsordnung; LuftVZO), German airport fees for take-off and landing, terminal use and the parking of aircraft require a permission of the respective state authorities. They have to ensure that the fees are in line with the principles of cost-covering, public transport policy and appropriateness. Regulation is thus based on the cost-plus principle. This raises the problem that incentives for cost-cutting are limited. (Heymann, 2006) The majority of German airports follow this regulation policy whereas Hamburg and Frankfurt have implemented dual-till regulation.

c. Degree of vertical integration

We should understand the different business models behind the operations of the typical German and British airport. German airports are highly vertically integrated, whereas the UK airports are not. German airports run all the operations in-house (e.g. ground handling, car parking)[10]. On contrary, the British airports tend to outsource many activities. Such outsourcing activities deflate the number of employees included in an efficiency measure, which leads to favorable labor productivity measures, which does not necessarily imply highly efficient labor usage. This is shown in Figure 2 below, where the Berlin Airports appear to be extremely productive. This is because they are the only German airport group that outsources their ground handling services to a subsidiary mainly owned by Lufthansa and therefore need fewer employees for a much smaller core activity than typically performed by other German airports. Moreover, revenues and expenses are not evenly compared when data in the sample come from airports which outsource ground handling services and those that do not. Similarly, cost efficiencies and profitability are affected.

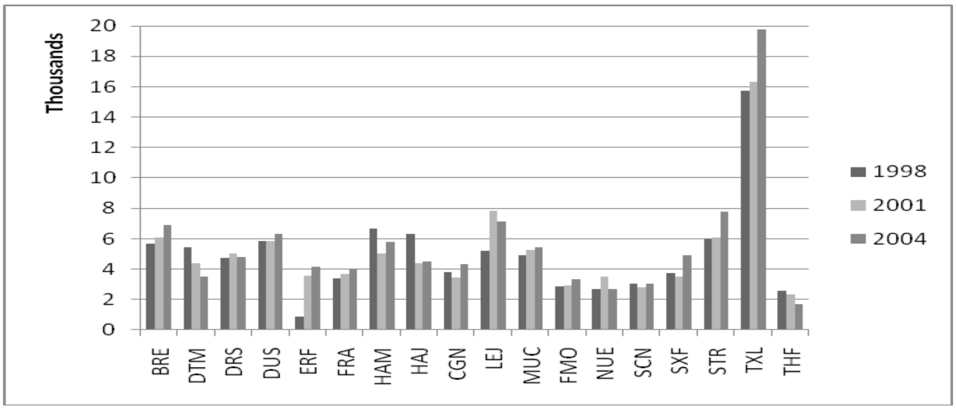

Figure 2: PAX per Employee for German international airports

Therefore, in benchmarking analysis one has to make appropriate adjustments. For example, if the outsourcing activities are included in the data, the employees of the company performing the operations should be added to the number of the airport employees. An alternative adjustment is carried out by TRL, which removed the ground handling operations out of the data. Nevertheless, as seen Table 1, all airports in Germany achieved low rankings in the TRL studies despite the adjustment in the data. However, Munich scores pretty well by achieving 18000 passengers per employee in 2000. This compares to only 7000 passengers per employee in 1999. The increase observed most probably comes about as a result of measurement errors rather than a productivity increase. It seems that TRL study accounted for the ground handling services in 1999 while excluding them in 2000 and this produced better performance measure for Munich airport. When the labor productivity in TRL is compared to ATRS (where no adjustments for outsourcing activities took place), Munich achieved much worse scores. This example illustrates very well how vertical integration distorts the analysis, or when adjusting for outsourcing activities, the productivity

[10] An exception is Berlin Airports which fully outsource their ground handling operations to GlobeGround. Berlin and BLAS.

measure changes dramatically.

The structure of revenues at a typical British and German airport should be given more attention. In general, German airports generate most income from airside activities, whereas the British airports, especially the large ones, often have commercial activities as the major sources of income. Dennis and Graham (2006) showed that airports that are highly dependent on the low cost carriers (LCC) have lower aviation revenues. The airports serving the LCC have had to charge lower fees in order to be attractive to this sort of traffic. With a rapid development of LCC, the discounting on airport charges has become a common practice. This explains why the airports have been turning to the non-aviation activities, which are now becoming the core revenues. On contrary, the airports in Germany have just pioneered into commercial activities; even so they have also been exposed to so much pressure of LCC[11]. Still, increased revenues from the non-aviation sector may also represent a future potential for the German airports.

3.5 WHAT HYPOTHESIS EMERGE

The privatizations have taken place mostly because of the need to reduce the burden of public sector and enhance the efficiency in the operation of the airports (Department of Transport, 1985). We expect that privatized or partially privatized airports achieve higher productivity, cost efficiencies and better capacity utilization than public airports. Some theories (transactions costs, property rights theory) support the view that the change of the ownership structure should result in cost efficiencies and higher profit-orientation.

Funds obtained from private sources should help the airports expand their facilities, offer more services as well as explore the option of generating additional revenues from commercial or non-aviation activities. The changing market environment should also have significant effects, as increased competition in the aviation sector produces cost cutting programmes that make also airports strive for higher efficiency. 100% government owned corporations are likely to realize lower performance due to the lack of control mechanism for their employees and less binding budget constraints; they will run higher costs that can be financed through tax collection.

[11] Eurocontrol (2004) shows an LCC share of 22% for the UK, and only 12% for Germany in 2004, but Wilken (2006) shows the LCC share in Germany rise to 22% for the first half of 2006

4. EMPIRICAL ANALYSIS

4.1. PARTIAL FACTOR PRODUCTIVITY ANALYSIS

4.1.1. Regarding financial comparison

We have looked at a number of financial indicators and recorded our impressions below, however further analysis is necessary: Figure 3 below shows the average real operating costs and revenues per WLU for each airport and Figure 4 shows the average revenue to expenses ratio for each country over the period 1998-2005. British airports are more cost efficient than the German ones, but we also observe wide variations in costs in for the two subgroups, sometimes due to the special nature of the airport (e.g. London City). In general, the better UK performance reflects their lower degree of vertical integration and the greater degree of outsourcing that we discussed above.[12] This can be further illuminated by looking at the number of employees at each respective airport, which is to be presented below (see Labor Productivity). Therefore, the best way to compare the airports is to investigate the time trends separately within the groups. When we analyze average growth rates over the period 1998-2005, interesting conclusions emerge for two countries. Real revenues and costs per WLU in both countries decreased over this period.

