



RESEARCH INTO THE METHODS OF ANALYSING THE PRODUCTIVITY INDICATORS OF TRANSPORT TERMINALS

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Abstract. The measurement of terminal productivity is the issue of extreme importance to both terminal owners and management and customers. As the sector of transport is highly intensive in terms of investments into the infrastructure, the productivity of a terminal may play a crucial role in competing with other terminals. Productivity is defined in terms of inputs and output. The majority of the available studies, wherein this issue is addressed, are generally focused on the determination of functional dependence between inputs and output using the method of regressive analysis. The present article provides an insight into the Data Envelopment Analysis method as a tool for measuring productivity. This technique enables a rather accurate evaluation of terminal productivity by means of comparative analysis, which, in fact, appears to be the only feasible alternative in cases where statistic data required for performing regressive analysis is lacking.

Keywords: productivity, terminal, input, output.

1. Introduction

The efficiency of terminal performance plays a particularly important role in the competition between airports for attracting more passengers, cargoes and air operators to their terminals (Baublys 2009; Liu *et al.* 2009; Batarlienė and Jarašūnienė 2009; Bagdonienė 2008; Kisler 2008; Meirane 2007; Jaržemskienė 2007; Gromule and Yatskiv 2007; Kabashkin 2007; Meidutė 2007; Labauskas and Palšaitis 2007). Depending on the mode of transport, terminals may be of different types. In addition, the distinction is made between freight (warehouse, logistics centre) and passenger (railway station, bus station, airport) terminals. The efficiency of terminal performance is measured as the ratio of inputs and output. This ratio may show what volume of passenger or freight traffic the terminal may handle given the fixed inputs. It is particularly important in planning and managing the operations of terminals and in monitoring their performance. Terminals with the same inputs but different performance efficiency may handle different volumes of passenger, freight or transport traffic. Thus, knowing the values of efficiency indicators, it is possible to perform the comparison of terminals and forecast their development trends. The determination and measurement of performance indicators is a very important tool for terminal owners in planning development investments

and programs and in identifying investment priorities. Moreover, it helps air operators to make a better selection of terminals for their operations and the management of terminals to ensure the competitiveness of their airports.

The present article provides the analysis of limitations characteristic to the previous works and studies carried out on the subject of terminal productivity indicators. The aim of the paper presented herein is to design a systematic model for the evaluation and prediction of efficiency indicators based on the findings of the previous research effort in the light of the latest developments within the sector of transport.

Before 1980, the practise of performing a systematic monitoring of efficiency indicators and their comparison with those of other terminals was not common, basically due to the absence of any need. It acquired relevance only with the start of the airport privatisation and commercialisation process. Having examined the best practise examples, Hooper and Hensher (1997), Graham (2003), Francis *et al.* (2002) attempted to identify performance indicators to be used for comparing the performance of different airports. The overview of national scientific literature revealed no evidence that similar research had been ever carried out in Lithuania. The sources of worldwide literature, wherein the issue

on the efficiency indicators of airports is investigated, are comparatively limited in number, though it should be noted that the recent decade has witnessed an increasingly growing interest in the subject. In addition, a number of studies involving an efficiency-based comparison of airports have been carried out in individual countries: Australia – Abbott and Wu (2002), Great Britain – Parker (1999), USA – Gillen and Lall (1997), Bazargan and Vasigh (2003), Sarkis (2000), Sarkis and Talluri (2004), Spain – Martín and Román (2001), Brazil – Fernandes and Pacheco (2001, 2002, 2005), Japan – Yoshida (2004). However, only very few researchers attempted to investigate the issue on a larger scale than the national one, for example, on the European (Pels *et al.* 2001 and 2003) or international (Adler and Berechman 2001; Oum *et al.* 2003; Oum and Yu 2004) level. None of the researchers applied the approach of systematic interaction between terminals, either. Affected by the process of globalisation, terminals are losing their individuality and in evaluating the productivity more significance is being attached to the characteristics of terminal interaction with other terminals and the transport system at large rather than to the specific characteristics of an individual terminal.

