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**Working Paper**

## Can we learn from benchmarking studies of airports and where do we want to go from here?

Working Paper, No. 28

**Provided in Cooperation with:**

IMB Institute of Management Berlin, Berlin School of Economics and Law

*Suggested Citation:* Müller, Jürgen; Kamp, Vanessa; Niemeier, Hans-Martin (2005) : Can we learn from benchmarking studies of airports and where do we want to go from here?, Working Paper, No. 28, Fachhochschule für Wirtschaft Berlin, IMB Institute of Management Berlin, Berlin

This Version is available at:

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## Working Papers

# Can We Learn From Benchmarking Studies of Airports and Where do we Want to go From Here?

Author: Jürgen Müller, Vanessa Kamp, Hans-Martin Niemeier

Section: Business & Management  
Paper No. 28, 11/2005

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# **Can We Learn From Benchmarking Studies of Airports and Where do we Want to go From Here?**

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Paper No. 28, 11/2005

Working Papers of  
The Institute of Management Berlin at the  
Berlin School of Economics (FHW-Berlin)  
Badensche Str. 50-51, D-10825 Berlin

Editors:  
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ISSN 1436 3151

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We thank Lori Palotas, Annika Reinhold, Cosgun Sagol and Sylvana Thiele for research assistance, helpful comments by Peter Forsyth and David Gillen are gratefully acknowledged. This paper arose from the research project GAP (German Airport Performance) supported by the Federal Ministry of Research and Technology, see [www.gap-projekt.de](http://www.gap-projekt.de) for further details.

## **Abstract**

This paper outlines some first results from a study on the technical efficiency and total factor productivity (TFP) of 17 international airports in Germany. The analysis was undertaken with panel data from 1998 - 2002. According to the Malmquist-DEA the performance at nearly every airport decreased from 2001, mainly due to the aftermath of September 11, 2001. As was assumed, the technical efficiency and productivity of most airports declined. This was especially the case for the terminal side since capacity expansions in the form of new or additional terminal buildings increased excess supply while passenger volume was decreasing. This study is the first step of a larger research project on measuring the performance of German airports.

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## 1. Introduction

What is the motivation for and significance of doing airport benchmarking and who is interested in the results of such studies? Generally speaking, airport benchmarking aims to provide objective comparative data on capacity utilization or financial performance. Consequently, it identifies best practice standards for facilities and services. Such studies are very useful for different groups of stakeholders and users of airports. For instance, airlines are concerned about the relative performance of the airports they use; the economic communities interlinked with the airport and local regulators would like to know more about local infrastructure performance.

Another factor motivating airport benchmarking is the need for better public policy analysis in the ongoing process of commercialisation and privatization of airports – and it is in this context that the question ‘*do privatized airports operate more efficiently than publicly owned airports?*’ is often raised. With competition intensifying in the European airline market, it has become more important for airports to provide high quality services in the most efficient manner and across all airport operations. Benchmarking enables airports or airport groups to be measured against the best practices in the industry. As a consequence, airport operators, airlines, government regulators and financial analysts show an increasing interest in this type of information.

Airport benchmarking is also attractive for planners. It helps them identify the gaps in their projects by comparing them to world-class standards. It therefore leads to a better understanding of transport problems and observed differences in airport performance.

Airport benchmarking is challenging because of the so-called ‘uniqueness’ of airports, with the operation of each airport slightly differing from any other.

Perhaps for this very simple reason, only a limited number of studies have measured German airport performance. The studies that do exist are based on a national or international level, whereas ATRS and ATRL, who publish *Airport Benchmarking* and the *Airport Performance Indicators* respectively, benchmark airports on an annual basis and focus on airports of different sizes and ownerships worldwide. (See Tab. 5 (in App.) below for examples of various studies).

The methodology of the studies varies from the measurement of partial performance indicators to analyses with aggregated data using Total Factor Productivity (TFP) or Data Envelopment Analysis (DEA).

This paper assesses the financial performance and relative efficiency of German airports, based on a literature review of available benchmarking studies. In the first section, the relevant studies are discussed. According to these studies, German airports are financially inefficient compared with other airports in Europe and in particular to Non-European airports.

In the second section, we attempt to analyze the reasons for the weak performance of German airports. The paper closes with an outlook to our own research project, GAP, and addresses how we aim to answer some of the questions related to airport benchmarking.

## **2. The Performance of German Airports in Published Benchmarking Studies**

First, we compare the benchmarking reports of ATRS and TRL, as they use similar performance indicators and have overlapping time frames. In addition, we include some aspects of the research by Doganis et al (1995) and Pels et al (2003). In the next section, the four studies will be briefly introduced, the results discussed and briefly summarised.

### **2.1. Introduction to the Selected Studies**

#### **a) Doganis et al (1995): The Economic Performance of European Airports**

Doganis et al (1995) measured the economic performance of 25 European airports of different sizes and ownership structures for the financial year 1993. The study covers large hub airports such as London Heathrow, which is Europe's largest airport with more than 48 million passengers in 1993. However, it also includes smaller airports such as Vigo in Spain with less than 376,000 passengers per year. The German airports examined in the study are Frankfurt (32 million passengers) and Düsseldorf (13 million passengers).

As airports differ in terms of the services supplied, a straightforward comparison with raw data might produce misleading results. Some operate ground handling by themselves; others outsource this service to third parties and merely provide core airport facilities and receive concession fees for other services. Therefore, Doganis et al (1995) have defined core activities at the airport and adjusted the overall data accordingly<sup>1</sup>. Hence, the following services have been excluded from the cost and revenue figures as well as from the staff numbers:

- Air Traffic Control
- Security
- Ground Handling
- Commercial Activities, e.g. Duty-Free, Retail, Catering
- Car Park
- Terminal Cleaning
- Recharges from water and electricity
- Head Office Functions

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<sup>1</sup> While the need to focus comparisons on core activities by removing all measurable effects of other activities seems logical, published information does not always allow this to be done. Even if it is possible on the revenue side, adjustments to costs, where joint or common costs are involved, are difficult to carry out. To the extent that airports differ in their commercial activities, there may also be differences in the scale of joint and common costs.



To measure the airports' output, seven descriptive measures were used such as passenger volume, cargo, Work Load Unit (WLU)<sup>2</sup> and aircraft movements. Furthermore, 21 performance indicators were defined to calculate partial productivities. The overall profitability of the airport is also benchmarked, as are the revenues generated on the aeronautical and the commercial side. Next, the factors that had a significant effect on the airport performance were identified via multiple regression analysis. This calculation can identify whether the relationship between a dependant variable (e.g. unit costs or revenues) and some independent factors such as WLU (indicating the airport size) are statistically significant.

#### b) Air Transport Research Society: Airport Benchmarking Report

The ATRS study is already in its fifth year. The purpose of the ATRS study is to benchmark airports worldwide and to categorize them into three different geographical regions: North America, Europe and Asia-Pacific. The ATRS studies measure productivity and efficiency; unit cost and cost competitiveness; and financial performance, i.e. revenue generation and profitability. Productivity calculations of partial performances such as labour or capital productivity are carried out, and inputs and outputs aggregated to measure Total Factor Productivity (TFP).

Measurements of Factor Productivity (variable and total) include some factors that are beyond managerial control and also influence productivity and efficiency measurements. Some authors therefore differentiate between Gross and Residual Factor Productivity. ATRS for example, undertakes a regression analysis to differentiate between the two factor productivities. By adding this additional step to their process, certain external factors can be identified and removed from the data set. This allows for the residual productivity (again either variable or total) to be measured. External factors that are likely to have such an effect on the measurements are the shares of international traffic or the capacity constraint indicator.

In our paper, we review the ATRS studies published in 2003 and 2005, covering the financial years 2000/2001 and 2003 respectively. The 2003 publication includes 90 airports and 8 authorities<sup>3</sup>; the 2005 publication covers 116 airports and 15 airport authorities. In both studies Cologne-Bonn<sup>4</sup> (6.3; 5.7; 7.8), Düsseldorf (16.0; 15.4; 14.3), Frankfurt (49.4; 48.7; 48.4), Hamburg (9.9; 9.4; 9.5) and Munich (23.2; 23.6; 24.2) are the German airports included. In the 2005 publication, Berlin is listed twice (i.e. Berlin-Tegel; 11.1 and the whole Berlin Group (including Tegel, Tempelhof and Schönefeld; 12.1) and Fraport (70.6) is also included.

<sup>2</sup> A Work Load Unit (WLU) is defined as one passenger or 100kg cargo

<sup>3</sup> Airport Authorities have been analysed separately.

<sup>4</sup> The passenger volume in million of both periods is given in brackets.

The output variables used in both studies are

- Number of passengers
- Amount of cargo (in tons)
- Number of air transport movements
- Revenues received from airport charges and non-aeronautical operations

As inputs, the study included:

- Number of employees
- Expenses in purchased goods and materials as well as purchased services
- Capital inputs
- Number of runways
- Total terminal size
- Number of gates (ATRS 2005)

#### c) Transport Research Laboratory: Airport Performance Indicators

TRL has been publishing its reports annually since 1999. The data collection is based on financial and traffic data from annual reports. To be able to compare 'like with like', TRL and Doganis et al. (1995) use the same methodology to isolate core activities. They both adjust their data to reduce the airport operations to an airport's specifically defined core activities. These core activities are, as already mentioned, the provision and operation of the terminal as well as the provision of airside facilities and the space within the terminal. Thus, non-core activities like ground handling, car park operations, Air Traffic Control (ATC), catering services and hotel operations are extracted from the raw data.

The worldwide comparisons made by TRL cover airports of different sizes and ownerships. Over the years, the sample ranges from 33 to 47 airports and airport groups and all are covered in a single analysis. The German airports in these publications were Frankfurt, Munich and the Berlin Airport Group. We consider the reports for the years from 1997 to 2002 (published from 1999 to 2004).

As well as Doganis et al (1995), TRL uses different performance indicators to measure, for example, labour productivity, cost performance, revenue generation or the profitability of an airport. The following outputs have been used to calculate these indicators:

- Total passengers
- Cargo/mail (in tons)
- Total WLU
- Number of air transport movements
- Aeronautical, commercial and other revenue

The inputs in this study cover

- Number of employees
- Operating and personnel expenditure
- Depreciation and tax

Further variables and the net interests are from an annual balance sheet data.

In order to assess the overall performance of an airport, TRL uses the multi-attribute assessment approach, which is based on a weighted sum. In a further step, the airports that obtained similar scores and characteristics are formed into a joint group or block. If an airport differs significantly from any other airport it is called a singleton.

#### d) Pels et al (2003): Inefficiencies and Scale Economics of European Airport Operations

Pels et al (2001, 2003) measure the relative efficiency of 34 European airports in the period 1995 to 1997. They published two papers using the same airport sample but different data in 2001 and in 2003. In our paper, we mainly use the latest article and the PhD thesis of Eric Pels (2000). Their focus is different to the other studies, with more attention given to technical efficiency rather than financial performance.

The methodology used in their study consists of Data Envelopment Analysis (DEA) and Stochastic Frontier Analysis (SFA). Both studies include the German airports in Berlin-Schönefeld (1.9), Frankfurt (40.1), Hamburg (8.5), Hanover (4.7), Munich (17.6) and Nuremberg (2.4). These airports are compared with European airports of different sizes and ownerships. Pels et al (2003) have separated the airports into two operational areas, namely the airside and the terminal side.

For the terminal side, output is measured by the number of passengers. Inputs are the size of the terminal, the number of aircraft parking positions at the terminal and the available remote stands, the number of check-in desks and baggage belts. For the airside, output is indicated by the number of aircraft movements; inputs are the total airport area, the total length of runways, the number of parking positions at the terminal and at remote parking positions.

