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TECHNICAL EFFICIENCY AND THE METHODS OF ITS MEASUREMENT

EFEKTYWNOŚĆ TECHNICZNA I METODY JEJ POMIARU

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Summary: The main purpose of this publication was to try systemizing the efficiency performance with particular regard to technical efficiency and measurement methods, and to identify the problems in defining and measuring the existing problems. The paper presents definitions of efficiency by selected authors, the classification and characterization of various types of efficiency made with particular emphasis on technical efficiency, and the basic methods for testing the effectiveness of the division on the indicator parametric and parametric detailing the different measurement methods. A detailed analysis of the non-parametric methods for testing the effectiveness of technical support is the DEA (Data Envelopment Analysis) method presented with the example of the procedure for calculation of relative efficiency. The study identifies various modifications of the DEA method and also signalled areas where this method can be used to measure the effectiveness of specific entities. The main research method used in the present study was to review and analyze the literature on the subject topic.

Keywords: efficiency, technical efficiency, measurement, methods, DEA.

Streszczenie: Podstawowym celem niniejszej publikacji była próba usystematyzowania dorobku z dziedziny efektywności ze szczególnym uwzględnieniem efektywności technicznej oraz metod jej pomiaru a także wskazanie na istniejące w tym zakresie problemy definiowania i pomiaru. W opracowaniu zaprezentowano definicje efektywności wybranych autorów. Dokonano klasyfikacji i charakteryzacji poszczególnych rodzajów efektywności ze szczególnym uwzględnieniem efektywności technicznej. Przedstawiono podstawowe metody badania efektywności z podziałem na wskaźnikowe, parametryczne i nieparametryczne z wyszczególnieniem poszczególnych metod pomiaru. Dokonano szczegółowej analizy nieparametrycznej metody badania efektywności technicznej jaką jest metoda DEA (Data Envelopment Analysis) oraz zaprezentowano na jej przykładzie procedurę obliczania wskaźnika względnej efektywności. W opracowaniu wskazano na różne modyfikacje metody DEA a także zasygnalizowano obszary w których może być stosowana ta metoda do pomiaru efektywności określonych podmiotów. Główną metodą badawczą wykorzystaną w niniejszym opracowaniu był przegląd i analiza literatury dotyczącej przedmiotowej tematyki.

Słowa kluczowe: efektywność, efektywność techniczna, pomiar, metody, DEA.

1. Introduction

The issue of efficiency has been guiding aspects of all human activities from the very beginning of time. The limitation and finality of the resources at humans' disposal in every field causes the inability to fulfil all needs simultaneously and enforces making optimal decisions and economic choices. Therefore, the issue of the efficiency and methods of measurement related to it are of such exceptional importance, making them the main subject of contemplation not just for theorists, but also for the practitioners undertaking on its basis crucial decisions in nearly all domains of economic activity. Efficiency started to be investigated on almost every level of management by small, medium, as well as large businesses, but also in every economy sector, now not only private, but also public and even non-profit making [Kozuń-Cieślak 2013].

In the literature on the subject, the issue of efficiency is such a broad, ambiguous topic, understood in various ways by many authors, described in very general or even intuitive terms, that it causes certain difficulties in formulating one full, universal definition of efficiency [Domagała 2007].

The main goal of this paper was an attempt to systematize the output on efficiency, with special consideration for technical efficiency and the methods of its measurement, as well as indicating the problems of defining and measurement existing in this field.

The main research method used in this article was a review and analysis of literature on the subject.

2. Selected definitions of efficiency and its typology in economics

In the subject literature, the issue of efficiency is understood differently and ambiguously interpreted. The amount of synonyms identified with this term indicates the multidimensionality of the efficiency issue. Efficiency is most commonly identified with productivity, efficacy, proficiency, capacity, thriftiness, profitability, competitiveness, favorableness, rationality, frugality, utility, expediency, skill, fruitfulness or even competence, and those terms may be interrelated, but not identical. This clearly shows that even presenting a concise definition of efficiency becomes a problematic task [Wolszczak-Derlacz 2013].

Efficiency is most commonly interpreted as the relation of achieved results to the expenditure incurred for their production which constitutes a special case of the efficiency relation. Therefore the issue of efficiency can be recorded with the following mathematical equation:

$$H = \frac{Q}{N}$$

in which: Q denotes the value of the economic effect being obtained, and N denotes the value of expenditure incurred for obtaining the intended effect. The effects and expenditure should be expressed with specific values. They should also be generically homogenous, i.e. while analyzing the values, the ratios must be possible to compare and expressed in the same units for the result to be objective. The formula for the efficiency calculation quoted above is the general efficiency ratio [Meredyk (ed.) 2007].