In summary, it may be concluded that the scientific novelty of the article lies in the new approach, whereby the productivity of terminals is investigated as the systemic efficiency of the integral transport system part instead of focusing on the productivity indicators of individually operating terminals that was the case in the previous studies.

2. Parametric Approach

Efficiency in the areas of services and production is generally defined as the ratio between the value of input resources and the value of the obtained benefit. The evaluation of efficiency within such complex systems as terminals, let alone their interaction, becomes problematic. Efficiency comprises a multitude of mutually interrelated internal and external factors, a certain number whereof cannot be measured. The indicators of input resources are normally of a complex nature and are determined by the input of labour and capital. These resources generate output manifesting itself in a complex manner, generally as the throughput of transport, passenger and freight traffic. As inputs and output are multicomplex, for deriving each single common indicator that would define both inputs and output, it is necessary to evaluate each constituent element i.e. all inputs may be evaluated in terms of partial efficiency indicators.

Basically, two types of productivity in terms of evaluation are distinguished in literature – partial factor productivity and total factor productivity.

The values of performance productivity are in principle related to a single factor output of the terminal, for instance, most frequently output is measured by the rate of passengers per employee, the rate of handled transport means per employee or the weight of handled freight in tons per employee.

Meanwhile, Humphreys (1999) and Humphreys and Francis (2002) carried out research that revealed the emergence in the air transport sector of new measurement values brought about by the process of the privatisation and commercialisation of airports. These new measurement values were split into three categories: financial values for monitoring commercial performance, values for monitoring compliance with governmental requirements and values for monitoring the environmental impact. Partial values are very easily estimated using computer because they require a limited scope of data and are fully comprehensible. These partial values have been used by the majority of airports worldwide.

Comprehensive analysis and systematic approach to the issue of how airports measure the efficiency of their performance are provided in Hooper and Hensher (1997), Francis *et al.* (2002) and Oum and Yu (2004).

As observed by the aforementioned authors, the efficiency of terminals is being measured on several levels:

- the global level (A);
- the partial level (B);
- the level of specific activities (C);
- the level of services (D).

With respect to the evaluation of airport performance on the global level (A), the following three main categories may be distinguished:

- 1) the measurement of profitability is generally based on such values as income per passenger or freight unit, the rate of return on capital, cost/income ratio and profit per handled unit of freight;
- 2) for the evaluation of cost efficiency, normally, values per workload unit are used; these can be the total costs as well as the costs of activity, capital or labour;
- 3) the efficiency of income is also measured per unit of workload such as the total income or income of storage, loading or parking.

On the partial level (B), normally the following two factors are being measured:

- 1) for evaluating the productivity of capital in terminals, there may be measured the added value created per unit of capital costs, the amount of workload per unit of net assets or the total income per unit of net assets;
- 2) the productivity of labour force is estimated based on the amount of generated workload per employee, income per employee, the added value created per employee and the number of passengers or freight units handled per employee.

For the evaluation of efficiency on the level of specific activities (C), the values of the following three categories are generally used:

- 1) the efficiency of airport take-off runways and loading ramps is evaluated based on such indicators as the number of take-off aircrafts per runway, the number of aircrafts per runway length unit, the number of aircrafts per time unit or the number of reloaded cargoes per ramp;
- 2) passenger attendance is evaluated using such indicators as check-in time per passenger, time

for issuing luggage, the flow of passengers per boarding gate and the number of passengers per terminal space area;

- 3) the efficiency of baggage handling is generally evaluated based on the values of handled baggage per unit of time and safely handled baggage per unit of time.

For the evaluation of productivity on the level of passenger services (D), the values of the following three categories are measured:

- 1) within the category of passengers – distances to departure gates and passenger jams measured by the number of passengers per space area unit;
- 2) within the category of freight – time from picking the cargo from the freight terminal to the moment of delivering it to the transport means and the scope of cargo thefts and damages;
- 3) within the category of air operators – the index of aeronautical taxes, the index of non-aeronautical taxes and aircraft handling time estimated as the maximum time required for accepting and servicing the aircraft and dispatching it back.