## **2.2. Results of the Studies**

In the following section, we will compare some of the results from the benchmarking studies with respect to labour productivity, cost performance and some aggregated scores. These results were primarily obtained from the ATRS and TRL studies<sup>5</sup>. Furthermore, we will briefly compare the financial performance of the airports with some of the results obtained from the study on technical efficiency of Pels et al (2003). Our focus is on comparing the German airports covered in these studies with respect to the European average and the Best Practice

<sup>5</sup> Note that the data from TRL and Doganis et al (1995) have been converted from Standard Drawing Rate (SDR) and ECU respectively to US\$ based on conversion rates from the mid-year of the corresponding financial year.

airports in the sample. This is to show:

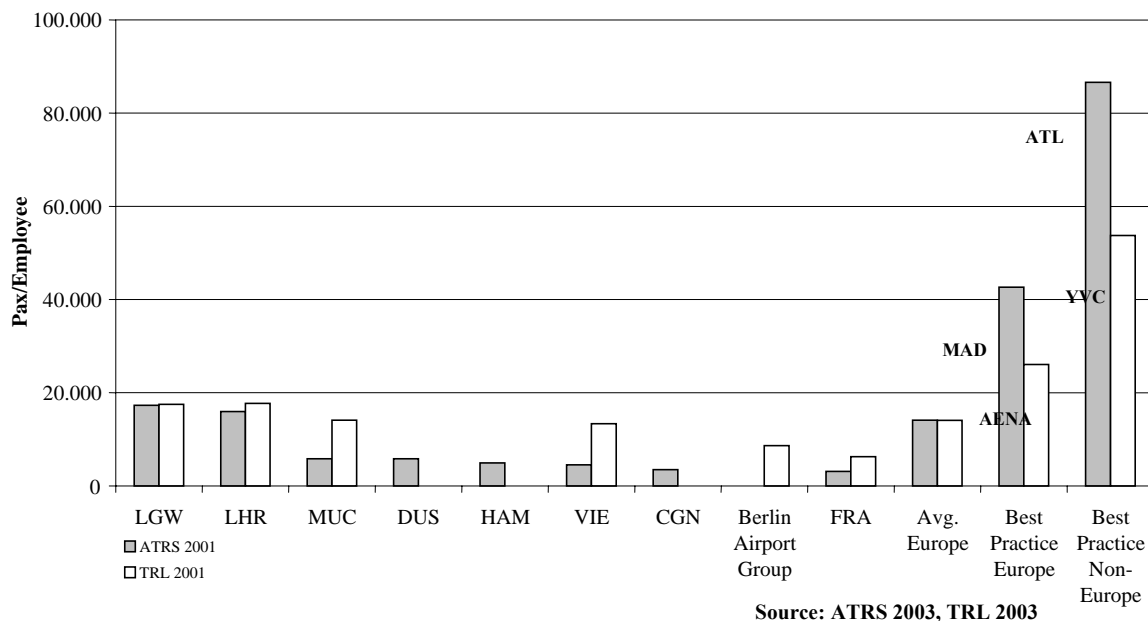
- 1) how the German airports perform in an international comparison and
- 2) that this type of comparison can be misleading due to different airport structures and operation.

### 2.2.1. Labour Productivity

#### a) The Performance of the German Airports

The ratio of ‘passengers per employee’ is a common measure for labour productivity.<sup>6</sup> But the measure has to be treated with caution, as the Irish Commission for Aviation Regulation notes when trying to assess the performance of Dublin airport:

*“The interpretation of partial measures of productivity – such as passenger per employee – is made more difficult by two considerations. First, the measures are partial, and therefore may not capture the way in which a company chooses to substitute one input for another. Second, airports with different managerial arrangements, in particular with regard to outsourcing versus direct service provision, may give different performance measures.”* (Commission for Aviation Regulation 2005, p.14)



**Fig. 1: Labour Productivity (Differences between ATRS and TRL Data)**

As indicated in Fig.1<sup>7</sup>, nearly all German airports performed below average in the ATRS and TRL studies, some differing by around 40% from the European mean. TRL as well as ATRS

<sup>6</sup> Note that the results of TRL are based on adjusted data. As a result, the labour productivity of adjusted airports will be higher than ATRS’ results.

<sup>7</sup> The European average represents the mean of individual airports.

calculated a European average of around 15,000 passengers per employee for individual airports. In the ATRS data from 2000/2001<sup>8</sup>, the German airports were ranked the last seven out of 23 European airports, with a labour productivity of less than 6,000 passengers per employee. Frankfurt had a productivity ratio of less than 4,000 passengers per employee throughout the whole period and was ranked last in Europe.

The higher labour productivity for Frankfurt and Fraport<sup>9</sup> in the TRL-study (with a ratio between 5,000 and 8,000 passengers per employee) is due to a data adjustment, namely the removal of the labour intensive ground handling operations, which is considered a non-core activity. Nevertheless, all airports in Germany achieved low rankings in the TRL studies, just as in the ATRS data. German airports were numbered among the last ten in all rankings.

On the other hand, in the TRL study Munich does surprisingly well, recording a large increase in labour productivity between 1999 and 2000. Labour productivity rises from 7,000 to 18,000 passengers per employee. This seems to be an unrealistic increase and will be looked at further in section c) of this chapter. Obviously the weak performance of German airports in ATRS results might be due to the low level of outsourcing. All airports in the sample operate ground handling and other in-house operations, such as car parks, by themselves. Consequently, they have higher staff numbers per passenger volume in comparison to other airports that have outsourced these operations.

Berlin-Tegel is the only German airport with above average labour productivity. ATRS figures give a ratio of 17,700 passengers per employee in 2003 (compared with a European average of 14,300 in the same year). Data related to revenues, expenditures and employment figures for ground handling are not included in Berlin-Tegel's financial statement because these services are outsourced to another company (Globe Ground Berlin GmbH). Hence, when comparing ATRS and TRL labour productivity on the Berlin Airport Group, both return the same productivity ratios of approximately 8,000 passengers per employee for 2002/03. However, excluding ground handling figures cannot fully explain such a low ranking, as even with TRL's adjusted data, the German airports still perform badly.

It is interesting to compare these figures with the Vienna airport, since that also operates ground handling itself. However, TRL reports higher labour productivity for the Vienna airport (with on average 13,500 passengers per employee) compared with the German airports. The effect of having adjusted the data for ground handling seems to be greater for Vienna than for the German airports. The labour productivity calculated by ATRS (which does not adjust down to core activities) for Vienna substantially deviates from TRLs data, with a score of less

<sup>8</sup> In the following, the years always refer to the financial years rather than the year when the report has been published. For further information on the results of ATRS and TRL, please refer to the corresponding studies.

<sup>9</sup> TRL officially switched from Frankfurt to Fraport in the 2004 publication.

than 5,000 passengers per employee in both periods. This figure is as low as the one we found for German airports in ATRS.

#### b) German Airports in an International Comparison

In comparison with non-European airports, both ATRS and TRL show substantial differences in their figures on German airports (see Fig.1).

Atlanta is the best airport over the whole period in the ATRS study, with almost 100,000 passengers per employee in 2003<sup>10</sup>. This airport handles more than 75 million passengers per year and employs less than 500 people for the airport's core activities, indicating a considerable degree of outsourcing. Indeed, the terminals in North America are not usually operated and maintained by the airport, but rather by the airlines or a management company.

In the TRL study, the most labour productive airports worldwide are considered to be Calgary, with more than 60,000 passengers per employee between 1997 and 2001, and Melbourne, with nearly 120,000 in 2002. Even in this TRL study, with staff data already removed from non-core activities, only non-European airports, and especially airports in Australia and North America, yielded high labour productivity levels. This seems to indicate that European airports and in particular the airports in Germany are more labour intensive in the operation of their core airport activities.

The fully privatized airports in London also do not achieve substantially higher productivity ratios than the European average; both yielded around 17,000 passengers per employee in 2001 and 2002. In the TRL report, the best European airport from 1997 to 2000 was Stockholm, followed by AENA from 2001 to 2002. The same results were obtained in the ATRS studies; here Madrid and Barcelona had the highest labour productivity and Stockholm was also ranked high in this area.

#### c) Productivity Changes at German Airports

Some of the trends that were measured can be misleading. The airports in Munich, Frankfurt and Hamburg show big increases in labour productivity that cannot purely arise from passenger increases or decreasing staff numbers<sup>11</sup>.

As already mentioned above, TRL, (see Tab 1), for example, shows a substantial increase from 7000 to more than 18,000 passengers per employee in Munich between 1999 and 2000. One reason for this large increase in productivity could be that TRL has adjusted the data related to ground handling from 2000 onwards. The increase observed might therefore be due to measurement errors rather than a productivity increase.

<sup>10</sup> Data for Melbourne was not available in this study.

<b>Labour Productivity</b>	<i>Passengers per Employee</i>					
	<b>1997</b>	<b>1998</b>	<b>1999</b>	<b>2000</b>	<b>2001</b>	<b>2002</b>
FRA	7.697	7.190	7.697	8.050	<b>6.276</b>	<b>5.020</b>
MUC	8.377	6.473	<b>6.941</b>	<b>18.032</b>	14.126	12.609
Berlin Airport Group	6.135	6.780	8.632	9.199	8.653	8.372
VIE	10.631	14.036	14.959	14.632	13.363	13.753
AMS	17.345	18.304	21.498	23.531	20.898	21.087
LHR	13.252	15.676	16.949	19.066	17.702	17.019
LGW	12.865	15.161	16.221	18.092	17.543	16.207
Average Europe	13.196	13.585	13.568	15.575	14.092	14.995
Average Total	19.965	23.318	22.670	25.063	22.283	27.034
Best Practice Europe	24.594	23.102	25.642	26.241	26.037	25.664
	ARN	ARN	ARN	ARN	AENA	AENA
Best Practice Non-Europe	66.372	65.044	55.717	61.759	53.755	118.874
	YVC	YVC	YVC	YVC	YVC	MEL

**Tab. 1: Labour Productivity (TRL)**

Similar measurement effects can be observed when one looks at the results for Frankfurt. The slight decrease in labour productivity from financial year 2001 to 2002 is probably due to the full consolidation of ICTS in 2002, a Dutch security service provider<sup>12</sup>. On the other hand, until 2001, the traffic data for Frankfurt airport was consolidated with the financial data for the whole Fraport group. This led to recording an 'increase' in 20 million passengers from 2001 to 2002 which was not due to a real passenger increase. In fact, passenger volume for Frankfurt slightly decreased by 0.2% from 48.6 to 48.5 million passengers during this period. In Hamburg, ATRS (see Tab. 2) indicated an increase from 5,000 to more than 12,000 passengers per employee from 2001 to 2003. What could be the reason? Since October 2002 the airport has outsourced the IT-Department Airsys, thereby reducing the number of employees by 48. This increase in productivity cannot be due to such a small decrease in staff numbers and only a slight increase of 0.42% in passengers. Again, a measurement error may have caused the observed productivity increase. This possible measurement error is probably due to the fact that the whole group was used as the basis for the analysis in 2000 and 2001, whereas subsidiaries and their staff numbers were excluded from the data in 2003 and later. If one correctly accounts for these changes, then the productivity increase between 2001 and 2003 is only 4.5% (instead of 150%) and 1.3% from 2000 to 2001.

<sup>11</sup> The passenger decreases due to 9/11 or SARS do not show substantial effects on the passenger volume. This aspect is not considered as a reason for the changes in productivity.

<sup>12</sup> In total the staff numbers for Fraport have increased by 38% from 15,500 to 21,400 between 2001 and 2002.

Corrected productivity ratios based on the 2003 annual report are: 11,715 (2000), 11,731 (2001), 12,265 (2003). This would leave Hamburg with a higher labour productivity than other German airports when measuring with raw data. Overall, this result seems clear because in 1999 the handling of ground services was outsourced to “Groundstars”, a 100% subsidiary of the Flughafen Hamburg GmbH.

<b>Labour Productivity</b>	<i>Passengers per Employee</i>		
	<b>2000</b>	<b>2001</b>	<b>2003</b>
CGN	3.837	<b>3.479</b>	<b>4.147</b>
DUS	5.850	5.837	5.963
FRA	3.459	3.128	3.718
HAM	5.329	<b>4.909</b>	<b>12.265</b>
MUC	5.714	5.846	4.951
TXL	n/a	n/a	17.710
VIE	4.879	4.514	4.381
Berlin Airport Group	n/a	n/a	7.487
Fraport	n/a	n/a	3.021
AMS	20.270	19.387	17.911
LHR	17.002	15.985	16.065
LGW	17.814	17.323	15.029
Avg. Europe	14.428	14.119	14.382
Avg. North America	43.803	40.875	40.025
Best Practice	41.271	42.640	44.993
Europe	MAD	MAD	BCN
Best Practice Non-Europe	91.510	86.586	99.983
	ATL	ATL	ATL

**Tab. 2: Labour Productivity (ATRS)**

Only the Cologne-Bonn airport recorded substantial increases in labour productivity , which can be explained by an increase in passengers. In the study by ATRS, the number of passengers rose from 5.7 million to 7.8 million from 2001 to 2003. This large increase is due to the development of the low cost segment, primarily from Hapag-Lloyd Express and germanwings, the main low cost carriers at the airport.



d) Ranking Differences between ATRS and TRL

When looking at the differences in the airport ranking in the European sample between ATRS and TRL in Tab.3, Munich and Vienna show considerable differences<sup>13 14</sup>. Again, we notice TRL records Munich's substantially higher productivity at 18,000 passengers per employee as compared with 5,000 in the ATRS study in financial year 2000. This indicates that removing ground handling from the data can substantially improve the productivity when comparing with other European airports. It should also be noted that the ATRS calculation uses 4000 employees, whereas TRL only includes 1300 core employees. In the European ranking, Munich was in 7<sup>th</sup> place (out of 12 European airports that were investigated in both studies) in the TRL table and 10<sup>th</sup> in the ATRS results. Hence, in the TRL study, Munich achieved a higher productivity level than Manchester, Copenhagen and Geneva<sup>15</sup>.