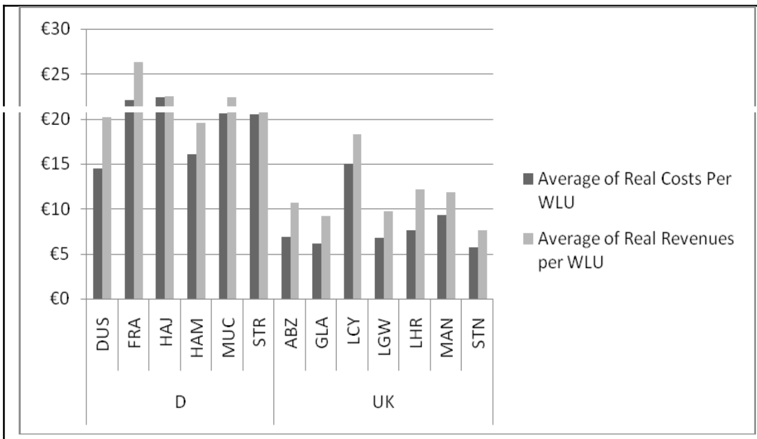

Figure 3: Average Real Costs and Revenues per WLU

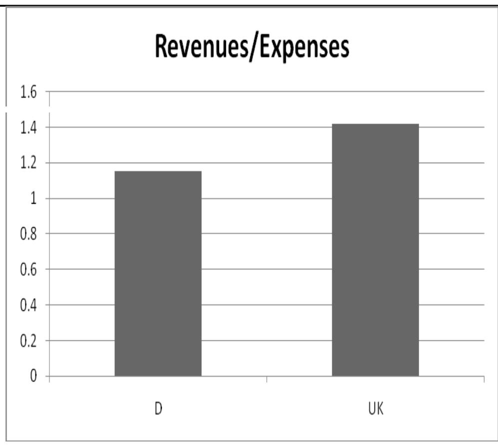

Figure 4: Average Revenues to Expenses

Figure 5, which shows the detailed trends for each airport, shows again that the British airports incur significantly lower costs than the German airports. Frankfurt has had the highest real costs per WLU, which has been rising over the time of analysis; whereas Hamburg and Hanover, the two partially privatized airports, tend to run lower costs than other public airports in Germany. From 2003 to 2004, a sharp drop in costs at Düsseldorf respectively is to be noted, warranting further investigation[13]. London City generates the

[12] Most of the UK airports are not engaged in ground handling and also outsource most of their non-aviation activities.

[13] Perhaps, the opening of a new terminal at Düsseldorf has lead to higher costs, as suggested below.

highest costs, whereas real costs show a significant drop for Manchester and an increase for Aberdeen. Stansted and Glasgow have the lowest ratio of all airports, possibly due to the pressure from low cost carriers.

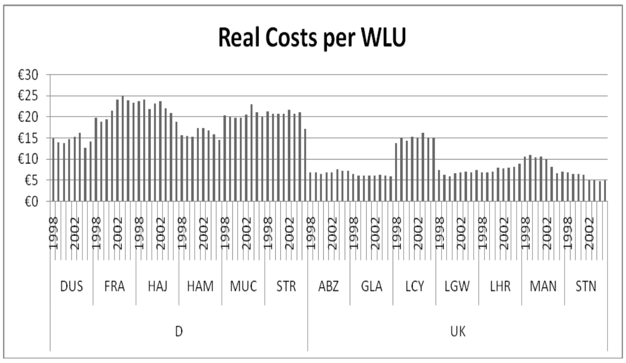

Figure 5:Real Costs per WLU

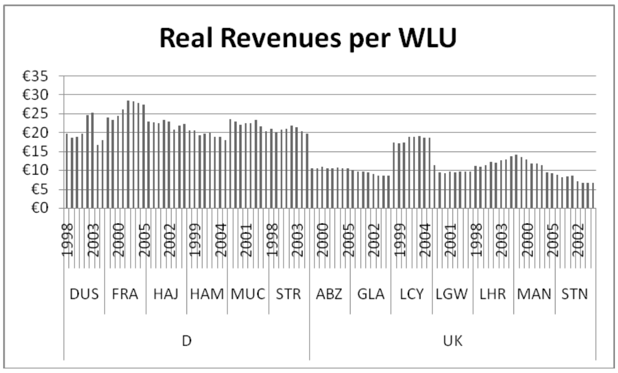

Figure 6: Real Revenues per WLU

Real costs per WLU at Heathrow, Frankfurt and Gatwick have shown a gradual growth after 2001, most likely due to higher security measures. For example, Frankfurt had €20 in late 1990s and reached €25 in 2003. These results are consistent with a previous study undertaken by Graham (2006).

German airports have much higher revenues per WLU, between €15 and €28. This could possibly result from high level of charges, but the increase in Frankfurt could also indicate higher non-aviation income or the strong effects of market power. Hamburg and Düsseldorf generated the lowest revenues; Stuttgart shows a stable trend over time. Among the British airports, Stansted and Glasgow are characterized by the lowest ratio of all airports, possibly due to pressure from low cost carriers, which has resulted in lower charges. London City generates the highest revenues most probably due to market power. The airport has locational rents and charges more, which indicates that people with high opportunity costs tend to fly from the airport.

4.1.2. Regarding labour productivity

In Figure 7, all British airports are much more efficient than German airports with respect to labor productivity (measured in WLU per employee). An average British airport worker seems to be more than twice as productive as his German counterpart. In a German airport a worker handles about 6000 WLUs per year, while for the British one this number almost reaches 16000. When analyzing trends at each airport, we note that as capacity utilization increased at Manchester, it rapidly rose and finally became the leader, overtaking Stansted, but also Gatwick and Glasgow moved up to the top by realizing slightly more than 20000 WLUs per employee. Among the German airports, Stuttgart appears to have become the most labor efficient, replacing Hamburg, while Hanover not only performs the worst, but also has a decreasing productivity in the last years.