As noted in Hooper and Hensher (1997), while the issue of partial factor productivity evaluated using a multitude of criteria is very extensively addressed across the numerous sources of literature, references to aggregate evaluation factors are yet very rarely come across. The major problem in this case lies in combining the isolated partial factors into a single aggregated model. For instance, if labour force productivity at the terminal is very low but other indicators of productivity outmeasure the component of labour force, the airport may still stand as highly competitive. This point was also made in Nyshadham and Rao (2000). The issue of the evaluation models of total factor productivity as the subject of increasing interest is already addressed in Gillen and Lall (1997), Oum and Yu (2004), Pels *et al.* (2001, 2003) and Yoshida and Fujimoto (2004).

The major problem of evaluating the productivity of terminals by aggregate indicators is encountered by researchers while attempting:

- 1) to assign weight to each indicator;
- 2) to determine functional dependence between respective indicators defining inputs and output.

Hooper and Hensher (1997), in attempting to find a solution to the problem, proposed to determine the weights of indicators defining inputs based on the ratio of their costs and carry out the empirical evaluation of elasticity for output indicators. Nyshadham and Rao (2000) argued that in determining the weight of evaluation indicators, instead of costs, the ratio of input costs and input generated income should be used. As income directly relates to prices and these in turn relate not only to the cost price generated by inputs but also to the market situation (which may be different depending on whether the market is dominated by monopolies or competing terminals), rating of the weight as cost/income ratio does not seem to be reasonable.

In analysing the effect of aggregate factors in productivity, researchers put strong focus on the compu-

ter-based determination of functional dependence. For modelling, generally two approaches, including parametric and nonparametric are applied. Both approaches have their own advantages and limitations and the choice in between the two depends on the accessibility of data. In certain cases, as noted by Pels *et al.* (2003) and Yoshida and Fujimoto (2004), both approaches may be applied simultaneously.

In the parametric approach, all inputs are rated by their weighted values or weights and expressed as a single unit. Also the same procedure is applied for the indicators of output. In the next step, there is a determined volume of individual output generated by individual input. Knowing the pattern of functional dependence and the exact values of indicators, it is possible to proceed with making computer-based estimations. For the purpose of determining functional dependence, Pels *et al.* (2001) carried out the analysis in 34 European airports and evaluated the stochastic frontiers of productivity. Hence, there was determined the functional dependence of passenger number on the number of luggage claims and the number of aircraft parking spaces as well as functional dependence between the number of handled aircrafts and the number of take-off runways and aircraft parking spaces at the terminal. In the follow-up study carried out by the same authors in 2003, the function of the handled aircrafts number was supplemented by the parameters of the airport area size and relative imaginary constant. The functional dependence of passenger number was also complemented by the parameter of relative imaginary constants such as the average annual load factor of aircrafts and the number of check-in desks. Martín-Cejas (2002) evaluated the performance of 31 Spanish airports using the deterministic model of marginal costs, based on which the functional dependence of total costs per workload unit on the cost of labour force and capital was determined.

3. Non Parametric Approach

While the parametric approach may be defined as an attempt to determine functional dependence between certain selected indicators of inputs and output, in the nonparametric approach, the evaluation of parameters is not carried out, which means that there is no need to identify them and determine their value as due to lack of statistic data, this exercise proves to be rather complicated. Furthermore, the derivation of equal functional dependence between parameters for each airport may lack accuracy required for the comparison of performance results between airports as the external conditions, under which different airports operate, may vary a lot. In the nonparametric approach, the major focus is put on the method known as Data Envelopment Analysis (DEA) which, as revealed by the analysis of literature, is recognized as the most popular technique applied in evaluating the productivity of airports. The nonparametric method shares certain similarities with the parametric approach. At the initial stage of evaluation, each input and output must be expressed in a numerical value. In addition, each input and output must have attached

to respective weights. Now, when the weights and numerical values have already become known, it is possible to proceed with the exercise of making computer-based estimations. According to the definition, the indicator of total factor productivity is the ratio between output and inputs. A higher index of productivity speaks of higher airport performance efficiency. This conception is shared by both approaches.