According to Samuelson and Nordhaus, efficiency means the use of economic resources in a way that is the most effective, and the economy works efficiently if it is located on the brink of production possibilities, while the production of one good cannot be increased without decreasing the production of another good [Samuelson, Nordhaus 2002].

While discussing efficiency it is impossible not to mention the so called Paretian efficiency, also called Pareto's optimum or optimum in Pareto's sense. The name derives from the Italian economist and sociologist, Vilfred Pareto (1848-1923). An economy is efficient if the production of one good is impossible without decreasing the production of other goods, or in other words, efficiency is the improvement of the situation of certain people without the simultaneous deterioration of other people's situation [Stiglitz 2004].

Efficiency in the briefest summary means the lack of waste. It is the use of economic resources in such a way that as a goal it maximizes the level of possible satisfaction, the net profit of their use, the relation of the outcome to the input or as an evaluation criterion of organizational efficiency by people who use its resources. Efficiency is defined as the relation between an organization's resources (input variables) and its effects (output variables) [Kowal 2015].

Efficiency is predominantly related to the rule of rational management defined in two variants. The first variant concerns the maximization of effect, in other words performance. On the other hand, the second variant, also called economical, concerns the minimization of expense [Matwiejczuk 2000].

In the organization and management theory the targeted and system approaches are distinguished. According to the targeted approach, efficiency denotes the state of realization of set goals combining performance with efficacy. Efficiency in such an understanding means surveying the use of resources – the relation of effects to expenses, the effects are not required to be accordant with goals. On the other hand, efficacy in this expression defines whether the effects of a certain action are in accordance with the goals set, while efficiency in the system approach is the organization's ability to handle the environmental variability and shape it to the organization's favour [Leja 2003].

In literature on the subject, two fundamental approaches to studying efficiency are most commonly distinguished that are diverse in terms of time in which the analysis is performed, namely dynamic grasp efficiency and static grasp efficiency. Static grasp efficiency focuses on preventing the waste of fixed resources in a certain time and their best possible allocation. The goal of the thus understood efficiency is the party's pursuit to achieve the production capacity curve assuming that it is known at the given moment. In this sense, efficiency is represented by the neoclassical economy and Pareto's optimum concept, as well as the marginalist concept of general equilibrium. On the other hand, dynamic grasp efficiency is related to the ability of long-term growth. Its goal is not, as occurs in static efficiency, to pursue the achievement of the production capacity curve but to constantly move it to the right, not avoiding waste but constantly discovering and creating new goals and means. The dynamic grasp of efficiency is related to the concept of entrepreneurship set to organizational innovation and the development of new technologies. In literature on the subject the static approach to studying efficiency is dominant [Kozuń-Cieślak 2013].

In literature on the subject matter, efficiency may be understood in various ways by the authors because various types of efficiency exist. Depending on the given approach to studying it, efficiency is subjected to a division. Static grasp, also called short-term efficiency, is divided into economic efficiency, also called allocative, and technical efficiency related to type X efficiency and affecting dynamic efficiency. Economic efficiency requires achieving technical efficiency and allocative efficiency in the area of production and consumption, as well as production structure. Economic efficiency means the optimal allocation of production factors along with the produced goods, as well as the optimal mix of the generated production on the whole level of economy. The stabilizing factor here is the price system. Therefore it possesses two planes, productive and consumptive. Technical efficiency denotes the use of available resources in the most technologically optimal way. The author will expand on this type of efficiency in the next chapter. Productive efficiency, economically expressed through technical efficiency is characterized by all the technically efficient methods of production, efficient in the sense that they minimize costs of production. The decomposition of productive efficiency into technical and allocative efficiency was done by Michael J. Farrell. Allocative efficiency occurs when among all the productively efficient solutions, those that are picked give the biggest satisfaction on the consumption side, i.e. through the available resources the highest possible level of satisfaction on the client's side has been achieved [Kozuń-Cieślak 2013].

The typology of efficiency in the static and dynamic grasp is presented in Figure 1.