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

**Tab. 3: Labour Productivity in Passenger per Employee (Ranking Differences)**

In Vienna, labour productivity changed from less than 5,000 in ATRS to nearly 15,000 in TRL. As with Munich, the reason for the difference in calculations was due to the removal of ground handling activities from their data, which made the airport perform better in relation to other European airports. Indeed, according to ATRS, staff in Vienna amount to 2,400 for the

<sup>13</sup> Passenger movements are not, of course, the only output of an airport. Output may be measured more broadly by an aggregate of passenger, plus Air Transport Movements (ATMs), plus non-aero output (that is appropriately aggregated) and then compared with the labour input in order to give an overall labour productivity measure. We will return to this issue below.

<sup>14</sup> Only airports that have been included in ATRS and TRL studies have been considered.

<sup>15</sup> The differences in the productivity ratio of ATRS and TRL in Copenhagen, Geneva and Manchester are not as high as in Munich and Vienna.

financial year 2000, while TRL only record 816 staff at the airport. In the European ranking, Vienna was 9<sup>th</sup> in the TRL table and 11<sup>th</sup> in the ATRS results. Hence, Vienna achieved a higher productivity level in the TRL study, than Manchester and Copenhagen.

For Frankfurt as well, we observe a difference in labour productivity of 4,500 passengers per employee for the two studies, with 3,500 passengers in ATRS and 8,000 passengers in the TRL data for the financial year 2000; consequently, both studies recorded low labour productivity. No relative improvement to other airports was observed, which supports the view of low labour productivity at Frankfurt Airport.

In contrast to Germany, the airports in North America and Asia-Pacific do not show significant changes in the order of their ranking in ATRS and TRL. This also indicates that airports in Germany are more heterogeneous in terms of the services provided. The list of the adjusted airports in the TRL study supports this hypothesis, as in their publications only European airports<sup>16</sup> are taking care of their own ground handling services. Of all non-core activities, this service is the most labour intensive. Therefore, the effects of data adjustments will have a greater impact on changes in the ranking between European airports compared with North America or the Asia-Pacific Region.

### **2.2.2. Cost Performance**

Properly determining an airport's performance requires measuring more indicators than just labour productivity -. and this is particularly true for Germany, where the airports tend to produce more in-house operations, resulting in higher staff numbers in comparison with passenger volume. In a case such as Germany, it is also important to look at the more general indicators, such as cost performance, and to aggregate the measures to be able to estimate Variable and Total Factor Productivity. Cost performance is investigated under several aspects in the literature. In the next section we primarily looked at the ratio of labour costs and non-capital costs per passenger, as both ratios were used in the ATRS and TRL benchmarks.

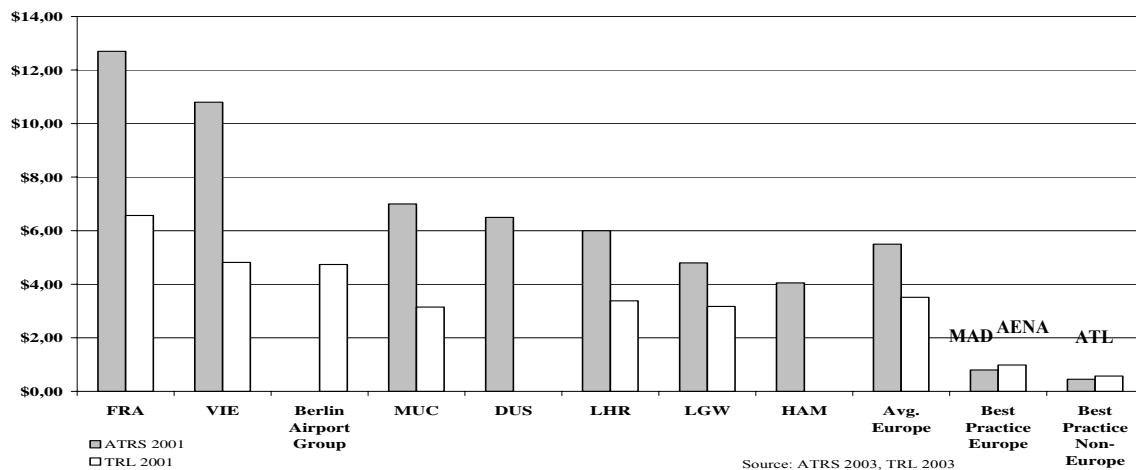
#### **a) Labour Costs and Labour Cost Shares**

When looking at labour costs per passenger in Fig. 2, the ATRS and TRL results indicate a negative correlation with labour productivity. ATRS lists Frankfurt as having extremely high labour costs per passenger of \$10.00 to \$15.00. This is around twice the average in Europe (\$4.00 to \$6.00 per passenger between 2000 and 2003). Again, the lower figure in the TRL study of around \$7.00 per passenger in Frankfurt is due in particular to the removal of ground handling.

<sup>16</sup> The airports in the sample that operate their own ground handling services are in Paris and Rome, Budapest, Frankfurt, Manchester, Munich, the Swedish airports and Vienna (based on the sample in the 2002 edition).

As we saw in the findings on labour productivity, the data adjustment related to ground handling in Munich in 2000 is the reason for the substantial decrease in staff costs per passenger from \$7.30 to \$2.80 recorded in the TRL study. This decrease in staff costs is probably not due to an increase in passengers.

When ranking the German airports, the ATRS study indicates that Frankfurt has higher staff costs per passenger than any other German airport. Hamburg performs best with staff expenses per passenger that are three times lower than Frankfurt. TRL does not show these large differences: although Frankfurt has higher staff costs than Munich and the Berlin Airport Group, the size of these costs is not as high in the ATRS publication. This seems to indicate that airports have high staff costs when ground handling is included, since the high labour costs in that segment of the value added chain receives more weight in the labour costs per passenger calculation.

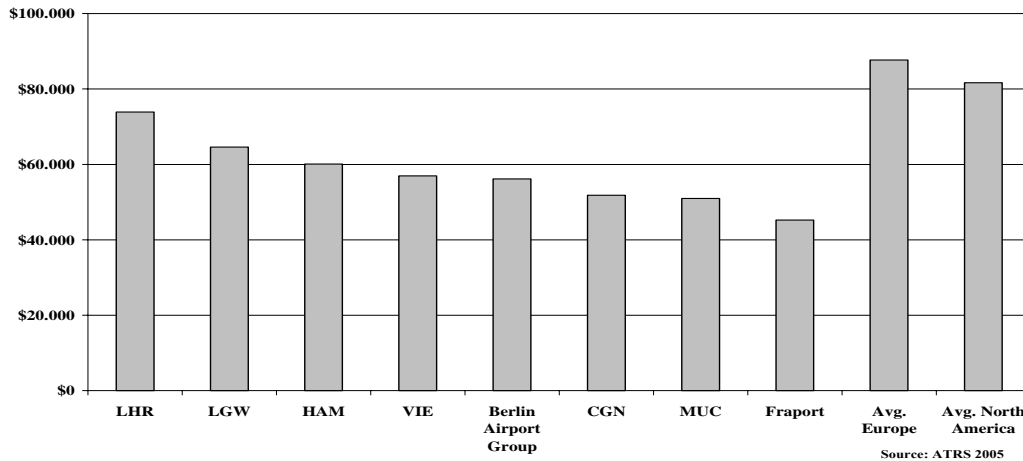


**Fig. 2: Labour Costs per Passenger**

As measured by ATRS, the average labour costs in North America of between \$1.50 to \$2.00 per passenger are much lower than in Europe. In the TRL study, North American (Atlanta) and Australian (Brisbane and Melbourne) airports lead the ranking with expenses per passenger of less than \$1.00, which is in line with the results derived from the analysis of labour productivity above.

However, the high staff costs per passenger are not necessarily due to the low passenger-to-employee ratio, but rather because of higher wages. As Fig. 3 shows, if we multiply labour productivity by staff costs per passenger, Heathrow and Gatwick have higher staff costs than any German airport. In addition, the previous results indicate that Gatwick and Heathrow have average European labour productivity. This is not that surprising since London is one of the world's most expensive cities to live in. Furthermore, large airport groups usually pay higher salaries than small individual airports. Whereas the average annual wages at German

airports range between \$35,000 to \$50,000 (with the exception of \$60,000 in Hamburg in 2003), the London airports had annual staff costs of more than \$64,000 in 2003. Vienna also has higher wage levels than airports in Germany. In 2003 their average staff costs of \$56,000 were around \$10,000 higher than those of Fraport.

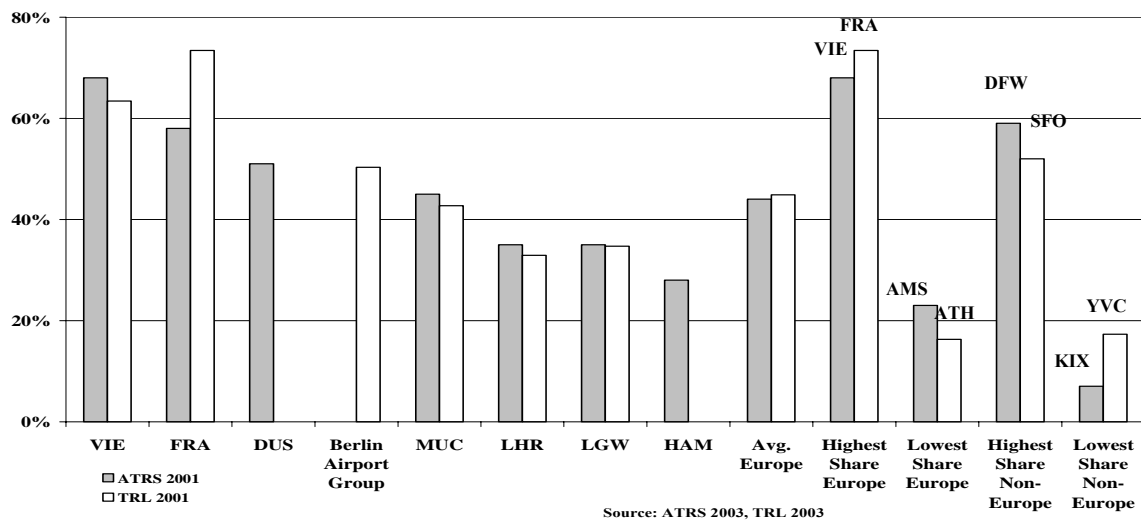


**Fig. 3: Staff Cost Level ATRS (2003)**

The differences in the ATRS and TRL European rankings (2.2.1, section c) for labour productivity costs per passenger indicate the same improvement in Munich's ranking, with the airport moved from 3<sup>rd</sup> place in the ATRS study (the 3<sup>rd</sup> highest staff costs per passenger) to seventh (out of 13 airports). Furthermore, London-Heathrow improved its position, moving up from seven to nine. Indeed, the ATRS study lists staff expenditure at Heathrow as \$6.00 per passenger, while TRL estimates it to be \$3.40. Data adjustments for the BAA airports included the World Duty Free operation and Head Office staff. There were substantial differences in staff costs for Vienna and Frankfurt, but as these costs are substantially higher than anywhere else, both airports still head the rankings in terms of labour cost shares in both studies.

A close look at labour cost share also indicates that staff costs in Germany are an essential part of expenditures. TRL and ATRS used the same measure to determine the labour cost share by calculating the labour costs as a share of non-capital expenses. Having adjusted the data for ground handling and the other non-core services, TRL ranks Frankfurt with the highest share of labour costs in Europe with more than 70% (exception in financial year 2000). The highest labour cost shares at Non-European airports<sup>17</sup> are only around 50% to 60% (see Fig. 4).

<sup>17</sup> These non-European airports include: the Hawaiian airports in 1997/98 and 2000, Capetown in 1999, San Francisco in 2001 and Ontario in 2002.



