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APPROACHES TOWARDS AIRPORT ECONOMIC PERFORMANCE MEASUREMENT

Summary. The paper aims to assess how economic benchmarking is being used by airports as a means of performance measurement and comparison of major international airports in the world. The study focuses on current benchmarking practices and methods by taking into account different factors according to which it is efficient to benchmark airports performance. As methods are considered mainly data envelopment analysis and stochastic frontier analysis. Apart from them other approaches are discussed by airports to provide economic benchmarking. The main objective of this article is to evaluate the efficiency of the airports and answer some undetermined questions involving economic benchmarking of the airports.

ПОДХОДЫ К ИЗМЕРЕНИЮ ЭКОНОМИЧЕСКОЙ ЭФФЕКТИВНОСТИ АЭРОПОРТОВ

Аннотация. Целью статьи является оценка того, как экономический бенчмаркинг используется аэропортами в качестве средства измерения и сравнения основных международных аэропортов в мире. Исследование сосредоточено на текущей практике бенчмаркинга и его методах, принимая во внимание различные факторы, в соответствии с которыми они являются эффективными для сравнения производительности аэропортов. Как методы рассматриваются в основном методы *анализа* среды функционирования (DEA) и анализа стохастической границы (SFA). Помимо них обсуждаются другие подходы проведения экономического бенчмаркинга аэропортами. Основная цель этой статьи заключается в оценке эффективности аэропортов и позволяет ответить на некоторые неясные вопросы, связанные с экономическим бенчмаркингом аэропортов.

1. INTRODUCTION

The interest in the performance evaluation is not a new issue. "Until the 1980s, the systematic monitoring and comparing airport economic performance was not a widely practised activity within the airport industry. With airport commercialization and privatization has come a market interest in performance comparisons and benchmarking" [12]. The airports moved from being public utilities and started to pay attention to commercial activities. The benchmarking has become performance improvement technique to evaluate efficiency of the airports.

The type of studies deals with airport economic performance can be helpful in policy decisions. Such studies are crucial for airport managers while deciding to choose the best framework to organize airport system. As managers are obliged to make decisions according to different criteria and methodology approaches, benchmarking has been created as an increasingly important performance managerial tool that can be used for monitoring and improving aspects regarding economic performance within the company, as well as among peers. Basically, "it is a positive, proactive process to change operations in a structured fashion to achieve superior performance" [9].

The paper discusses conclusions of several studies (Table) focusing on airport economic performance and its methods. It provides readers with different techniques, inputs-outputs measures which were used by different authors in different parts of the world to estimate best performing airports.

There is strong assumption that the term *airport economic performance* will be discussed as very ardent issue in the future.

2. MOTIVES AND PURPOSES

The main purpose of this paper is to evaluate ten different studies. All of them deal with airport efficiency.
First of all, the comparison of the studies will be provided. According to results one determines the best approach which is used by airports to measure economic performance. As the most popular and usually used methodology approaches are presented Data Envelopment analysis (DEA), Stochastic Frontier Analysis (SFA) and Total Factor Productivity (TFP). The approaches will be discussed more precisely in following chapters.

3. LITERATURE REVIEW

The first study in the sample (Francis et al. 2002) examines benchmarking as important performance tool which is used by managers to provide internal performance comparison. The paper evaluates current benchmarking practices on the sample of 200 world busiest passenger airports. Best Practice Benchmarking is considered as the best approach. It is the most popular technique commonly used by managers as the best way to gain competitive advantage of the enterprise, as well as to meet customer needs. Measures in this paper are based on WLU[1] (Doganis, 1978). The main purpose of the study was to gain better understanding of benchmarking practices. From the sample of 200 airports, there are around 72% of airports reported as involved in any form of benchmarking.

The study (Humphreys, Francis, 2002) focuses on performance measurements of airports by means of considering past, present and future time period. The authors examine how the nature of performance measurements has been changed during the last couple of decades. The paper deals with several factors which have crucial bearing on natural environment and technical innovation of the airports. It assesses number of reasons why airports and governments are obliged to measure airport performance [13]:
- To measure efficiency from a financial and an operational perspective (Doganis, 1992)
- To evaluate alternative investment strategies
- To monitor airport activity (safety perspective)
- To monitor environmental impact

As well as previous study even this one is using WLU as basic unit to provide all performance measurements (Doganis, 1978). The study distinguishes from others by means of understanding basic idea of the paper. The authors highlight "not to measure what was easy to measure as opposed to what was useful" [13].