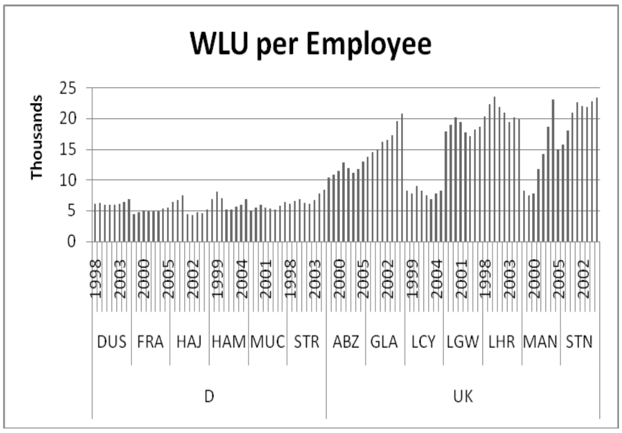

Figure 7: WLU per Employee

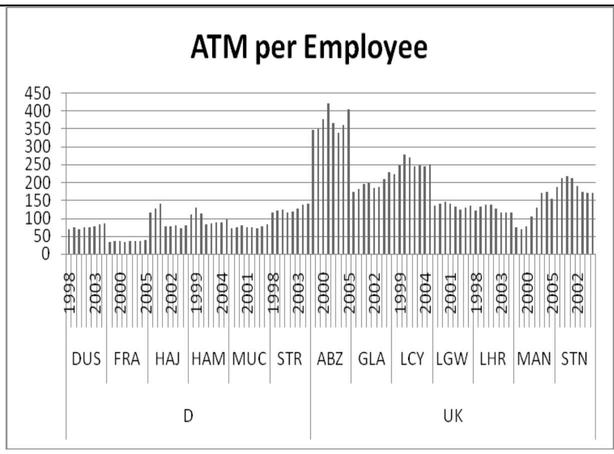

Figure 8: Movements per Employee

An additional labor efficiency indicator, movements per employee (Figure 8), confirms the favorable picture about more productive British airports. Given the discussion above, this is hardly surprising, due to the different degree of vertical integration previously mentioned[14]. We observe much more variation among the UK airports, whereas German labor productivity does not seem to vary much across airports. Figure 8 shows that the leader was Aberdeen, even though the ratio was not stable over time. It stems from the fact that Aberdeen could keep its number of employees at a low level, perhaps even outsourcing more than a typical UK airport, or perhaps having a very different fleet mix (see Figure 9). In comparison to the better performing British airports, German airports realized fewer aircraft movements per employee and their labor productivity was much lower. (The exception is Stuttgart.) The sudden decreases in Hanover and Hamburg with respect to this indicator are striking. Besides, Frankfurt remains to be the worst performer. The data also support that, labor productivity gets smaller if the aircrafts get bigger (fewer movements per employee). Figure 9 below shows the average aircraft size for each airport over 1998-2005. Aircraft size and vertical integration lead to biased results about labor productivity.

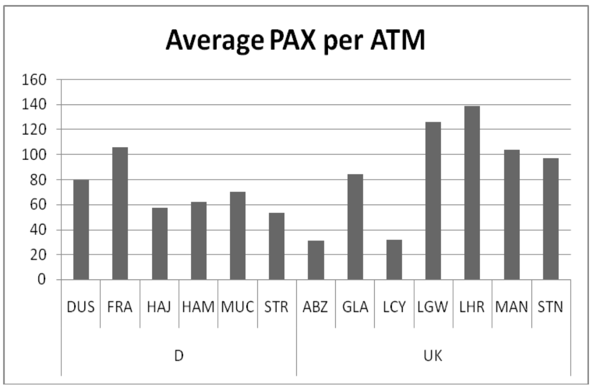

Figure 9: Average PAX per Movement

[14] Also, UK labor market characteristics, such as fewer and less powerful labor unions, less rigidities in the labor market, and more competition from service providers may also play a role in these results.

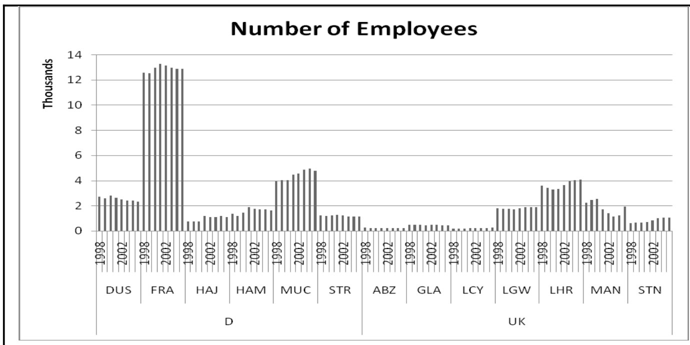

Figure 10: Number of Employees

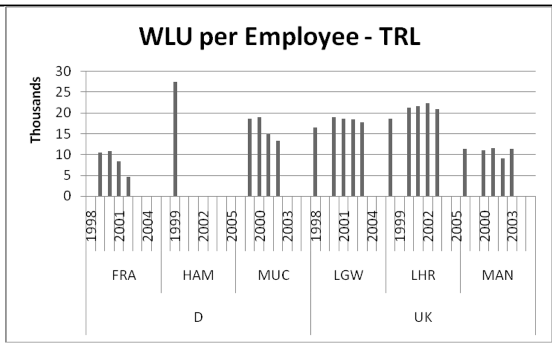

Figure 11: WLU per Employee with TRL-Adjusted Employee Numbers

Large differences in labor productivity come from vertical integration. A quick look at the number of employees at the different airports helps to illustrate the huge differences between the labor productivity in these countries (see Figure 10). This becomes especially apparent, if one compares the figures for London and Frankfurt. Frankfurt has more than 3 times as many employees as London, mainly for activities, which are all outsourced in London. This makes partial productivity comparisons across the two countries so difficult. Still some of the time trends are very interesting. For a better comparison one should exclude outsourced activities from the German airports, as TRL did. Unfortunately, the adjusted figures by TRL for employee numbers cover only a few airports and a few years. However, in order to get a grasp of how the employee numbers would distort the analysis of labor productivity, the WLU per Employee is depicted in Figure 11, when the employee numbers are comparable. As expected the labor productivity increases in German airports when compared to those in Figure 7, as the ratios are now based on the adjusted employee numbers, i.e. lower numbers of employees.