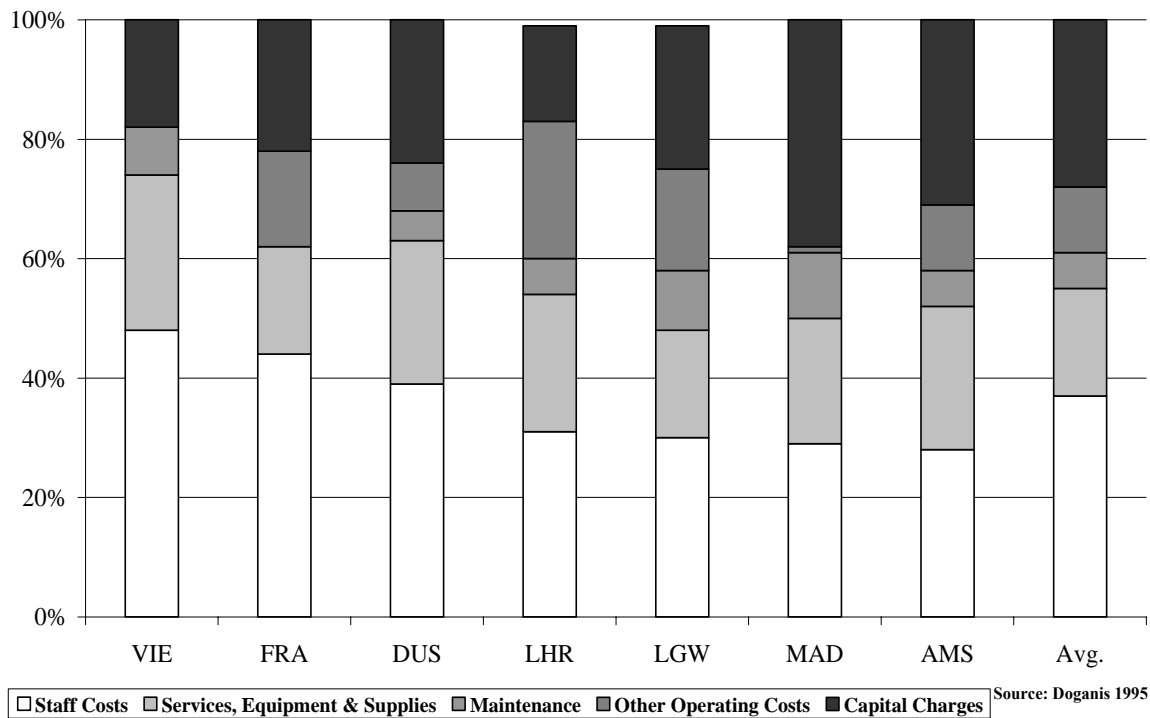
**Fig. 4: Labour Cost Share (of Variable Costs)**

In the ATRS study, Frankfurt again has the highest labour cost shares of 58% and 65% in 2001 and 2003<sup>18</sup>, compared with the European average of less than 50%. The Berlin Airport Group and Munich have average shares of 40% and 36% respectively in 2003; with labour cost shares of 60% and 80% lower than Fraport. Düsseldorf and Cologne-Bonn are also around the European average in the ATRS study of 2003. The value for Hamburg seems quite low in relation to the other German airports, with less than 30% in both periods.

The highest labour cost shares in Europe are reported for Frankfurt (and Fraport in 2003 data), together with Vienna and Copenhagen. As with Frankfurt, Vienna also has a high cost share due to the large share in ground handling. But the same does not apply to Copenhagen, since it has already outsourced ground handling. Instead, this result seems to be more related to high staff cost levels. Furthermore, high labour cost shares can also be seen for airport groups with small airports such as those in Sweden and Hawaii. TRL argued that this is due to diseconomies of scale (TRL 2003).

The study of Doganis et al (1995) shows cost shares of the airport before data adjustment, with the expenses separated into staff costs, services/equipment and supplies, maintenance, other operating expenses and capital charges (see Fig. 5). The data in this table supports some previously mentioned rankings. Frankfurt and Vienna both show high labour cost shares of 45% and 48%, respectively. Düsseldorf's cost share of 39% also comes close to the 37% average. In comparison, the airports at Heathrow and Gatwick spend merely 30% of total costs on salaries and pensions; even so, we saw earlier that their average annual salaries are among the highest in Europe.

<sup>18</sup> The 2003 figures are for Fraport.



**Fig. 5: Cost Structure (Doganis et al 1995)**

Overall, the results correspond to the earlier observations on labour productivity. They point to a relationship between a high ranking in labour productivity and a low labour cost share. Where this is not the case and high labour cost shares correlate with a relatively high labour productivity ratio, the airports may have high wage levels. In addition to Heathrow and Gatwick, this is also the case for Copenhagen and Geneva according to the latest ATRS and TRL publications.

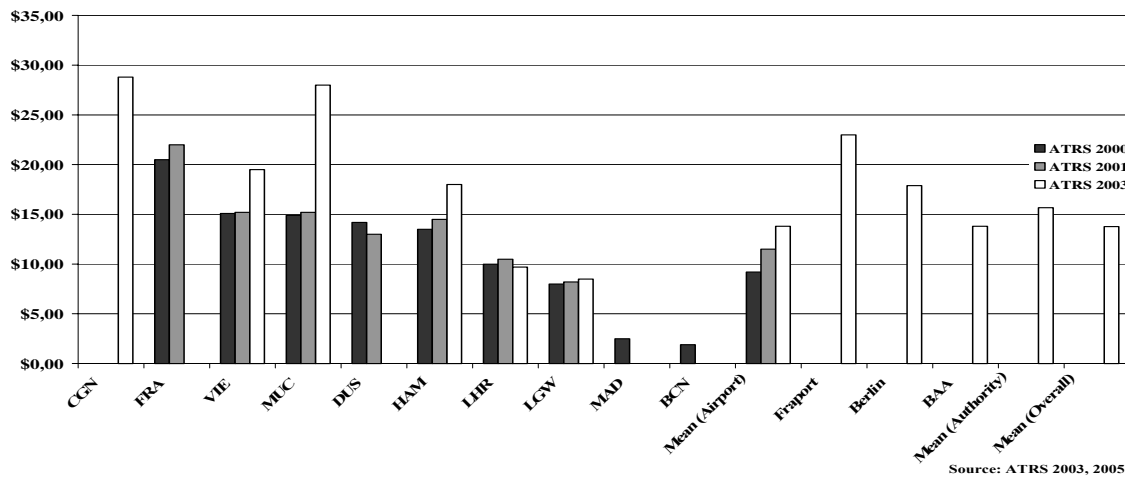
**b) Non-Capital Expenditures**

The ATRS measure of variable costs per passenger and the TRL's operating costs per passenger are other indicators of the high costs at German airports.

When looking at variable costs per passenger in Fig. 6, the cost for Frankfurt is more than \$20.00 per passenger, higher than the European average (\$9.00 to \$14.00) during the research period. This can be basically attributed to the high staff costs identified previously. The other airports in Germany also record above average costs for Europe.

In general, ATRS has ranked the German airports as among the most costly. In 2003, Cologne and Munich reported even higher variable expenses per passenger than Fraport, recording \$29.00 and \$23.00 per passenger respectively, with Cologne being the most expensive in the sample. Given the higher staff costs per passenger in Frankfurt, these high costs indicate higher operating costs. Furthermore, ATRS shows a substantial increase in variable costs per passenger from 2001 to 2003 in Hamburg and Munich. However, these

costs could also arise from a decline in passengers during that time.



**Fig. 6: Variable Costs per Passenger (Europe)**

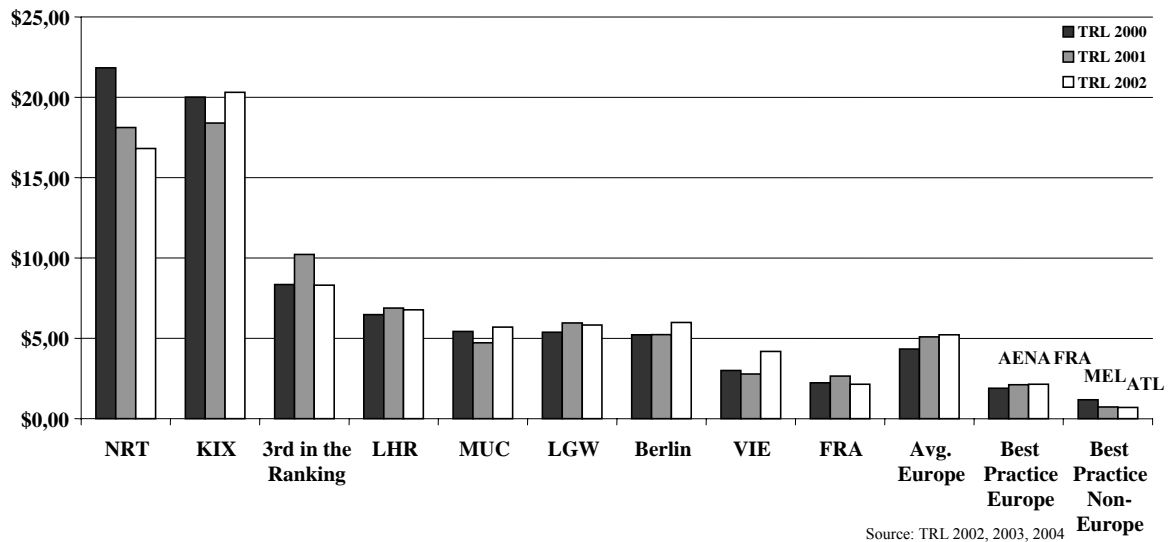
In the Asia-Pacific Region too, the Japanese airports seem to have extremely high variable costs of more than \$20.00 per passenger. Hong Kong, with variable costs per passenger (that is staff costs plus operating costs) of less than \$13.00 is ranked in third place. This is not surprising, as the Japanese airports are well-known for having high expenditures<sup>19</sup>.

When looking at operating costs per passenger<sup>20</sup> as reported by TRL, it is worth mentioning that Frankfurt recorded average operating costs per passenger of \$2.00 to \$3.00 after data adjustment for non-core activities (see Fig. 7), putting it below the European average of \$4.00 to \$5.00 per passenger. These figures seem to be much lower than those measured in Munich and Berlin. Both airports reported above average costs: Berlin's operating costs per passenger were \$5.00 to \$6.00 and Munich's \$5.00 - \$8.50. The latter's wide range is due to the reduction of expenses related to ground handling in the 2000 data. Moreover, in comparison with Heathrow and Gatwick, Frankfurt had lower operating expenses; the London airports' operating expenses were above average at about \$6.00. Frankfurt's lower operating costs might be due to excluding staff costs from operating expenses.

Does that mean that staff costs have an especially negative impact on Frankfurt's financial performance? Furthermore, we find operating costs per passenger still lower outside Europe. The best airports over the period, at less than \$1.00 per passenger, were Cape town, Melbourne and Atlanta.

<sup>19</sup> The same result can be observed in the TRL study, where the airports in Osaka Kansai and Tokyo Narita have been included from the 2002 edition onwards. In the three studies published since then, both airports listed operating costs per passenger of nearly \$20.00 per passenger, more than 100% higher than the next non-Japanese airport. When comparing these expenses with those at German airports it appears that the operating costs are particularly high in Japan. Whereas variable costs per passenger amount to \$25.56 in Osaka and \$29.00 in Cologne-Bonn, staff costs per passenger only amount to \$2.30 in Osaka but over \$12.00 in Cologne.

<sup>20</sup> Note, that expenses related to staff costs are not included.



**Fig. 7: Operating Costs per Passenger**

### 2.2.3. Gross versus Residual Factor Productivity – An aggregated approach

Besides the partial productivity measures, we also briefly examined the aggregate results obtained from the ATRS study. The question is ‘*how have the German airports performed on an aggregated level and how do factors which are beyond managerial control influence their performance?*’. To help provide an answer, the two ATRS editions considered here formed an output and an input index. The output index contains the number of air transport movements, the number of passengers, the amount of cargo (in tonnes) and a quantity index for non-aviation related revenue. The input index is made up of labour and soft cost<sup>21</sup> data (weighted by the variable cost shares) as short and medium term variables capable of being used to determine Variable Factor Productivity (VFP)<sup>22</sup>.

The figures are based on the assumption that capital input is held constant. In other words, the VFP statistic measures the efficiency with which the airport utilises its variable inputs for a given level of capital infrastructure. The VFP estimate is reported gross, or unadjusted, as well as net, after excluding the estimated contribution to the productivity of factors outside the airport’s control.

By additionally including further capital variables, namely the number of runways, the terminal size and the number of air bridges in the input index, the Total Factor Productivity (TFP) as long term performances can be calculated<sup>23</sup>. For both productivity measures (i.e. VFP and TFP), a multilateral translog index has been used, combining the cost shares of the input variables as weights for the aggregation (ATRS 2005).