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[1] Note: Work load unit is generally 1 passenger proceeded or 100 kg of freight handled.

Following study (Thompson, 2002) encompasses the development of third level airports in France. The paper focuses mainly on regional airports in the alpine region. There are just a few studies dealing with the strengths and weaknesses of regional airports. The idea to construct a hierarchical classification of French airports is almost impossible due to many aspects which must be taken into account. Such aspects are not only passengers or freight traffic but also operational aspects and the quality of infrastructure. Moreover, the paper discusses efficiency of airports located in tourist attractive areas. The only reason why the future of these airports is ambiguous can be the proximity to international airport or well developed infrastructure within region. Regarding to this aspect such regional airport seems to be useless over there. The next disadvantage can be considered boom of high-speed trains in the last few decades. They have become a great competitor of air transport as relatively low-cost alternative to air travel.

Determination of productive efficiency and productivity of the world's major airports is stated in the study (Oum et al, 2006) which takes into account different ownership structures. Following The Airport Act in 1986, majority part of airports all over the world moved from being public into private sector. That is why the airports have taken different ownership forms. The ownership form plays an important role in performance evaluation because of different owners pursuing different goals. Under government ownership, the airport is run by bureaucrats who focus their attention to maximize social welfare. On the other hand, when airport is under private ownership, only effort of the managers is achieving profit maximization (shareholder value). It is generally true that publicly-owned airports are less productively efficient than airports privately-owned. However government-owned airports are less efficient, surprisingly they perform much better than the PPP[2] airports.

Consequently, in the study written two years later (Oum et al, 2008) the authors stressed their attention in the same way as in the previous study so that to measure the effects of ownership forms on the airport performance. Difference in this study is the way how airport performance is estimated. In this case, the authors use SFA, more precisely Bayesian approach. The SFA model has been widely used as a means of measuring the deviation of an enterprise's efficiency as compared to the best achievable target.

Another widely used approach, Data Envelopment Analysis, was applied by Lin C.L. (Lin C.L. et al, 2006) to examine operational performance of 20 major airports around the world. DEA model can be used for benchmarking purposes and it is also suitable for evaluation of airport performance. The paper assesses five factors directly influencing airport efficiency.
These are followed:

- Ownership
- Size
- Hub or Spoken system
- Location
- Economic growth rate of region

Data Envelopment Analysis is utilized even in next paper (Tseng K-J. et al, 2008). The study determines the performance evaluation of 20 world's major international airports. DEA is there defined as the basic approach to reach targets. The study assesses overall performance from point of view of different world regions, namely Asia, America, Europe and Oceania. As conclusion of this study is a finding that Asian international airports outperform airports in three other world regions.

The aim of the study (Muller J. et al, 2008) is to estimate economic and technical performance of 13 airports in United Kingdom and Germany. The authors carry out comparative analyses by applying several different methods, such as DEA, SFA, PFP and 2nd Stage Tobit Regression, to obtain overall performance measures. As a conclusion, they discovered that British airports perform much better than German ones. It can be caused by different ownership structures in both countries. As we already know from previous papers this factor might play important role in evaluation of airport efficiency. This study follows again earlier paper *Privatization, corporatization, ownership forms and their effects on the performance of the world's major airports* (Oum et al, 2006).

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[2] Note: PPP- Public-Private Partnership

The study (Suzuki et al, 2009) provides comparative performance analysis of 19 largest European airports by applying DEA as the most popular approach for evaluating airport performance. DEA includes several approaches which are widely introduced and applied on the sample of airports to estimate best practice and consequently best performing airport.

Last study in the sample (Martin C.J. et al, 2009) deals with evaluation of the efficiency of Spanish airports by using SFA, MCMC[3] Simulation. Application of SFA model leads to a simple comparison trying to analyze whether size plays a role regarding the performance between small and large airports. Results shows that larger airports are more efficient than small ones.