Hooper and Hensher (1997) in their comparative study on Australian airports analysed the weighted values determining the weight of each input and output as the share of costs and income generated per each input and output. As inputs, there were evaluated such factors as capital, labour force costs and other costs and output was estimated separately as aeronautical and non-aeronautical income. In both cases, regressive analysis was applied. Nyshadham and Rao (2000) followed a similar path and attached weights to indicators based on the share of costs and income generated by them. The operational capital and other costs per unit of workload were evaluated as inputs. The output was estimated as aeronautical and non-aeronautical income per unit of workload. Oum *et al.* (2003) carried out the performance analysis of 50 largest airports operating in Asia, the Pacific Region, Europe and North America. The evaluation was carried out based on such inputs as the number of full-time equivalent employees, take-off runways and passenger boarding gates, whereas output was estimated as the number of handled aircrafts, the number of passengers, the volume of freight and non-aeronautical income. The regressive equation for the airports of Asia and the Pacific Region was supplemented by extra constants which were also used to adjust certain disparities occurred due to a different size of airports. In the study analysing the performance of 30 airports in Japan carried out by Yoshida (2004), the length of take-off runways and the space of the terminal were taken as inputs and the number of handled aircrafts, the number of passengers and the volume of baggage were evaluated as output. Youshida and Fujimoto (2004) evaluated the length of take-off runways, the space area of the terminal and the number of terminal employees as inputs and the number of handled aircrafts, the number of passengers and the volume of baggage as output.

One of the major difficulties referred to by the aforementioned authors is associated with the availability of data, i.e. the methods discussed above require the availability of a comprehensive database of quantitative indicators. However, in the majority of cases, this data is not accessible. Another problem encountered by the researchers lies in the fact that for estimating output, generally the total income is used. However, the total income in frequent cases depends on prices and not on inputs, as prices rather than inputs represent the ratio of market supply and demand when operating under market conditions. This point was made by Martín and Román (2001). In their opinion, income, when based on unfair prices due to the dominance of one or another airport within the market, should not be selected as an evaluation criterion in determining airport pro-

ductivity as this may produce misleading results. Due to raised prices, the evaluation results may show monopoly airports being highly productive, though the actual efficiency of their performance will be very low. It is a perfect tool for the management of airport monopolies seeking favourable assessment on the part of owners. Alternatively, a small airport operating under conditions of tough competition may be misleadingly rated as non-productive because of low competition-oriented prices generating low income indicators.

On the other hand, it is very convenient to evaluate income as output because as income represents the most accessible and easily estimated set of data, whereas other outputs, in particular negative ones, such as delays, noise or pollution, pose difficulty in terms of their measurement and evaluation.

The method of Data Envelopment Analysis (DEA) does not require to attach weights to indicators and hence to evaluate the weights of the partial indicators of inputs and output for the aggregate indicator. This method is based on linear functional dependence on purely empirical data. It is very successfully applied in cases when income is based exceptionally on prices.

Theoretical aspects related to applying the method of systemic data analysis are addressed in Charnes *et al.* (1994), Cooper *et al.* (2004), Zhu (2002), Ray (2004) and Cook and Zhu (2005).

The issues of employing the technique of systemic data analysis in evaluating the productivity of airports are subjected to the most comprehensive analysis in Gillen and Lall (1997, 2001), Murillo-Melchor (1999), Parker (1999) and Sarkis (2000).

In the nonparametric analysis, the parameters of output indicators are normally measured by means of survey. For example, Adler and Berechman (2001) carried out a survey of 26 airports operating in West Europe, North America and Far East using a questionnaire of 14 questions and the Likert scale.

The method of nonparametric analysis was also applied in the research survey of 35 airports in Brazil conducted by Fernandes and Pacheco (2001) and the research survey of 37 airports in Spain carried out by Martín and Román (2001). Among the most recent works, there could be mentioned Abbott and Wu (2002), Fernandes and Pacheco (2002) and Bazargan and Vasigh (2003). Pathomsiri and Haghani (2004) conducted a special study investigating changes in the productivity of airports brought about by the introduction of more stringent security measures after the September 11 events in New York.