Note that the scores for European airports have been normalized at Vancouver Airport = 1.0

<sup>21</sup> Non-capital and non-personnel data are considered as soft cost input.

<sup>22</sup> This productivity measure has been calculated in both editions.

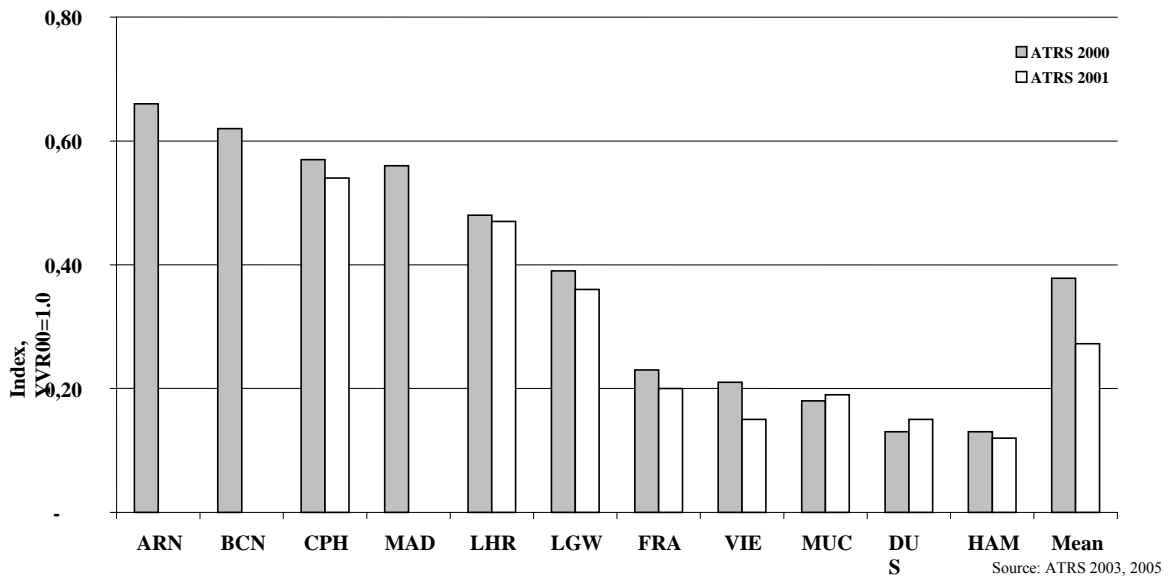
<sup>23</sup> The calculation of the Total Factor Productivity is only in the 2003 edition.



of financial year 2000 for 2000/01 data and at Copenhagen = 1.0 for 2003 data.

a) Variable and Total Factor Productivity

Looking at the results for the 2000/01 data in Fig. 8, all German airports recorded a low VFP, with the lowest VFP level of 0.15 recorded by Düsseldorf and Hamburg .



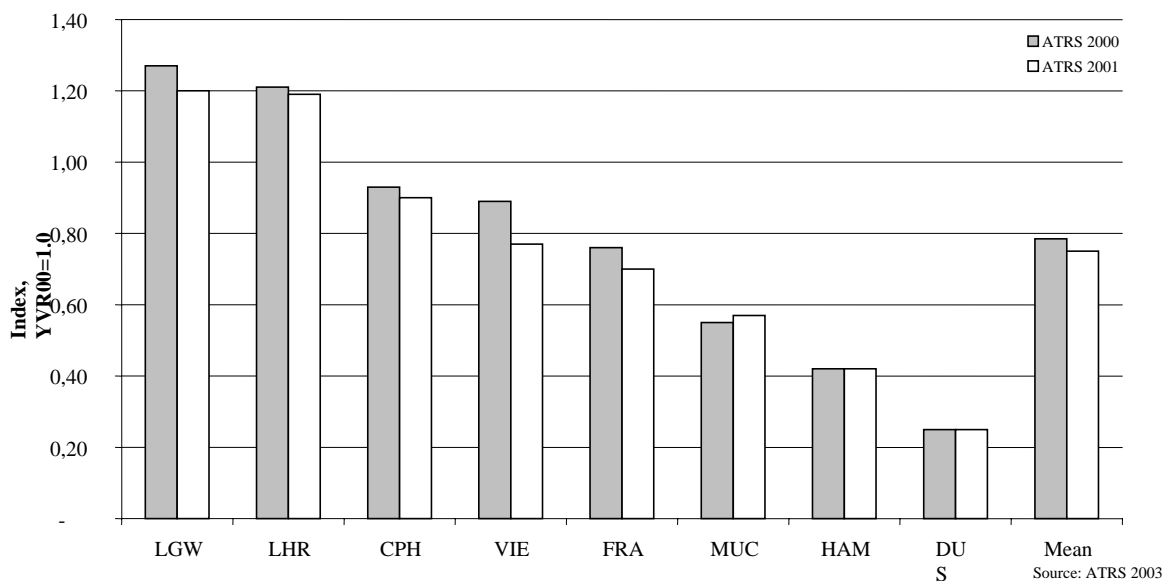
**Fig. 8: Variable Factor Productivity (Europe) I**

The German airports, together with Vienna, performed far below average (0.38 in 2000 and 0.3 in 2001), although this is hardly surprising given the comparison between these figures and the results derived from the partial productivity measures above. The best European airports in this sample are again a Scandinavian and Spanish airport - a result in line with the previous analysis. Comparing the results of the European airports with North America, we again find higher VFP values. As expected, Atlanta is by far the ‘most productive’ airport in this sample, with high labour productivity and low expenses. Atlanta obtained a productivity score of more than 2.0 (also normalized at YVR = 1.0) in both years. When looking at 2003 data in Fig. 9, the ranking in the chart does not significantly change (Stockholm, Barcelona, Madrid and Frankfurt as individual airports are not included in this publication). For both individual airports and airports groups or authorities, Germany has low rankings: Berlin, Fraport, Cologne and Munich are far below the European average of 0.62 for individual airports and 0.54 for airport groups and authorities. Only Vienna and Hamburg did slightly better, reporting a score of nearly below average. For Hamburg this might be due to the measurement error in 2003 that we have already mentioned above. For Vienna, the good VFP performance is quite surprising as the airport had been identified above with low labour productivity and high costs, similar to Frankfurt’s position in 2000.

**Fig. 9: Variable Factor Productivity (Europe) II**

When looking at the TFP for 2000 and 2001 in Fig. 10, the values estimated for German airports exhibit similar rankings to those for VFP. Again, all German airports are ranked below average (0.85 in 2000 and 0.77 in 2001); Düsseldorf, with a TFP of less than 0.3, is ranked last. The airport in Vienna could improve its ranking relative to the VFP analysis. This might indicate better long-term productivity, i.e. once capital expenditures are included in the analysis. The same applies to Heathrow and Gatwick. The best European airports achieved TFP values of 1.0, close to the most productive airports in North America.

**Fig. 10: Total Factor Productivity (Europe)**



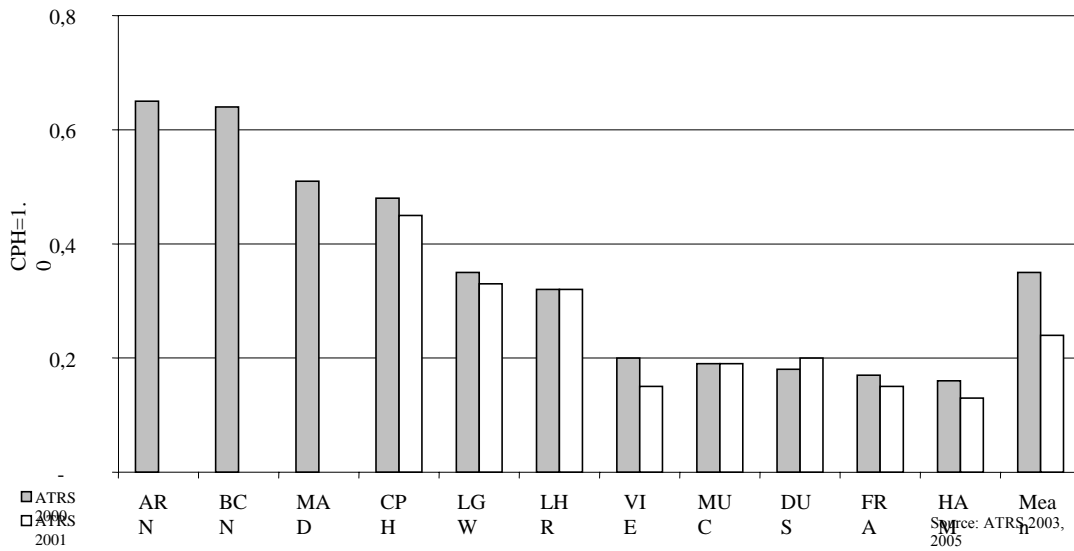
**b) Residual Variable and Total Factor Productivity**

Estimating gross VFP and TFP is only part of the exercise. The next step is to see whether a regression analysis for both VFP and TFP can help explain these differences in productivity. The results show that airport size, the share of cargo and non-aviation activities, the type of terminal operator (public, mixed, or private) and an indicator of capacity constraints are statistically significant explanatory variables, thus suggesting that these factors lead to higher productivity levels. In the VFP analysis, the share of international traffic was found to be statistically significant with a negative coefficient, but it was not significant in the TFP analysis. The same lack of significance for both measures was recorded for average aircraft size and overall passenger satisfaction (ATRS 2003).

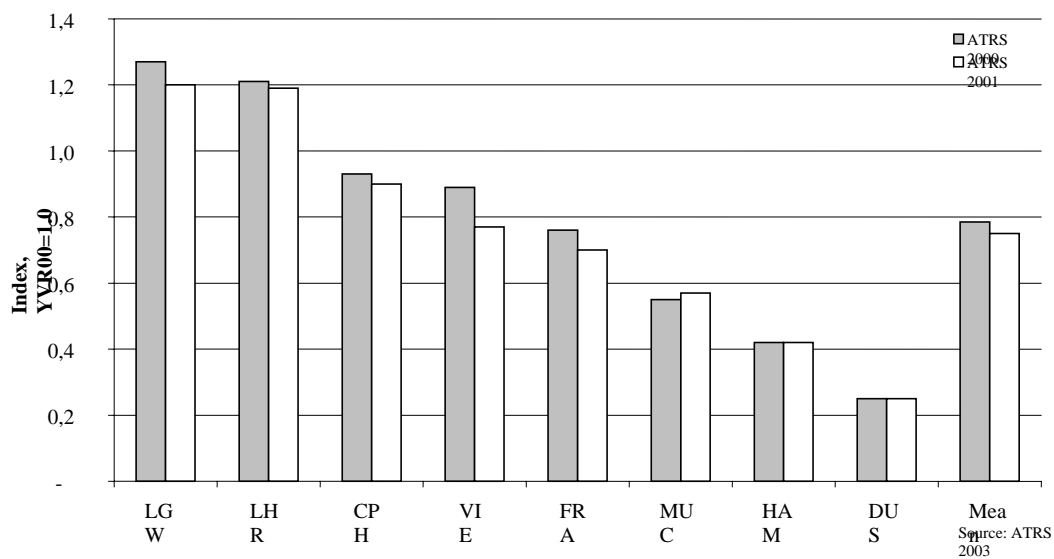
The airport size, the amount of international traffic and cargo as well as the capacity constraint indicator, represent factors that are beyond managerial control. Consequently, in a second step, these factors were removed from the data and new productivity indices for both the residual VFP and TFP were calculated. Overall, after adjusting the data in this way (see Fig. 11 and 12), no significant changes were found in 2000 and 2001: all four German

airports in the ATRS sample still remain at the bottom of the ranking.