4. METHODOLOGY APPROACH

The sample of studies has examined the economic performance of airports using different methodologies. Most of them stress their attention to express airport efficiency by applying Data Envelopment Analysis (DEA), although others rather use Stochastic Frontier analysis (SFA) as an approach which resolves some shortcomings of DEA or Total Factor Productivity (TFP) index which is quite common among airport managers to evaluate overall performance.

4.1. Data Envelopment Analysis

The Data Envelopment analysis (DEA) is a popular and frequently used technique to encompass the relative efficiency of airport. "The DEA model was formulated in the 1970s (Charnes et al., 1978), building on the ideas of Farrell's (1957) non-parametric production frontier function" [15].

The general purpose of DEA by providing a comparative airport performance analysis is to determine decision making unit (DMU) paying attention to discover how to improve airport efficiency and how to reach efficiency frontier by reducing the inputs or increasing the outputs.

As was aforementioned, the DEA is non-parametric approach that uses linear programming to construct linear "efficient frontier" that envelops the data based on multiple inputs and multiple outputs. Efficiency measures are then calculated relative to this frontier.

The technique estimates the relative efficiency of multiple DMUs. The DMU can take two forms, the first is efficient DMU and the second one is inefficient DMU. An efficient DMU has the most appropriate combinations of input and output variables which constitutes the efficiency frontier. The relative position of a DMU with the respect to this efficiency frontier is used as a measure of the extent of efficiency of an inefficient DMU.

The DEA approach has some positive factors regarding regression methods, which are widely introduced in one of the examined studies (Lin C.L. et al., 2006). Mainly two up to five DEA models are commonly used by airport managers to stipulate relative efficiency. These are the CCR (Charnes et al., 1978) based on constant return to scale measurements, and the second model is BCC (Banker et al., 1984) focusing on variable return to scale measurements.

Regarding many advantages, the approach became popular and used by economists all over the world. Some of the benefits of DEA are [27]:
- No need to explicitly specify a mathematical form for the production function;
- Proven to be useful in uncovering relationships that remain hidden for other methodologies;
- Capable of handling multiple inputs and outputs;
- Capable of being used with any input-output measurement;
- The source of inefficiency can be analysed and quantified for every evaluated unit.

The main criticism of DEA is that as it is not a statistical estimation technique. It does not offer a diagnostic statistic for determining whether or not the chosen model is appropriate.

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[3] Note: MCMC- Markov chain Monte Carlo

The comparison of the approaches used to evaluate economic performance of airports

Title of study	Origin date	Author	Number of A/ds	Catch.are	Met app	Inputs	Outputs
The benchmarking of airport performance	2002	Francis G., Humphreys I., Fry J.	200 busiest PAXA/ds	world	BPB	WLU	
Performance measurement – a/ds review	2002	Humphreys I., Francis G.	unreported	world	DEA, TFP	WLU (PAX, CARGO)	
Air transport liberalization and the development of third level airports in FR	2002	Thompson B.I.	5 alpine A/ds	France			A/c movements, PAX, Cargo
Privatization, corporatization, ownership forms and their effects on the performance of the world's major a/ds	2006	Oum H.T., Adler N., Yu Ch.	unreported	world	DEA, TFP	Labour, purchased goods, material a services	A/c movements, PAX, Cargo, Concessions
Ownership forms matter for airport efficiency: A stochastic frontier investigation of worldwide airports	2008	Oum H.T, Yan J., Yu Ch.	unreported	world	SFA	Labour, purchased goods, material, services	A/c movements, PAX, Cargo, non aero revenues
Operational performance evaluation of international major airports: An application of DEA	2006	Lin C.L., Hong H.C.	20 major A/ds	world	DEA	Check-in desks, gates, aprons, employees, RWYs, park lots, terminal area	A/c movements, PAX, Cargo
A study on the performance evaluation of major international airports	2008	Tseng K-J., Ho J-F., Liu Y-J.	20 major A/ds	world	DEA	RWYs, aprons, employees, A/d size	A/c movements, PAX, Cargo
Privatization, restructuring and its effects on performance: A comparison between German and British airports	2008	Muller J., Ulku T., Živanovic J.	13 A/ds	Germany UK	PFP, DEA, SFA, 2nd stg Tobit		WLU
Comparative performance analysis of European airports by means of extended DEA	2009	Suzuki S., Nijkamp P., Pels E., Rietveld P.	19 major A/ds	EU	DEA	RWYs, gates, labour, capital, material	A/c movements, PAX, Cargo
A stochastic frontier analysis to estimate a relative efficiency of Spanish airports	2009	Martin C.J., Roman C., Voltes-Dorta A.	unreported	Spain	SFA	Labour, capital, material	A/c movements, PAX, Cargo

4.2. Stochastic Frontier Analysis

In comparison with DEA and TFP, the Stochastic Frontier analysis (SFA) has been only used in very scarce occasions. The reason for this choice is personal beliefs and competences of researchers as well as availability of data.