4.1.3. Regarding capital productivity

Number of gates, terminal size and length of runways are measures for capital (and very lumpy investments), but not perfect measures; therefore we are measuring capacity utilization instead of capital productivity and we are trying to identify which airports make best use of their capacity and which ones are operating with overcapacity and undertaking excessive investment. Measurement of capacity by using runways is still a controversial issue[15]. Total length of runways is considered to be a better measure than the number of

[15] In general, the number of runways represents a rather controversial measure since many airports possess the runways that are not used (e.g. Köln-Bonn Airport keeps one runway only for historical reasons) or have such a runway system where simultaneous landings and take-offs are restricted (e.g. Düsseldorf). In fact, runway capacity depends on multiple factors, the most important of which are the type of multiple runway system and regulatory restrictions. Airports located in areas which are susceptible to erratic weather changes also might build a runway which is orientated at a different degree. Dangerous cross-winds, which could cause massive delays at airports with only one runway or a parallel runway system, therefore become a non-issue at airports which prepare for this by building a runway at a different angle, allowing airplanes to land more safely. These runways cannot be used concurrently

runways, since some airports (e.g. Hanover) have short runways for general aviation only and indicators based on movements per runway could be very misleading.

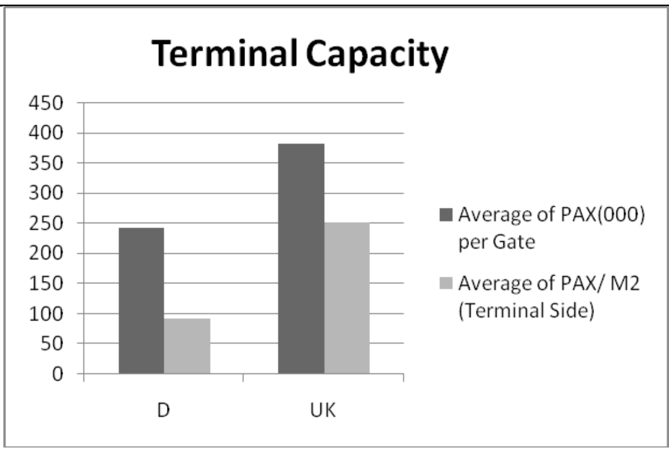

Figure 12: Capital Productivity Indicators

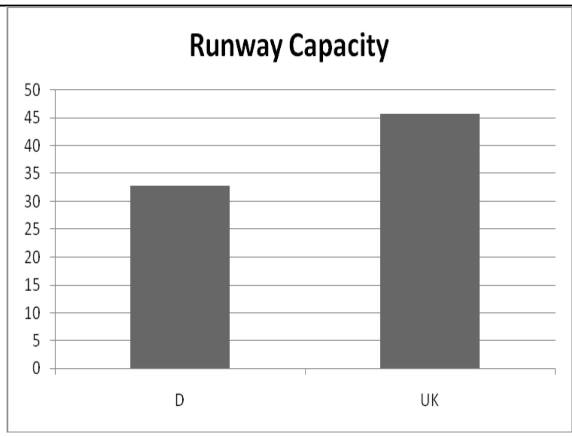

Figure 13: ATM/Runway Length

Figure 12 and 13 show that over 1998-2005 British airports utilize its capacity much better than the German ones. In this period British airports served around 382 thousands passengers per gate, whereas German airports could only reach 242 thousands passengers. In addition, Figure 14 shows that the British airports utilized their runways more efficiently over this period.

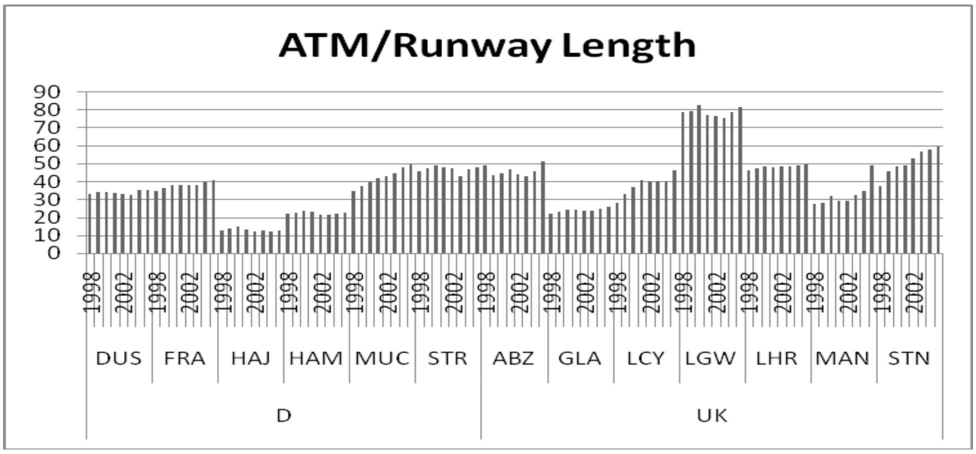

Figure 14: ATM / Runway Length

Gatwick achieves a high score thanks to the high number of movements it receives. It is one of the airports with the most traffic volume in the world; however, this reflects capacity bottlenecks as it has only one runway at its disposal.[16] The other two London airports, next to Frankfurt and Munich airports, also have a high level of aircraft movements. Among the German airports, Munich has consistently achieved the best

because they usually intersect one another, an example of which can be seen at Dublin airport, where both runways intersect at their ends and disallow concurrent takeoffs and landings.

[16] Even though the construction of a new runway has been expected in the near future, due to the protests of residents about noise and gases the decision has been postponed till 2019

capacity utilization since 2000, however most other German airports seem to be operating with overcapacity[17].