**Fig. 11: Residual Total Factor Productivity (Europe)**

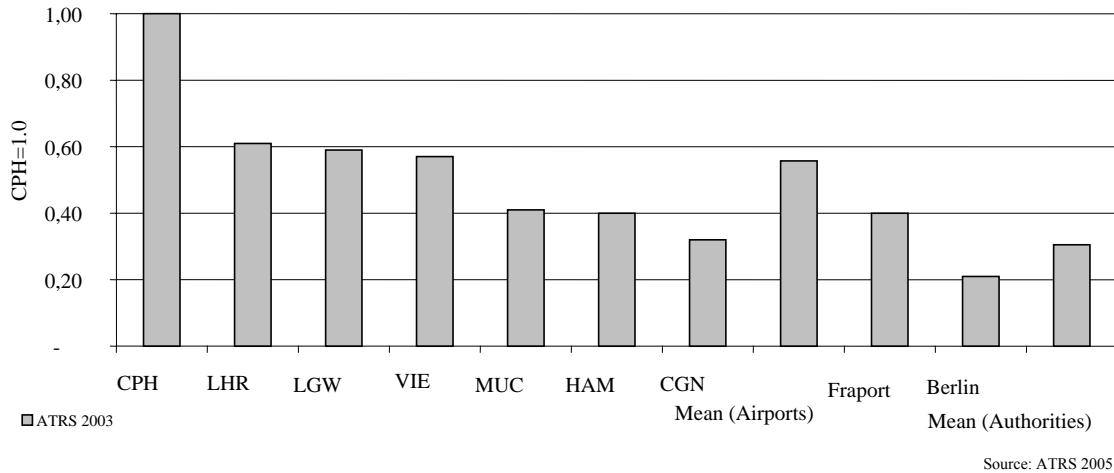


**Fig. 12: Residual Variable Factor Productivity (Europe) I**



The 2003 data analysis, which merely presents the residual VFP, also indicates no significant changes to the values of gross VFP (see Fig. 13). Having removed the fraction of international traffic, cargo and connecting traffic as well as the capacity constraint indicator<sup>24</sup> the German airports are still left in the last places and Vienna in the middle, but slightly below average (0.594).

<sup>24</sup> The airport size has not been considered in the regression analysis. The reason is that a recent study found that in airports in the US, economies of scale are levied out at a passenger volume of 2.5 to 5 million passengers.



**Fig. 13: Residual Variable Factor Productivity (Europe) II**

In summary, the aggregated estimates of Gross and Residual Factor Productivity also show poor productivity outcomes for German airports. This result was already expected from the partial productivity measures, where the German airports performed weakly in nearly all areas. After having removed the effects that are beyond managerial control, the ranking has not changed.

#### 2.2.4. The Technical Efficiency at German Airports

Technical efficiency scores offer another form of benchmarking. Here, we rely on the findings of Pels et al (2003), who included physical instead of financial data in their analysis. It is interesting to see, that compared to the financial performance, the scores for technical efficiency are much better for the German airports. In general, the efficiency scores for all European airports are relatively high on both operational sides (with a mean value of 84% on the terminal side and 82% on the airside)

##### a) The Technical Efficiency on the Airside

For the airside, Frankfurt obtained an efficiency score of 100% in 1997, which is surprising as it was one of the worst performers in the previous analysis<sup>25</sup> (see Fig.14). The same results can be found for Munich, Nuremberg and Stuttgart. Only the Berlin airports in Schönefeld and Tegel attained low scores of around 50%. Hanover's performance was average, while Hamburg returned a weak score of only 65% technical efficiency.

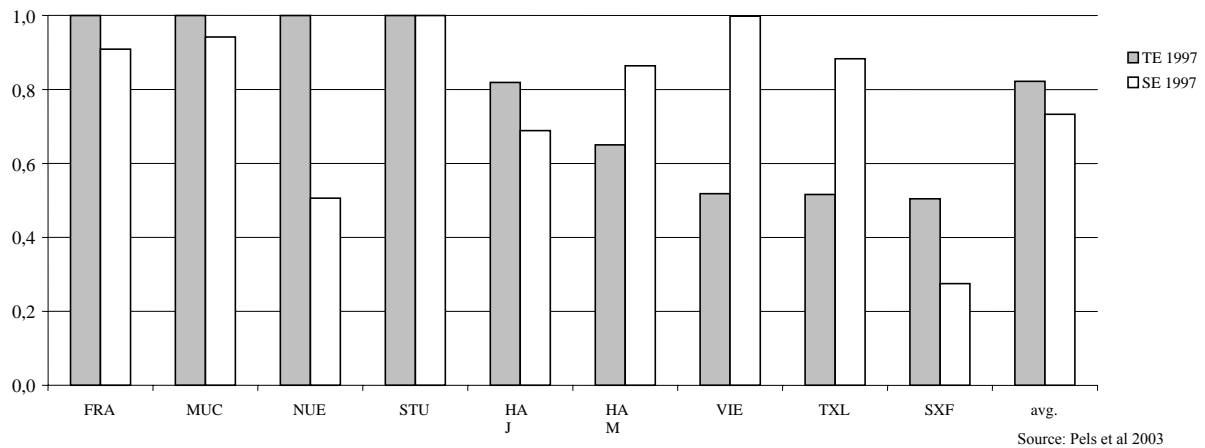
These results are not very surprising for most of the German airports: Frankfurt suffers from severe capacity constraints, leading to high capacity utilization and hence a higher level of

<sup>25</sup> Only scores for 1997 have been published.

technical efficiency. In contrast, Berlin Schönefeld has considerable excess capacity, especially on the airside, and thus recorded low technical efficiency performances.

The authors then attempt to explain these differences and investigate the correlation between the scale efficiency<sup>26</sup> and airport size. Although the coefficient is only 0.18, the larger airports such as Frankfurt and Munich are operating with near constant returns to scale or slight decreasing returns to scale, whereas small airports like Nuremberg and Berlin-Schönefeld show increasing returns to scale.

In addition to Frankfurt and Munich, the other airports operating with high technical and scale efficiency are the larger airports in the study, namely Copenhagen, Gatwick, Heathrow, Paris Charles de Gaulle and Zurich. Since the airport in Milan-Linate, a medium-sized airport, was highly congested, it also obtained a high ranking. From 2000 onwards, Milan-Malpensa took over most of the traffic because it still had capacities to expand and relieved the Linate airport.



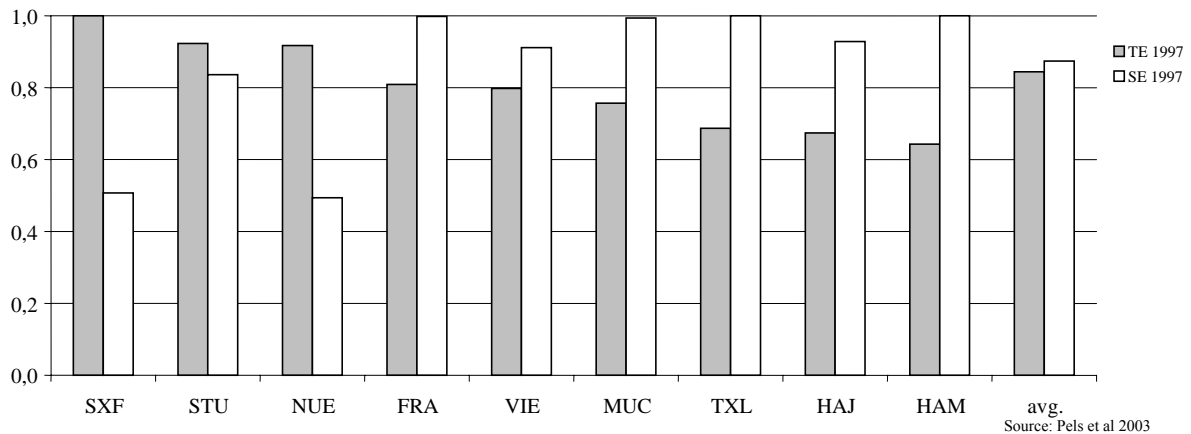
**Fig. 14: Technical and Scale Efficiency (Airside)**

**b) The Technical Efficiency on the Terminal Side**

The analysis of technical efficiency on the terminal side exhibits nearly the same average score as on the airside, though finding fewer technically efficient airports and also few airports with low efficiency scores. Here, all German airports operate relatively well; with technical efficiency scores of more than 60% (see Fig.15). One reason for this may be that during the time period under investigation (1995-1997), no major airport capacity expansion took place in Germany which, in turn, would have led to lower efficiency scores. The most technically efficient terminal-side airport in Germany is Schönefeld. This is a rather interesting finding since it returned low scores on the airside. Nevertheless, Schönefeld's scale efficiency is quite low at 50%, indicating increasing returns to scale.

<sup>26</sup> "Scale Efficiency recognizes that economy of scale cannot be attained at all scales of production, and that there is one most productive scale size, where the scale efficiency is maximum at 100 per cent." (Ramanathan 2003, p. 78)

The correlation between scale efficiency and airport size on the terminal side is much higher, with a value of 0.53, but still indicating a weak effect. As on the airside, Frankfurt and Munich, as the larger airports in Germany, operate under slight decreasing returns to scale, whereas Schönefeld und Nuremberg operate under increasing returns to scale and could increase their airport operations to improve performance.



**Fig. 15: Technical and Scale Efficiency (Terminal Side)**

### 3. Some Shortcomings and points of further research

The picture of German Airports emerging from the benchmarking studies shows them to be relatively strong, vertically integrated, with relatively low labour productivity, and high labour costs but high technical efficiency. This immediately raises the question if this picture is true for all German airports and we will try to answer that in our GAP project. However, it also raises other questions: What are the reasons for this rather poor performance? Do the results clearly indicate the inefficiency of German airports or could they also reflect efficient behaviour?

These are questions the studies do not answer, since they have more or less confined themselves to listing performance differences.

We limit our further analysis to only two important factors which, from our point of view; deserve further attention and which we intend to study in our GAP project.

#### 3.1. Economies of scale and scope

Benchmarking airports of different sizes raises the issue of how to eliminate the effects of size for a multi- product firm 'airports'. In particular, the following questions need to be asked when considering differences in scale and scope:

- Is the German airports' weak performance partially due to the effects of size?
- Does size matter for the GAP project? How important is it for the sample of German and international airports?

In order to answer these questions, we will first define economies of scale and scope, then discuss the results of empirical studies, and finally provide a preliminary answer to these two questions.

The concept of economies of scale and scope belongs to the long run theory of production. It is assumed that all factors are variable and a profit maximizing firm will find a cost efficient combination of outputs with given factor and output prices. If long run average costs decrease with the scale of production, the airport operates under economies of scale. The long run average cost curve represents the minimum of the short run average cost curves. It is important to note that economies of density - that is lower average costs due to an increase in output with given capacity - is a short-term phenomenon (Gillen and Lall, 1997). Also, diseconomies due to congestion belong to the short term (Janic and Stough, 2003). When a firm produces more than one product, economies of scope are reaped if the firm saves costs by producing two or more products jointly, rather than separately.

There are surprisingly few studies on the long-run cost function of airports, given the fact that airports might be regarded as natural monopolies, presupposing knowledge of the shape of the average cost function. We have so far been able to review the following studies:<sup>27</sup>

Study	Observed period	Sample of Airports	Output	Method	Results
Doganis Thompson (1973)		18 UK airports	WLU	Regression Analysis	L-shape cost curve with decreasing average costs up to three million.
Doganis (1995)	1993	25 airports including 12 European airports	WLU	Regression Analysis	L-shape cost curve with decreasing average costs up to five million
Pels (2000)	1997	35 European airports	Air traffic movements (ATM) and Air Passenger Movements (APM)	DEA	Average airport with 12.5 m APM passengers and 150000 APM operates under constant returns to scale for ATM and increasing returns for PTM.
Salazar de la Cruz (1999)		16 Spanish airports	Passenger	DEA	Decreasing average costs up to 3.5 million passengers, increasing from 12.5 million
Vogel (2005)	1990 to 1999	47 European airports	Passenger	DEA	Increasing economies of scale of up to 4 million terminal passengers

<sup>27</sup> We have yet to look at the Jeong study (2005). According to Jeong, US airports have decreasing average costs up to a threshold of 2.5 to 5 million passengers and constant costs in a range of 40 million passengers.

#### Tab. 4: Studies on Economies of Scale at Airports

The standard interpretation of the empirical results would lead us to interpret these results as an L-shaped average cost curve. After the airport reaches the size of about 3 to 5 million passengers, economies of scale effects flatten out, so that for benchmarking of medium and large sized airport size does not matter (see for example, Graham 2004, Oum 2005).

From our point of view, it seems more appropriate to say that we do not know very much about the long run average cost curve in the airport context. The particular questions relate to:<sup>28</sup>

- 1) - The shape of the curve, i.e. how fast small airports can benefit from higher traffic volumes.
- 2) - The stability over time, i.e. how technical progress and innovative business concepts of terminal and traffic management might shift the curve and to what extent.
- 3) - The role of diseconomies of scale, i.e. from what range onwards large airports experience higher long run average costs.
- 4) - In addition, we feel there are also unanswered issues in the sources of economies and diseconomies of scale and scope. In our view, a joint effort of econometric analysis and management theory is necessary to address the sources of economies and diseconomies of scale and scope of airports.