Fernandes and Pacheco (2005) performed a comparative analysis of productivity in 58 airports in Brazil. A similar comparative analysis of 72 airports worldwide, again in the context of security measures after the September 11 events, is presented in Pathomsiri *et al.* (2005).

In Lithuania, the main papers in transport efficiency and productivity are made by Isoraite (2004, 2005, 2006).

4. Theoretical Grounding in the Method of Data Envelopment Analysis

Data Envelopment Analysis (DEA) is a relatively new 'data oriented' approach for evaluating the performance of the so-called Decision Making Units (DMU) converting multiple inputs into multiple outputs. The method of Data Envelopment Analysis was first introduced by Rhodes in his dissertation. In evaluating the efficiency of educational programs for disadvantaged students, Rhodes, instead of collecting a huge amount of information required for evaluating inputs and results in concrete figures, applied DEA. Parametric analysis in this particular case could hardly be applied due to the existence of multiple factors defining inputs and multiple criteria for determining output. Hence being incepted, DEA has grown into a powerful tool for evaluating the productivity of sophisticated technological operations. As pointed out in Cooper *et al.* (2006), recent years have seen a widespread application of DEA in evaluating the productivity of technological processes across a variety of industry sectors. The generic and flexible nature of the aforementioned DMUs makes it difficult to come up with a single definition of the concept (Cook and Zhu 2005; Cooper *et al.* 2004). One of the specific features of Data Envelopment Analysis method is that this technique requires only very few assumptions. In the sector of transport, DEA was first applied for public passenger transport (Kerstens 1996; Pina and Torres 2001; Boame 2004; Boame and Obeng 2005) and railways (Coelli and Perelman, 1999). In Ross and Droge (2004), DEA was employed for evaluating the productivity of distribution systems. Tongzon (2001), Itoh (2002), Turner *et al.* (2004) applied DEA for evaluating the productivity of airports. For measuring the productivity of air operators, DEA was applied in Scheraga (2004) and Capobianco and Fernandes (2004).

DEA in the sector of air transport was introduced in the late 1990'ies and this practice was pioneered by Gillen and Lall (1997, 2001) and Murillo-Melchor (1999). The evidence, suggesting that DEA could be applied in the transport sector by Lithuanian researchers, was not found.

DEA is a methodology directed to frontiers rather than central tendencies (Fig. 1). Suppose we have the case with several hypothetical airports, each whereof is evaluated per individual input (for instance, the number of take-off runways) and individual output, such as the number of handled aircrafts. The inputs and outputs of each airport are placed on the plane of coordinates, wherein the medial process function showing the average productivity is derived. This function is obtained by means of regressive analysis. For airports T_1 , T_7 and T_6 , a negative remainder is obtained, whereas airports T_2 , T_4 and T_8 show having a positive remainder. Each airport having a positive remainder at certain inputs performs with maximum efficiency. Productive process function A exactly marks maximum productivity γ at the specific values of inputs. DEA determines the frontier of efficiency by evaluating its distance for each airport.