A different picture emerges when looking at PAX/gate in Figure 15. With more than one million passengers per gate, Heathrow outperforms both other British and all German airports. The airport in Frankfurt, which served approximately 300,000 passengers per gate between 1998 and 2004, has reached its capacity limit.[18] More interestingly, Düsseldorf is initially characterized by very large number of passengers per gate, which dropped sharply in 2001. Before 2001 two terminals were not used due to the fire accident and capacity utilization in the remaining terminals strongly improved, but dropped when the number of gates increased from 34 to 84. This becomes very obvious when looking at Figure 16. While at most of the airports the numbers of gates remained constant, the very large increases in Stuttgart and Munich brought about huge changes in productivity per gate.

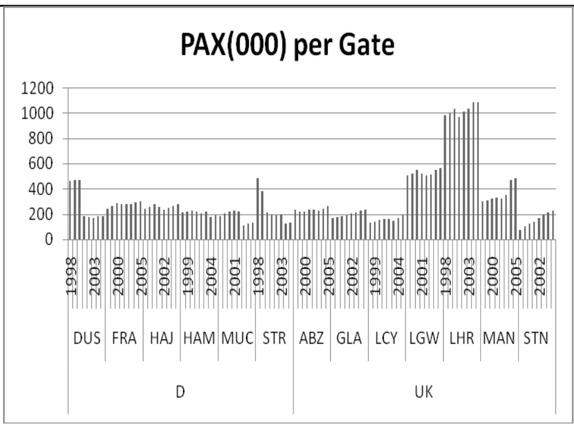

Figure 15: PAX (000) per Gate

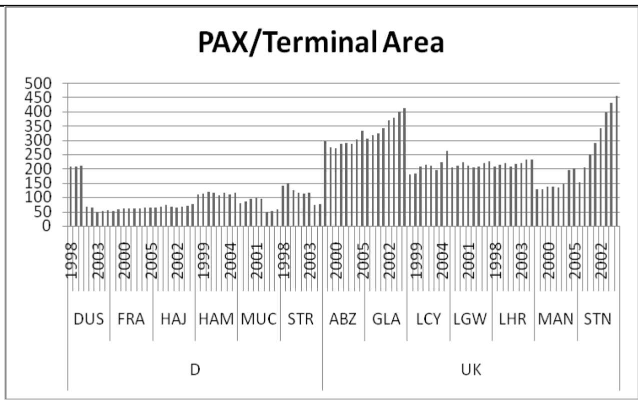

Figure 16: PAX per Terminal Area

The productivity development after large capacity increases can also be observed when looking at PAX/terminal area. Stansted triples its figure in 8 years and reaches the top among these airports thanks to an increasing number of passengers. Aberdeen and Glasgow follow with an increasing trend over this period. German airports report about 100,000 fewer passengers per terminal area and, in this sense, are comparably less productive than their British counterparts. In Düsseldorf, Munich and Stuttgart performance has dropped again, when the new terminal came into operation.

[17] Obviously, this is can not be influenced by management in the short term, and as a consequence, is less affected by different governance structures.

[18] In order to be able to serve additional 25-30 million passengers per year, the authorities decided to build the Terminal 3.

4.2 DATA ENVELOPMENT ANALYSIS (DEA)

From our review of the literature we recall that output and input specification represents a major issue when using methodologies like DEA or stochastic functions. The basic point is that we no longer just work with ratios, but now have to think about how to model the production process and its characteristics. DEA represents a powerful measure since it gives a whole picture and helps us confirm some of the previous findings.

Following Pels, Nijkamp and Rietveld (2001) and Kamp (2004), the most appropriate input-output combination for the DEA seemed to be the following:

Output: Number of Passengers

Inputs: Terminal Area, Number of Check-in Counters, Number of Gates

Since the DEA deals with the technical capacity comparison, these three capacity measures are the most important ones. However, in our partial analysis above, we have also seen how problematic some of these input variables are in representing the production process[19]. In addition, one should keep in mind the fact that, this analysis focuses on the terminal side efficiency, but not on the airside efficiency due to lack of data.

By using the same input-output combinations two different DEAs were implemented in this work. First one used the 8 years in the period to see the yearly efficiency trend within the airports and the second used only 2005, which shows if the airports operate under decreasing or increasing returns to scale. Since the sample includes airports with some differences in capacities, variable returns to scale were assumed when undertaking DEA. More specifically, output-oriented DEA was used in our analysis, which means airports focus on maximizing the output (PAX), holding all the inputs constant.

[19] In other DEA applications to airports, Martin and Roman (2001) studied 37 Spanish airports considering physical outputs (passengers, tons of cargo and aircraft movements) and cost of labor, capital and materials as inputs. Sarkis (2000) studied 44 U.S. airports by using operational cost, employees, gates and runway as inputs and operational revenues, passengers, aircraft movements and tons of cargo as outputs. Moreover, he differentiated between hub airports and others. In a study by Pacheco and Fernandez (2003), with data on 35 Brazilian domestic airports for 1998, revenue types (operating, commercial and other miscellaneous revenues) and domestic passengers and cargo were used as outputs, while employees, payroll and operating expenses measured inputs. Yoshida and Fujimoto (2004) used data from 67 Japanese airports in 2000 and estimated both DEA and endogenous weighted TFP (EW-TFP) index methods. Their dataset contains passengers, cargo and aircraft movements as outputs and runway length, terminal size, access cost (an estimated value including both monetary and time costs to reach an airport location) and number of employees as inputs. Abbott and Wu (2002) used Malmquist TFP and DEA to analyze the efficiency performance of 12 main Australian airports on the period 1990-2000. They used passengers and freight cargo as the outputs and staff employed, capital stock in constant dollar terms and runway length as the inputs.

With a sample of 13 airports, the DEA led to the following results in Figure 17: Among German airports, Frankfurt has the most efficient DEA score because of the high number of passengers and high capacity utilization. Hanover was clearly operating below capacity; as we had seen in the PFP analysis. Indeed it could have served two times more passengers than it actually did. The poor performance of Hanover airport does not stem from a recent expansion of capacity, but from the ongoing overcapacity when compared to other airports in the sample.