In order to illustrate these points, we offer an outline description of the sources of economies and diseconomies of scale, as well as sources in general, and ask if these factors are working in the airport industry. Following Besanko et al. (2003), the following factors in general might determine the long run cost curve:

➤ *Economies of scale.* Real economies of scale are caused by indivisibilities and the spreading of fixed costs. A airport's starting and landing system is a prominent example of indivisibilities, but it is not clear from which size such economies of scale cease to operate or which investments in capacity are marginal and which are incremental. The same is true for terminals and the non-aviation business, but their indivisibilities and the spreading of fixed costs are less important. Baggage systems for ground handling might be a good example for product specific costs which lead to falling average costs as the fixed costs can be spread out over larger output.

<sup>28</sup> Although benchmarking project *construction* costs might be useful in this connection, the more fundamental issues of whether an airport is faced with increasing or decreasing long-run average costs may be better addressed using alternative empirical approaches.



- *Cube square rule and physical properties.* These physical rules seem not to work for larger landing and starting systems but might be relevant for terminal and car parking.
- *Specialisation and the extent of the market.* The division of labour is limited by the extent of the market. The demand for air services in hub markets leads to additional scale effect. Airports like London, Paris and Frankfurt are more than double the size of medium sized markets such as Amsterdam, Munich and Zurich. Secondary hub markets, for example, Hamburg, Düsseldorf, Berlin and Vienna, can also be ten times larger than the regional markets for airports similar to Bremen, Nuremberg or Saarbrücken. To our knowledge there is no study on the effect of the specialisation of firms and labour in this industry.
- *Inventories.* As firms with higher output can maintain a relatively lower ratio of inventory to sales, average costs could therefore decrease. For traditional airports this might not be very relevant, but it might become relevant for non-aviation business activities.
- *Purchasing and advertising.* Discounts for volume purchasers and lower advertising costs per consumer might lead to lower average costs. How relevant this is for airports is not clear, as small airports cooperate with one another in purchasing inputs and thereby receive lower prices. As airports are increasingly addressing passengers directly, marketing and advertising may become a source of economies of scale.
- *Research and development.* R&D seems to be more relevant for the producing industry than for service-oriented airports.
- *Economies of Scope.* Economies of Scope can occur in the airline industry and also in the airport industry. Airports are not only producing “movements” and “passengers” but a variety of products and services. Cost complementarities might result from producing both freight and passengers, as well as aviation and non-aviation services. To the best of our knowledge, the relevant elasticities are not known.
- *Diseconomies of scale.* As industries are usually not governed by a few giant companies, there must be some internal limits to growth. Labour cost and firm size, as well as *bureaucracy and incentives*, might be the most relevant factors. Larger firms usually pay higher wages because of higher unionisation and they also draw workers from farther distances (see the BAA airports in our results). It seems very plausible that wages are higher at Frankfurt airport than at Saarbrücken airport even allowing for differences in productivity. However these effects have not been studied. Furthermore, larger firms find it increasingly difficult to set incentives and monitor workers and managers. This seems to be relevant for airports with different vertical and horizontal boundaries. The fact that airports are being commercialised and privatised adds another dimension to this source of diseconomy. Moreover, it might become increasingly more expensive to get the necessary inputs for large

airports. *Land* is becoming more expensive and most large airports are located in populated areas, and this means that airports have to go through expensive planning and permission processes.

Coming back to our two initial questions, it is clear that size might matter, but probably not so much for the typical medium-sized airports such as Cologne, Düsseldorf, Hamburg, Munich and Berlin-Tegel. These medium-sized airports seem to operate more or less in the range of constant economies of scale and scope. However, Frankfurt might be a size where diseconomies of scale start to play an important role. *Prima facie* relatively high labour costs and scarcity of cheap land might be relevant and explain part of the poor performance of Frankfurt.

For the GAP project size will play an important factor, since most of the German airports should operate with falling average costs and airports such as, for example, Munich might grow so fast that diseconomies of size become inevitable.

### **3.2. Product differentiation and strategic positioning of airports**

The last few years have seen a number of changes in the German and European airport sector. The most important one has been the development of low-cost carriers (LCC), which already accounted for more than 40% of all passengers in the UK in 2003. In the same year, the European share of LLCs was 15% and set for rapid growth (John, 2005, p.11). A further important factor is the increasing significance of air freight and the emergence of airports focusing on freight services, for example, Cologne-Bonn in the past and Leipzig in future.

We have argued above that, in the long run, airports could be perfectly adjusted according to local demand volume and product orientation. That would imply that the airports are, in the long run, similar to flexible units and can be adjusted to local conditions. However, we have also seen that airports themselves, through specific marketing, pricing and interlinkage strategies, can affect their demand and market conditions, especially over time. In order to reach a new equilibrium, these adjustments are clearly not achieved instantaneously. It takes time for capacity and service adjustment to be fully optimized to local conditions. Consequently, airport capacity and output orientation may not always be in an equilibrium, but in a continuous disequilibrium while trying to adjust to new conditions.

Let us first look at the case of repositioning due to changes in demand. This might well be illustrated by the case of the Cologne-Bonn airport. Originally it was designed as a regional airport, capable of serving the transport needs of Bonn, the previous German capital. When Germany's capital moved from Bonn to Berlin in the mid-90s, the airport found itself with significantly underused capacity. It was thus a logical step to reorient the airport strategy towards freight and, later, to LCCs. Over the last few years and as already indicated in our

empirical results, volume for freight and passengers has increased significantly, which has also resulted in improved financial performance and better productivity measures. The provision of a new rail link will increase the catchment area, adding extra demand for the airport. However, these effects will only be observed gradually in the near future.

Presumably, given local demand conditions and competition from other airports, as a new equilibrium is reached even better capacity utilization will be realized. This example illustrates how measured productivity may be affected as the airport repositions itself for a new product specialization. However, we find that no adjustment has been made for such developments in typical benchmarking exercises.

The other case to consider is airport repositioning due to changes in airport or intermodal competition, leading to lower capacity utilization. The airport may have been in an equilibrium before with respect to capacity and product orientation, but such changes place it in a position where it has to adjust to the new environment. Obviously such shifts, usually not subject to management control, will lead to a drop in productivity measures even if some managers adapt a forward-looking approach to try and reach a new equilibrium.

Consequently, if benchmarking is to be used in the typical disequilibrium environment, an informed debate about measures of capital and measures of capacity are needed. This implies not only looking at investment decisions, or at incremental costs, or the nature of the underlying cost function (i.e. whether there are constant or non-constant returns to scale), but also considering the lumpy nature of investment and the fact that different airport investment cycles might distort comparisons. The theory of real options would suggest that this could even lead to downward adjustment of the inputs needed to actual airport output (CAA 2000, p.27).

This issue of lumpy investment points to a number of problems associated with the measurement of airport capital, especially if trying to estimate whether there are returns to scale and what form incremental costs take. Incremental costs will be influenced both by the particular physical location and the constraints imposed by previous investment. In some instances, the most cost-effective expansion will lead to the premature retirement/replacement of existing assets. In its reply to the CAA inquiry about benchmarking, Manchester Airport therefore suggests "...that the use of benchmarking in terms of comparing airport investment/capacity relationships might be inappropriate" (CAA 2000).

### **3.3. Difference in the vertical activities of airports and the associated value chain**

Airports differ in terms of the services supplied, some operate ground handling by themselves; others outsource this service to third parties and merely provide the core facilities at the airport and receive concession fees from those providing these services. Doganis et al (1995) and TRL have defined the following as non-core activities at airports:

- Air Traffic Control
- Security
- Ground Handling
- Commercial Activities, e.g. Duty-Free, Retail, Catering
- Car Park
- Terminal Cleaning
- Recharges from water and electricity
- Head Office Functions

As we saw from our discussion of the TRL study above, German airports operate many services in the non-core area themselves: not only especially ground handling, but also commercial activities and car parking. Are the differences in the degree of outsourcing important? We have already raised the question of whether an airport needs to do more than just concentrate on its core activities (i.e. providing airport facilities). How competitive do some of the individual activity segments have to be for outsourcing to place effectively? How crucial is it for the operators to control a certain activity segment themselves in order to maintain efficiency and customer loyalty? Is the expectation of better service quality one of the reasons? Or does the degree of vertical integration also depend on the objective function of the owner/management? We will now proceed to identify some of the issues that we hope to analyze in more depth during our GAP project.

#### a) Balancing Technical and Agency Efficiencies

The organization of the vertical chain in airports is a matter of choice. They can organize around their core activities - the supply of services via arm's-length market transactions or they can organize these services internally, that is, they can vertically integrate. Besanko et al, in following Williamson, use the "Notion of Economizing", i.e. when a firm chooses between technical and agency efficiency. Technical efficiency indicates whether the firm is using the least-cost production process and agency efficiency refers to the process of exchange, i.e. the extent to which the vertical chain has been organized to minimize the coordination, agency, and transactions costs. The airports need to choose an appropriate vertical organization of production, which has to balance technical and agency efficiencies.

Following Besanko, this balancing act between "the relative efficiency of market exchange versus vertical integration is mainly determined by the trade off with respect to

- scale economies
- incentives and
- the transactions costs of market exchange."

We have already discussed the issue of scale economies above. The more the outside market specialists can take advantage of economies of scale and scope relative to the firm itself, the less the firm gains from vertical integration. This is certainly the case for ATC, and perhaps also for commercial activities.

The extent to which scale effects can be realized is also related to market scale and growth: The larger the market in which a firm operates, the more it can take greater advantage of economies of scale and scope through vertical integration. Small airports will certainly outsource activities in which scale economies are important. Larger ones have an option to vertically integrate such services. Large, dense catchments areas and better inter- and intra-modal linkages will have such effects.

Incentives are a particularly important issue in labour-intensive services, where organized labour plays a big part. If internal monitoring costs are high, and external labour markets function better, services purchased via the market may be cheaper for the airport.

#### b) Hold-up Problems and the Role of the Legal Environment

Transactions costs refer to the costs of organizing and transacting exchanges between autonomous parties that are governed by contract law (Besanko et al 2003). Firms will outsource their activities if the internal costs of production are higher than the cost of purchasing these services, plus the associated transaction cost. The legal environment in the form of contract law plays a very important role here. Contract law makes it possible for transactions to occur more smoothly when contracts are incomplete which, as we see below, is often the case. If a market for non-core airport activities exists, airports now have the chance to outsource in different ways, i.e. through long-term contracts or strategic alliances.

What makes this decision so complicated is the so-called hold up problem as a result of investment in relation specific assets. Relation specific investments refer to an investment made by either the buyer or the seller to support a planned service. Once these investments have been sunk, the two parties to the transaction cannot switch partners without cost, unless the investment can be easily switched to an alternative use. Now the terms of the exchange are determined by bilateral bargaining. The party that has sunk more into the specific investment is in a weaker bargaining position and could be held up in subsequent negotiations by threats from the other party. It will therefore try to protect itself against such a situation by contractually defining the rights and responsibilities of each contract partner. The more complete such a contract is, the better the protection against such a hold up.

In practice, such contracts are seldom complete and may require contract renegotiations. The vulnerability of the partner is related to the degree to which such relation specific investments lead to sunk cost. Besanko et al (2003) discusses four different forms of asset specificity:

- “Site specificity (location of assets)
- Physical asset specificity (physical or engineering properties are specifically tailored)
- Dedicated assets (investment in plant and machinery to satisfy a particular buyer)
- Human asset specificity (a worker's acquired skills that are more valuable inside a particular transaction than outside of it)“.

It is obvious from this discussion that the hold-up problem can raise the cost of transacting via the market exchange in four ways:

1. More difficult and frequent contract negotiations;
2. Reduced investment in relationship-specific assets and thereby a smaller market for the outsourcing of services;
3. Extra investments to improve ex-post bargaining positions (e.g. keeping a standby option for a key input as a hedge against a possible hold up);
4. Distrust (Besanko et al 2003).

In the market for non-core services, we can find many relation specific investments that could lead to such a hold-up problem, especially in the area of ground handling and commercial activities. As a consequence, airports will be looking at vertical integration as an alternative to outsourcing.

#### c) Market Imperfections as an Additional Reason for Vertical Integration

Market imperfections might drive a firm's decision to vertically integrate, because the structure of the product or service markets of the upstream or downstream firm is imperfectly competitive or because of imperfections in information flows. Vertical integration could help to avoid market foreclosure or to foreclose entry of competitors.

#### d) Alternatives to Vertical Integration

Instead of vertical integration, firms also have the option of strategic alliances and joint ventures which fall somewhere between arm's-length market transactions and full vertical integration.

- “In a strategic alliance, two or more firms agree to collaborate on a project or to share information or productive resources.

- A joint venture is a particular type of strategic alliance where two or more firms jointly create and own a new independent organization” (Besanko et al 2003).