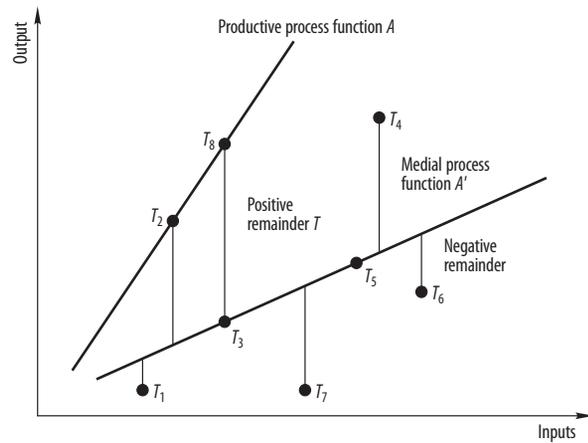


Fig. 1. Comparison between DEA and regressive analysis

During DEA, each airport is examined in order to determine which one performs at maximum productivity frontier (Fig. 2). Suppose the scalar ratio marked as δ is applied for a particular output Y_2 to achieve the maximum productivity level based on the frontier function of maximum productivity. Assume we have a virtual airport T_9 , which may be expressed as the linear function of airports T_2 and T_8 ($\alpha_1 x_1 + \alpha_2 x_2, \alpha_1 y_1, \alpha_2 y_2$). T_2 and T_8 represent the most efficiently performing airports, hence the growth ratio for them is either not applied at all or, if applied, its value equals to 1. The ratio for all remaining inefficiently performing airports will have the value other than 1. In practise, actual efficiency can hardly be determined by single input and output, and therefore the evaluation of efficiency requires the use of multiple inputs and outputs. In this case, the reflection of efficiency on a two-dimensional plane is not possible.

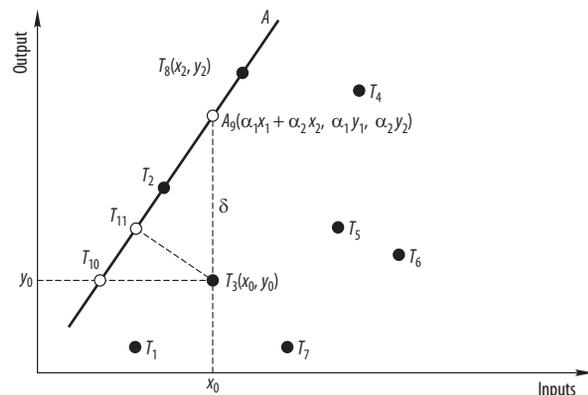


Fig. 2. Derivation of efficient process frontier

This case may be expressed using the following equations:

$$\begin{aligned}
 & \max \delta_k \\
 & \sum_{k \in K} \alpha_k y_{km} - s_m^+ = \delta y_{km}; \quad m = 1, \dots, M; \\
 & \sum_{k \in K} \alpha_k x_{kn} + s_n^- = x_{kn}; \quad n = 1, \dots, N; \\
 & \alpha \geq 0; \quad k = 1, \dots, K,
 \end{aligned}
 \tag{1}$$

where: k stands for the airport number ($k = 1, 2, \dots, K$); m marks the output number ($m = 1, 2, \dots, M$); n – respectively the input number ($n = 1, 2, \dots, N$); α_k stands for the intensity vector which comprises k number of elements and links all airports. x_{kn} and y_{km} are the numerical expressions of inputs n and output m respectively; s_m^+ and s_n^- stand for the remainders of inputs and outputs respectively; δ is the scalar expression of inputs efficiency (in scores), by which the current level of output shall be multiplied to achieve the maximum frontier of productivity.

If the airport has nearly approximated the maximum frontier of productivity, $\delta^* k = 1$ shall be applied. The range of δ set $[1, \infty]$.

The result of efficiency may be used for expressing aggregate productivity. In this case, the task of linear programming shall be performed for each airport individually.

The formulation of this linear programming task is often referred to as DEA-O-CRS (Output-Oriented with Constant Return-to-Scale Characterisation Data Envelopment Analysis) model. The task is performed to determine whether airport output stands at the frontier value given a particular set of inputs. This relative analysis shows how efficiently inputs may be used. This output-oriented DEA-O-CRS analysis was successfully applied in Gillen and Lall (1997); Fernandes and Pacheco (2002) and Pathomsiri and Haghani (2004).

Another way would be to express and evaluate inefficiency. Formula (2) illustrates both possibilities.

The first possibility is input-oriented, i.e. used for projecting A_3 to A_{10} and shows frontier output. Hence, the task of linear programming may be expressed as follows:

$$\begin{aligned} & \min \phi_k \\ & \sum_{k \in K} \alpha_k y_{km} - s_m^+ = y_{km}; \quad m = 1, \dots, M; \\ & \sum_{k \in K} \alpha_k x_{kn} + s_n^- = \phi x_{kn}; \quad n = 1, \dots, N; \\ & \alpha \geq 0; \quad k = 1, \dots, K, \end{aligned} \tag{2}$$

where all symbols have equal meanings as in (1); ϕ_k stands for the scalar ratio of efficiency which shows how many times inputs shall be multiplied to achieve the frontier value.