The dramatic decrease in efficiency of the Stuttgart airport seems to be the result of expansions of the terminal. While more than doubling the physical capacity of the airport, the number of passengers only increased from 7.2 million in 1998 to 9.4 million in 2005, leaving it with significant excess capacity. The same explanation applies to Düsseldorf, which had to recover from the fire. The two input measures we used increased more than twofold from 1998 to 2005. However, the number of passengers actually slightly decreased as a result of noise related capacity restrictions that have come into force during the period of analysis. Lastly, the measured efficiency of the Munich airport halved in 2003, due to the opening of new Terminal II and thereby increasing numbers of gates and check-in counters. The number of passengers initially decreased slightly, but then has increased steadily after 2002.

Clearly, such lumpy capacity increases play an important role as far as the long-term strategy of the airport is concerned, since capacity in the airports is subject to indivisibilities. By expanding capacity, the number of passengers cannot be increased simultaneously by as much as the new capacity would allow. Therefore, it turns natural to ask whether this capacity investment is necessary for the airport or not. On the other hand, such capacity investments require some time for demand to catch up, until their capacity can be fully used.

With a corresponding efficiency score of 1.000 Aberdeen, London City and Heathrow are considered perfectly efficient. One can see that these airports were the reference benchmark in all the years. In addition to that, Glasgow and Stansted reached almost a perfectly efficient score.

Hence, the conclusion of the DEA analysis is that the German airports lie far behind the optimal output level, which would pertain if the inputs were used efficiently. While the mean efficiency score for British airports is 0.936 for the whole period 1998- 2005, it is 0.718 for German airports.

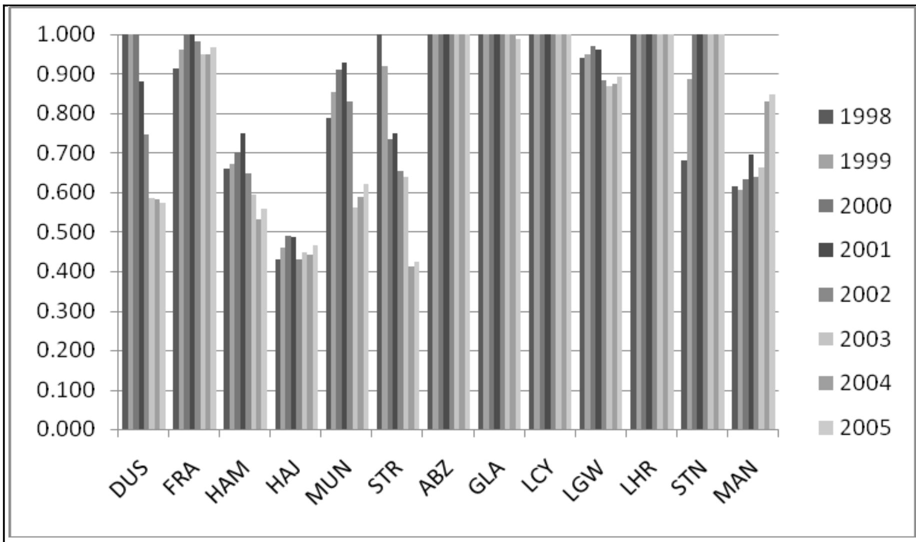

Figure 17: DEA Scores between 1998-2005

Airport	TE	Scale
DUS	0.572	irs
FRA	0.782	drs
HAM	0.548	irs
HAJ	0.443	irs
MUN	0.449	drs
STR	0.421	irs
ABZ	0.928	irs
GLA	0.97	irs
LCY	0.716	irs
LGW	0.892	irs
LHR	1	-
STN	1	-
MAN	0.841	irs

Figure 18: DEA Results for 2005

Output oriented DEA was again implemented by using the same inputs and output for 2005 for the 13 airports. Figure 18 above shows the results. Frankfurt and Munich are the airports which operate under decreasing returns to scale. If the terminals in these airports are expanded (i.e. inputs are increased), the passenger numbers would not increase as much as the increase in terminal inputs. On the other hand, for the other airports (except LHR and STN) a terminal expansion would bring more passengers in an increasing scale.

4.3 STOCHASTIC FRONTIER ANALYSIS (SFA)

In what the production estimation is concerned, we assumed a Cobb-Douglas technology for the general production function $f\ (x_{it};\beta)$. Given the high correlation between the inputs we considered them separately. Table 5 below presents the results for the estimation of both random-effects, fixed effects and frontier production specifications using the total number of gates, terminal size and total number of check-in counters as inputs, respectively. The assumed technology enables empirically an extremely high fit and thereby gains from more flexible models are not foreseeable.

Variable	RE	FE	FRONTIER
Gates	0.208 (0.047)	0.100 (0.037)	0.132(0.065)
Gamma	---	---	0.985 (0.010)

Variable	RE	FE	FRONTIER
Terminal Area (in sqm)	0.252 (0.061)	0.070 (0.043)	0.131(0.067)
Gamma	---	---	0.983 (0.012)

Variable	RE	FE	FRONTIER
Check-in Counters	0.800 (0.070)	0.287 (0.062)	0.780 (0.074)
Gamma	---	---	0.946 (0.056)

*All regressions are based on 104 observations s.e. in parentheses (asymptotically robust for RE and FE).

Table 5: Estimation of Production by using SFA

Airports	Gates	Terminal Area	Check-in Counters
DUS	0.224	0.240	0.720
FRA	0.609	0.614	0.918
HAM	0.145	0.165	0.530
HAJ	0.087	0.089	0.316
MUC	0.308	0.339	0.689
STR	0.124	0.139	0.526
ABZ	0.047	0.060	0.504
GLA	0.118	0.156	0.602
LCY	0.029	0.037	0.243
LGW	0.451	0.491	0.676
LHR	0.917	0.919	0.950
STN	0.199	0.268	0.915
MAN	0.299	0.327	0.606

Table 6: Efficiency Scores

In what concerns the frontier specification, total number of gates, terminal size and total number of check-in-counters tend to be significant. The coefficients are estimated to be significantly smaller than one. This implies that the returns to scale are decreasing. In what efficiency is concerned, the ratio $\gamma = \frac{\sigma_u^2}{\sigma^2}$ is estimated to be almost 1 indicating that most of the deviations from the frontier are due to firm-specific inefficiencies. Table 6 presents for each of the three cases reported previously the median estimates of technical efficiency $TE_i = E\left[\exp\left(u_i\right)\right] \leq 1$ by firm, where higher values of TE_i correspond to more efficient firms and $TE_i = 1$ denotes a firm on the efficient frontier. Heathrow and Frankfurt achieve the best efficiency scores, which leads to a conclusion that this technique favors big airports with a large number of passengers.