This theoretical framework should help us to look at the role of outsourcing versus vertical integration in more detail, especially as we try to benchmark processes instead of whole airports<sup>29</sup>.

#### **4. Conclusions and Outlook for GAP**

The benchmarking results of financial performance and technical efficiency show substantial differences for German airports when compared with their international peers. By European standards, their financial performance is very low. All airports in Germany have relatively high (staff) costs and low labour productivity; this is particularly the case at Frankfurt airport.

The weak financial performance contrasts with the relatively good performance of the technical efficiency results. Munich and Frankfurt show especially large differences between both types of financial and technical analyses. They are on the bottom ranking in financial performance and labour productivity but, as the study of Pels et al (2003) shows, they operate at nearly 100% technical and scale efficiency. They even operate with near constant returns to scale or only slight decreasing returns to scale.

Even when the comparisons are reduced to the core activities of the airport, we do not find significant differences. Although this makes this sort of benchmarking a very crude tool, it does help to point to significant differences in performance which suggest further research is needed. Data refinements are certainly necessary to put more thrust into these studies, but further in-depth analysis is also called for where large differences in performance suggests a deeper underlying problem. We will be considering this issue in more detail in the next section.

*What could be the reasons for the low performance of the German airports in these studies?*

Since the studies reviewed here do not provide a satisfying answer to this question, we have outlined the areas of economies of scale and scope, as well as strategic positioning and outsourcing, which might have resulted in this poor performance.

Firstly, given the rather limited knowledge on the long-run average cost curve and its determinants, we think that it is necessary to explain in depth the issue of diseconomies of scale for larger airports such as Frankfurt and in the future Munich. Given the fact that small and medium-sized German airports have not outsourced major activities like ground handling, it will be very interesting to benchmark airports of this size and analyze the size that allows them to operate under increasing returns.

<sup>29</sup> In BAA's reply to the CAA Benchmarking inquiry, we found the following quote to support this viewpoint: "BAA's view is that benchmarking's value lies in the extent to which it can be used to inform the company's drive for cost efficiency, focussing on key processes and the opportunities for competitive contracting and outsourcing" CAA APPENDIX 4, Responses to CAA Questions in Paragraph 4 (BAA 2001).

Secondly, we do not know the sources of economies and diseconomies of scale and scope for airports. The benchmarking studies do not deal with them, but obviously it is very important to know, from the point of view of management, which measures lead to such economies and how to avoid diseconomies.

Thirdly, it is clear that better analysis on product differentiation at airports is also necessary when carrying out such studies. The repositioning of Cologne/Bonn has increased passenger numbers and cargo volumes and thus will lead to productivity changes. The change in airport strategies regarding non-aviation activities will also change the performance measure of an airport, so this topic has to be further considered. How to benchmark airports which are in the long-run process of adapting capacity and product spectrum to changes with airports that have already reached their equilibrium is a methodological challenging question that needs to be answered in order to give a better interpretation of benchmark results .

Fourthly, are differences in the degree of outsourcing important? It can be seen from the analysis above that the German airports operate many in-house services, for example ground handling or car park operations. On the basis of the ATRS results, can we assume that these operations are the most labour intensive and the most important cost drivers for an airport? If this is the case, why are German airports organising these operations themselves and not motivated to outsource them to third parties? Is the market for outsourced services not providing competitive results or might the reason be that in-house operated ground handling provides better service quality? Generally speaking, is there a correlation between cost and service quality? Or do German airports provide a better service than other airports?

What is the difference in vertical integration among airports and what activities can an airport operate more efficiently than a third party? Obviously, one should investigate not only how competitive the individual activities can be provided, so that outsourcing can take place, but also how crucial it is for operators to control certain segments in order to maintain quality and customer loyalty.

But even when outsourcing is simulated, as indicated by TRL's procedure, which eliminated the effects of ground handling and other non-core activities, the German airports nevertheless reported below average results, especially in labour productivity and staff costs per passenger. In contrast, the operating costs per passenger, which exclude the staff costs, are not very high in a European comparison. This leads to the assumption mentioned above that the staff costs are the crucial cost driver at the German airports and need further research.

Fifthly, a further possibility for the weak performance of German airports in the TRL studies could be that the data adjustment was not very consistent. If an airport operates ground handling and other services, then more employees in central departments are also needed.



This would be especially the case, for example, for the Controlling and Finance Department and the Human Resources Department. If these variables were not adjusted properly, could this explain why the German airports in the TRL study still performed relatively poorly after the data had been adjusted? Perhaps the operation of core activities at German airports is essentially performed in an efficient way, but these results could not be seen with the use of the adjusted data. Thus the route of further data refinements mentioned above might shed further light on this analysis.

*What consequences does this have for our GAP research project?*

The intention of our benchmarking study is to use unadjusted and properly adjusted data to identify differences between both types of results and to undertake an in-depth analysis into the causes of these differences. Furthermore, the project not only plans to incorporate aggregate data to measure overall performance, but also to use disaggregate data for partial performance measures. With disaggregated data it is possible to identify, for example, cost driving departments by comparing different individual departments of an airport to one another or to look at individual processes in more detail. On such a basis, one would be in a better position to provide recommendations of how to improve performance in-line with best practice airports<sup>30</sup>.

In terms of methodology, the project intends to use different approaches to test strengths and weaknesses with the different instruments and identify the most appropriate approach. For an overall analysis, Total Factor Productivity, Data Envelopment Analysis and Stochastic Frontier Analysis are considered adequate methods. The partial performance measurement will also be based on the calculation of various financial and capacity ratios.

In contrast to previous analyses, the project does not set out to establish a challenging worldwide comparison. Instead, it will focus on benchmarking German airports with a restricted sample of international airports where we can guarantee good data quality.

To overcome shortcomings in previously disregarded issues, such as economies of scale and scope, we will also study the degree of outsourcing and product differentiation in detail, and hence this will comprise a large part of our benchmarking study. We also aim to provide a more disaggregated, process-oriented approach with a greater capacity to compare "like with like". Both aspects will be carefully worked out via questionnaires and interviews at the airport.

<sup>30</sup> The problem of using such results has also been recognized by the airports in regulatory proceedings. For example, BAA undertook a cost benchmarking exercise as part of the 1991 price review "but there were a number of concerns about the reliability and usefulness of the results. The information was used only to establish in broad terms if there was scope for radical improvements in BAA staff productivity "...". BAA believes that the examination of key processes is likely to be a more fruitful approach to addressing an airport's efficiency than a top down methodology. Material and controllable costs can be identified and in some cases benchmarked. Inefficiencies identified through process examination would provide BAA with clear objectives and lead to quantifiable improvements through a target setting approach". (BAA ,2001, exec. summary p 3)

In our analysis we will also focus on the subsequent causal analysis and the corresponding interpretation of results, after initial benchmarking measurements have been carried out. In a similar approach to the regression analysis in ATRS and Doganis et al (1995), we will also try to improve identification of factors able to significantly influence an airport's performance. The project thus plans not only to gain results from running the standard models but also to give better explanations for the differences. The questions to be addressed include: *Is there a difference between privatised and publicly owned airports? How does the type of economic regulation affect the airport's performance?* Further external factors that should be considered in the analysis are: airport size, capacity constraints, noise restrictions, runway configuration, regional economic environments, competition with other airports in the region, state aids, ATC, slot coordination, peakiness of traffic, and the objective function of the airport (profit maximising or otherwise).

All these issues indicate that airports are not unique but complex phenomena, well worth studying in depth. The ongoing GAP project will provide a platform with which to study these questions in more detail and analyze the available data with various econometric and basic benchmarking methods, and to use more in-depth case studies. We therefore hope that we are soon in a position to give more comprehensive answers to this questions.

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## 6. Appendix Tab. 5: Airport Benchmarking Studies

Author	Airports	Year Under Review	Methodology
Adler, N. and Berechman, J. (2000)	26 European Airports	-	Data Envelopment Analysis (DEA)
Barros, C.P. and Sampaio, A. (2004)	13 Portuguese Airports	1990 - 2000	DEA
Bazargan, M. and Vasigh, B. (2003)	45 US Airports (15 small, medium, and large hub airports)	1996 - 2000	DEA
Doganis, R., Lobbenberg, A. and Graham, A. (1995)	25 European Airports	1993	Data Adjustments; Productivity Measurement; Regression Analysis
Fernandes, E. and Pacheco, R.R. (2002)	35 Domestic Brazilian Airports	1998	DEA
Gillen, D. and Lall, A. (1997)	23 of the top 30 US Airports	1989 - 1993	DEA/ Tobin Regression
Gillen, D. and Lall, A. (2001)	22 Major US Airports	1989 - 1993	Malmquist-DEA
Graham, A. and Holvad, T. (2000)	25 European and 12 Australian Airports	1993 (Europe), 1992/93 (Australia)	DEA and Free Disposal Hull Analysis (FDH)
Hooper, P.G. and Hensher, D.A. (1997)	6 Australian Airports	1988/89 - 1992/93	Total Factor Productivity (TFP)
Jessop, A. (1999)	32 international airports worldwide	1997 - 2002	DEA and Multiattribute Model; In a 2 <sup>nd</sup> step Cluster Analysis for both models
Martín, J.C. and Román, C. (2001)	37 Spanish Airports (AENA)	1997	DEA
Murillo-Melchor, C. (1999)	33 Spanish civil Airports run by AENA	1992 - 1994	Malmquist-DEA
Pacheco, R.R. and Fernandes, E. (2003)	35 Brazilian Domestic Airports	1998	DEA
Parker, D. (1999)	BAA as a whole, i.e. 32 (22 in a second model) UK Airports	1979/80 - 1995/96 (1988/89 - 1996/97 in a second model)	DEA
Pels, E., Nijkamp, P. and Rietveld, P. (2001)	34 European Airports	1995 - 1997	DEA/ Stochastic Frontier Analysis (SFA)
Pels, E., Nijkamp, P. and Rietveld, P. (2003)	34 European Airports	1995 - 1997	DEA/ SFA (for SFA an production function was estimated)
Sarkis, J. (2000)	44 Major US Airports	1990 - 1994	DEA
Sarkis, J. and Talluri, S. (2004)	44 Major US Airports	1990 - 1994	DEA and clustering method
Vogel, H.-A. (2005)	31 individual and 4 airport systems in Europe	1990-1999	Performance Indicators and Financial Ratios with t-test; DEA (BCC-i-model)
Yoshida, Y. (2003)	30 Japanese Airports	2000	TFP (Endogenous-Weight)
Air Transport Research Society	airports and airport authorities worldwide	published annually	Partial Performance Measurement, TFP
Transport Research Laboratory	airports and airport groups worldwide	published annually	Data Adjustments; Partial Performance Measurement, Multi Attribute Assessment

## **7. Working Papers des Institute of Management Berlin an der Fachhochschule für Wirtschaft Berlin**

- 1 Bruche, Gert / Pfeiffer, Bernd: Herlitz (A) – Vom Großhändler zum PBS-Konzern – Fallstudie, Oktober 1998
- 2 Löser, Jens: Das globale Geschäftsfeld „Elektrische Haushaltsgroßgeräte“ Ende der 90er Jahre – Fallstudie, Oktober 1998
- 3 Lehmann, Lutz Lars: Deregulation and Human Resource Management in Britain and Germany – Illustrated with Coca-Cola Bottling Companies in Both Countries, March 1999
- 4 Bruche, Gert: Herlitz (B) - Strategische Neuorientierung in der Krise - Fallstudie, April 1999
- 5 Herr, Hansjörg / Tober, Silke: Pathways to Capitalism - Explaining the Difference in the Economic Development of the Visegrad States, the States of the Former Soviet Union and China, October 1999
- 6 Bruche, Gert: Strategic Thinking and Strategy Analysis in Business - A Survey on the Major Lines of Thought and on the State of the Art, October 1999, 28 pages
- 7 Sommer, Albrecht: Die internationale Rolle des Euro, Dezember 1999, 31 Seiten
- 8 Haller, Sabine: Entwicklung von Dienstleistungen - Service Engineering und Service Design, Januar 2000
- 9 Stock, Detlev: Eignet sich das Kurs-Gewinn-Verhältnis als Indikator für zukünftige Aktienkursveränderungen?, März 2000
- 10 Lau, Raymond W.K.: China's Privatization, June 2000
- 11 Breslin, Shaun: Growth at the Expense of Development? Chinese Trade and Export-Led Growth Reconsidered, July 2000, 30 pages
- 12 Michel, Andreas Dirk: Market Conditions for Electronic Commerce in the People's Republic of China and Implications for Foreign Investment, July 2000, 39 pages
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