The SFA is an econometric method which is usually applied by airports to estimate technical efficiency.

According to Coelli (1998), the main advantages of this approach are [17]:

- It is easy to deal with environmental variables;
- It allows to conducting statistical tests of hypotheses concerning any parameter restrictions associated with economic theory;
- It allows an easier identification of outliers.

Three studies up to ten deals with airport performance by using SFA approach while they are concentrating on evaluation of technical efficiency as mentioned technique is the best for this purpose.

4.3. Total (Partial) Factor Productivity Index

Factor Productivity (TFP) index is rather as popular among economists as DEA does. The TFP is variable which accounts for effects in total output not caused by inputs.

The approach is often considered as the real driver of growth within economy. However, some economists believe that the method and its results are invalid.

5. INPUT AND OUTPUT INDICATORS

"To summarize, performance measures or indicators are all about relating one or more of the outputs to one or more inputs" [12]. Physically, the output is not homogenous and can be assessed in three ways; in terms of:

- Aircraft movements;
- Passengers;
- Freight handled.

Since most airports handle both passengers and freight, this suggests the use of an output measure which combines the two, such as the WLU. The WLU, although probably the most widely accepted aggregate measure, is a rather arbitrary method of linking the two outputs. All studies in the sample take into account as a basic output indicators combination of aircraft movements, passengers and freight handled.

"Performance measures analyse the relationship between inputs and outputs at an airport" [12]. As with other businesses, labour and capital are the major inputs of the airport system. As it is illustrated in Table 1, most studies deal with these two primarily major input variables if airport performance is considered. The simplest physical measure of the labour input is the total number of employees.

The labour input can also be measured in financial terms, namely employee wages and salaries. "The financial measurement of output is much more straightforward" [9]. It can be measured by considering the total revenues generated.

Apart from labour and capital as the most frequently used input indicators there is several other indicators which must be taken into account. These are, for instance, number of runways and also aprons, number of check-in counters and gates, parking lots and even terminal area expressed in sq m is important for performance evaluation.

On the basis of all proposed indicators there is possibility to make cross-country performance comparisons.

6. CONCLUSION

The main purpose of this paper was to benchmark several studies to make conclusions such as, what approach is considered as the best if the comparative performance analysis of the airports is provided and what kind of indicators is commonly used by airport management to assess the economic efficiency. Achieved results claimed "in general there is no accepted industry practice for measuring airport performance" [9].

As the airports behave like entities with multi-product nature, no one can easily stipulate best methodology approach neither best performing airport. There are plenty of factors which must be taken into account regarding to airport economic benchmarking. Such these factors are primarily size of the airport which can be sometimes more important than ownership structure. Other factors which can influence the airport efficiency are economic growth of the region or country whether is examined airport hub or spoke, and notable should be also location of airport.

In 1986 The Airport Act came into force in UK. It was the beginning of privatization and commercialization era in whole Europe. As the world's major airports started to be mostly privately-owned they focused their businesses on commercial activities.

As the most frequently used input indicators which estimate airport economic performance were selected labour, purchased good and materials, and purchased services. The output indicators were the same in every examined study, these are aircraft movements, and passengers and freight handled.

Logically large international especially privately owned hub airports were considered in the sample as the most efficient and the best performing.

The methodologies which have been applied to discover the best performing airports were DEA, as the most popular approach, SFA and TFP.

There are several organizations and research laboratories worldwide concerning the economic benchmarking of airport performance. Such the most popular ones are Transport research laboratory (TRL) and Air transport research society (ATRS).

Nowadays problem regarding evaluation of airport economic performance is widely discussed and there is several approaches used by airport to stipulate best practices and to adjust best performance strategies to reach targets.

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