The formulation of this linear programming task is often referred to as DEA-I-CRS (DEA-Input-CRS, Input-Oriented with Constant Return-to-Scale Characterisation Data Envelopment Analysis) model.

This is a fixed output-oriented model for determining the level of input inefficiency. If the airport is on the frontier line, it means that $\phi_k^* = 1$. In other words, in this case, inputs must not and cannot be decreased to retain the same output. ϕ is a set of $[0, 1]$ range. For expressing the efficiency of inputs, the value of aggregate productivity may be used. The task of linear programming must be performed k number of times, separately for each airport.

The examples involving the application of DEA-I-CRS model may be found in Abbott and Wu (2002), Adler and Berechman (2001); Bazargan and Vasigh (2003), Fernandes and Pacheco (2005) and Sarkis and Talluri (2004).

The second possibility is to project A_3 to A_{11} . In the latter case, in parallel, both the issue of output increase and the issue of input decrease are being solved. This could be a complex nonoriented DEA-CRS model. Yet the practical application of this model is subject to numerous limitations. So far, the model of nonoriented DEA-CRS has found practical application only in Fernandes and Pacheco (2001) study, wherein it was employed for the evaluation and comparison of 35 Brazilian airports.

Despite the selected orientation, the exercise aimed at classifying airports by assigning to them some universal achievable ratio of productivity does not seem to be reasonable from a practical point of view because the same productivity in this respect may be attained either by means of increasing output at the existing inputs or by way of decreasing inputs at the same output. In practice, it is hardly achievable. Furthermore, frontier productivity in DEA is relative and depends on the most productive airports within the set, i.e. it does not make possible to evaluate the productivity of most productive airports because these as such already represent a sort of benchmarks. Despite, DEA does make it possible to evaluate and rate nonproductive airports by evaluating their lag behind the airports recognized as the most productive.

Abbott and Wu (2002) subjected DEA-O-CRS model to criticism claiming that airports have very little possibility to keep their output under control unlike in the case with inputs. They argued that airports are not in the capacity of influencing passenger demand. For instance, the number of the handled aircrafts basically depends on external factors, such as economic situation and demand for travelling within the country or city, wherein the airport operates.

DEA-I-CRS model was severely criticized by Martín and Román (2001) who argued that a decrease in inputs is only feasible on the theoretical level, whereas in practise, it could imply lower investments into take-off runways and subsequent reduction in their number. However, it is not possible to reduce investments once they have been made or if runways have been already constructed and it is quite clear that the removal of take-off runways will not lead to any decrease of inputs. DEA-I-CRS model may find application only in cases it is purely theoretical and virtual. Certainly, it may be a very useful tool for projecting the number of the required inputs and the future output. However, such projections of investment are of a long-term nature, hence the errors due to uncertainty associated with external factors that determine output may be too large to enable a reliable application of DEA-I-CRS model.

5. Conclusions

1. Considering scholarly criticism overviewed in the paragraphs above, it may be concluded that DEA-CRS is more intended for the use evaluating potential rather than generating solutions. The airport may assess itself whether at the current inputs, it still has potential for output growth. It is possible to plan the further growth of inputs only if the frontier line is approached and only on condition that these plans do not imply the ambition to be more productive than the airports recognized as benchmarks, based on which this frontier line was derived.
2. The method of Data Envelopment Analysis proves to be most suitable for measuring the productivity of such complex systems as terminals.
3. The major problem of applying the method of Data Envelopment Analysis lies in difficulty encountered with respect to determining the scalar values of total factor productivity estimates. Despite this limitation, this technique has a sound advantage over the method of regressive analysis as the practical point for determining productivity is not to obtain a certain pattern of functional dependence but to have the possibility of comparing terminals.

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