4.4 SECOND STAGE TOBIT REGRESSION

The purpose of this part is to estimate numerically the effect of privatization on the airport efficiency. To do this we follow the ideas of Gillen and Lall (1997). Tobit model is an appropriate measure since the efficiency scores are censored, and they can not exceed 1 nor be lower than 0. The idea of the Tobit model is that we observe the variable only within a certain limits. If the true value of an unobservable dependent variable lies outside of the limits, we observe it as the value at the limit.

We have used the DEA results which were found in section 4.2 as our efficiency parameters in this analysis. The number of check-in counters, the number of gates and the number of runways are assumed to have an effect on the airport efficiency. Terminal area is ignored, since the most bottlenecks happen to be in gates and check-in counters. Including these three variables should provide evidence, if the scale of the airport has any effect on the efficiency. According the findings of Gillen and Lall (1997), increasing number of gates should decrease the efficiency, and the number of runaways is positively related to the efficiency, but the relationship is insignificant. In addition to that, the location in the UK or Germany ("Being in the UK" was introduced as a dummy variable specially to account for the other country-specific effects) and the ownership structure are assumed to affect the efficiency scores that were found in the previous analysis. It is expected, that 100% private airports are more efficient than the ones owned by the government. The results for the second stage Tobit regression can be found in Table 6 below.

Variable	Tobit coefficient[20]	t-statistics
Number of gates	.0010982*	1.89
Number of check-in counters	-.0001879	-0.75
Number of runways	.0594871	1.52
Country UK (dummy)	-.0068674	-0.09
Being private	.4940825***	6.05
Being partially private	-.0684006	-0.86
Year 1999[21]	.0194172	0.24
Year 2000	.0728532	0.85
Year 2001	.0586285	0.69
Year 2002	-.0180799	-0.22
Year 2003	-.0505771	-0.57
Year 2004	-.073012	-0.83
Year 2005	-.0713064	-0.82
Constant term	.5655854***	5.71

Table 7: Results of Tobit Regression

The coefficients of the Tobit estimation can not be interpreted as the marginal effects, but we can judge, if there is an influence, and what the direction of the relationship is. Three main conclusions are striking;

1- Being private increases the efficiency of airports and this relationship is significant.
2- Bigger airports tend to be more efficient (that is expressed in the coefficient before the variable "Number of gates")
3- Being partially private has a negative relationship with the airport performance, but the relationship is not significant.

In addition to that, we included the one year lagged privatization terms in the estimation, because one might suppose that the effects of the privatization will appear with a certain lag. The results of this estimation also confirmed the results of first estimation.

[20] *** - significant at 1 %
** - significant at 5%
* - significant at 10%

[21] Year 1998 is omitted so that it is possible to include the constant term

5. CONCLUSION

The impact of ownership structure on the performance and efficiency of the airports has risen much interest in the literature. On the case of the German and British airports we attempted to better illuminate the effects of structural changes, as airport privatization started to take effect. Privatizations allowed new investors to finance infrastructure expansion and provided changes in management. Measuring the effects on performance has been a rather difficult task since airports are exposed to different degree of vertical integration, economies of scale, regulatory arrangements and charges structures.

On a sample of 13 airports, we cannot explain the performance differences by the mere effects of privatization. The British airports appear more efficient; however, the results are biased due to vertical integration effects. Furthermore, the picture concerning the overall performance of privatized airports in the sample is less conclusive. In particular, we obtained mixed results on German airports. Partially privatized German airports tend to achieve lower labor and capital productivity (e.g. Frankfurt, Hanover). More traffic volume and better capacity utilization are characteristics of British airports, whereas overcapacities are encountered at some German airports. Some ratios in the PFP analysis supported the hypothesis for higher efficiency of privatized airports, but sometimes this trend is subtle. Manchester, a publicly owned airport, achieves a considerable high efficiency with respect labor and capital, and in few instances outperforms the partially privatized German airports. Moreover, partial indicators are dramatically affected by the changes in capacities. When an additional terminal is added, the performance drops significantly.

DEA and Tobit regression indicate better efficiency of private airports. Private ownership structure contributes to the increased efficiency of airports. DEA efficiency scores are to be interpreted as the ability of an airport to utilize its capacity, which puts the effects of privatization in the background, as a minor influence on the performance. SFA and Tobit regression have implied that bigger airports are more efficient. Tobit regression confirmed a significant relationship between the fully privatized airports and efficiency, whereas partial privatization showed a negative influence on performance.

Benchmarking analysis in this paper summarizes the performance differences between British and German airports, however, it also points put the deficiencies in methodology. Thereforefurther research and a broader comparison on a European level are needed. Problems of data, unconsolidated data sources and other constraints most often limit such a benchmarking analysis. Overcoming these problems will be a key challenge in developing a better understanding and creating a basis for comparison on the effects and fruits of privatization.

REFERENCES

Abbott M. and **Wu**, S. (2002): Total factor productivity and efficiency of Australian airports, The Australian Economic Review, 35, 244-260.

Abdesaken G. and **Cullmann** A. (2006): The Relative Efficiency of German Airports;
An Application of Partial Factor Methodology and Data Envelopment Analysis, German Airport Performance (GAP) discussion paper, Berlin

Betancor O. and **Rendeiro** R. (2006): Regulating Privatized Infrastructures and Airport Services, University of Las Palmas. Internet Publication: URL:
http://wbln0018.worldbank.org/Research/workpapers.nsf/bd04ac9da150d30385256815005076ce/6fecfad5719d54df8525680400091144/$FILE/wps2180.pdf [10 April 2006].

Civil Aviation Authority (2000): The Use of Benchmarking in the Airport Reviews, Consultation Paper.

Cullinane, K.,**Wang** T.-F.-F., **Song**, D-W. and **Ji**, P. (2006): The Technical Efficiency of Container Ports: Comparing Data Envelopment Analysis and Stochastic Frontier Analysis, Transportation Research A: Policy and Practice, Vol. 40, pp. 354-374

Ehmer H., **Ivanova** P., **Müller-Rostin** Ch., **Müller** J. and **Niemeier** H-M.(2007): Airport Entry and Exit in Europe, Gap Discussion Paper, Bad Honnef, Berlin and Bremen.

Dennis N. and **Graham** A. (2006): Airport Traffic Growth and Airport Financial Performance: Has the low cost airline boom been successful for airline operators?, Working paper, University Westminster.

Department of Transport (2003): The Future of the White Paper, www.dft.gov.uk

Doganis R. (1992): The airport business, London, New York: Routledge.

Eurocontrol (2004): LCC Study,
http://www.eurocontrol.int/statfor/gallery/content/public/documents/doc_119%20Low- cost%20study %20Dec04.pdf

Gillen D. and **Lall** A. (1997): Developing measures of airport productivity and performance:

An application of data envelopment analysis, Transportation Research E, 33, 261 – 273.

Gillen and Niemeier (2006): Comparative Political Economy and Infrastructure Performance:
The Case of Airports, Airport Economics, Policy and Management: The European Union, "Rafael del Pino Foundation", Madrid.

Graham A. (2006): Comparative political economy and infrastructure performance: the case for airports.

Graham A. (2003): Managing airports an international perspective, 2nd edition, Amsterdam, Elsevier.

Heymann E. (2006): Privatization and Regulation of German airports, Current Issues.
Deutsche Bank Research. Internet Publication: URL: http://www.dbresearch.com/ PROD/DBR_INTERNET_EN-PROD/PROD0000000000075253.pdf, [19 May 2006].

Humphreys I. (1999): Privatisation and commercialization changes in UK airport ownership patterns, Journal of Transport Geography, 7, 122-134.

Kamp V. (2004): The Measurement of the Technical Efficency of German Airports, MA Thesis, Bremen.

Kamp V., Müller J. and Niemeier H-M. (2006): Can We Learn From Benchmarking Studies of Airports and Where Do We Want To Go From Here?, Journal of Airport Management , 2006,
Vol 1 No. 3

Malighetti P., **Martini** G., **Paleari** S., **Redondi** R. (2007): Efficiency in Italian Airport Management: The Implications for Regulation, Working paper, University of Bergamo.1-25

Malina R. (2005): Market Power and the Need for Regulation in the German Airport Market, 4th conference on applied infrastructure research, Regulation and Organizational Models in Infrastructure Sectors, Berlin.

Martin J.C. and **Roman** C. (2001): An application of DEA to measure the efficiency of Spanish airports prior to privatization, Journal of Air Transport Management, 7, 149-157.

Niemeier H-M. (2002): Flughafenprivatisierung und Optionen der Entgeltregulierung (2002). Paper für Seminar „Zur Entgeltregulierung von Flughäfen: Erfahrungen, Optionen- Reformnotwendigkeiten“, Deutsches Zentrum für Luft- und Raumfahrt, Deutsches Verkehrsforum Luftverkehrswissenschaftliches in

Zusammenarbeit mit dem Bundesministerium für Verkehr, Bau- und Wohnungswesen Berlin, 2002, 1-30.

Oum T.H., **Adler** N., and **Yu** Ch. (2006): Privatization, Corporatization, Ownership Forms and their Effects on the Performance of the World's Major Airports, Sauder School of Business, University of British Columbia, Vancouver, V6T 1Z2, Canada.

Parker, D. (1999): The performance of BAA before and after Privatization, Journal of Transport Economics and Policy, Vol. 33 No.2, 133–46.

Pels E., **Nijkamp** P. and **Rietveld** P. (2003): Inefficiency and scale economics of European Airport Operations, Transportation Research Part E, 39, 341-361.

Salazar de la Cruz, F. (1999): A DEA approach to the airport producti function, International Journal of Transport Economics, Vol. 26 No.2 , 255-70.

Wilken D. (2006): The Development of Low Cost Carrier Services in Germany, DRL, Cologne, http://www.garsonline.de/Downloads/061112/GARS-LCC-LondonNov2006.pdf

Vasigh B. and **Haririan** M. (2003): An empirical investigation of financial and operational efficiency of private versus public airports, Journal of Air Transportation, Vol. 8. No: 1.

Vogel H-A.(2006): Impact of privatisation on the financial and economic performance of European airports, The Aeronautical Journal, No. 2984, pp.197-213.

Yokomi M. (2005): Measurement Malmquist index of privatized BAAplc, 9th ATRS World Conference 2005, Rio de Janeiro, Brazil.

Yoshida Y. and **Fujimoto** H. (2004): Japanese-airport benchmarking with the DEA and endogenous weight TFP methods: testing the criticism of overinvestment in Japanese regional airports, Transportation Research Part E, 40, 533-546.

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Capacity Measurements in Airport Sector: Drawbacks of Conventional Methods and Benchmarking Airports Using Declared Capacity, Tolga Ülkü, Paper No. 1., March 2009

Restructuring of the European Groundhandling Market after the EU Market Liberalization
Flohr, Lena; Schulz, Stefan; Berlin School of Economics and Law (HWR); February 2008

Benchmarking of German Airports - Some First Reults And An Agenda For Further Research
Kamp, Vanessa; Niemeier, Hans-Martin; University of Applied Sciences Bremen

Can We Learn From Benchmarking Studies Of Airports And Where Do We Want To Go From Here
Kamp, Vanessa; Niemeier, Hans-Martin; University of Applied Sciences Bremen

The Relative Efficiency of German Airports: An Application of Partial Factor Methodology and Data Envelopment Analysis, Abdesaken, Gerry; Cullmann, Astrid; December 2006

Privatisierungsentwicklung im deutschen Flughafensektor, Dummann, Frank; July 2005

Möglichkeiten der Regulierung von deutschen Flughäfen, Dummann, Frank, July 2005

Die Entwicklung der Low-Cost-Carrier und ihr Einfluss auf die Flughäfen, Hofer, Sören Matthias; Juli 2005

Das Benchmarkingkonzept, Schubert, Franziska