Whereas in the case of dynamic grasp efficiency, type X efficiency as well as innovative and adaptive efficiencies are distinguished, while innovative efficiency in the briefest summary is the organization's ability to implement innovations, i.e. methods to improve the production process or reduce its costs, in its agency, new technologies, new forms of organization or seeking new sources of funding of its agency can be an example here. By contrast, adaptive efficiency is the organization's ability to adapt to environmental changes. The environment of organizations is variable by nature, changes occur very rapidly and in order to survive an organization must be prepared for those changes. It is also the organization's ability to identify the reason behind the occurring changes or problems, as well as the ability to solve them properly [Kozuń-Cieślak 2013].

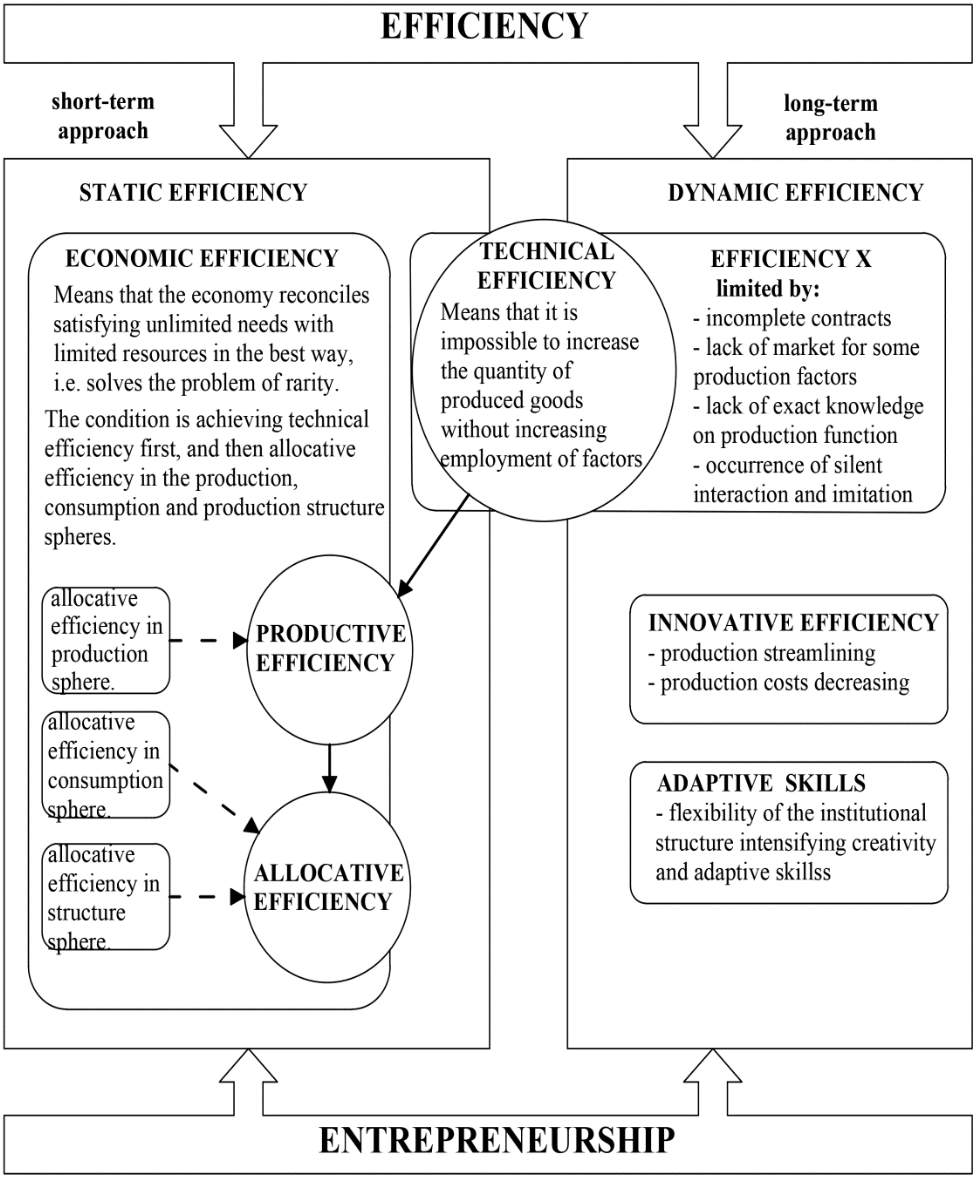

Fig. 1. Typology of efficiency in the static and dynamic grasp

Source: own elaboration based on [Kozuń-Cieślak 2013].

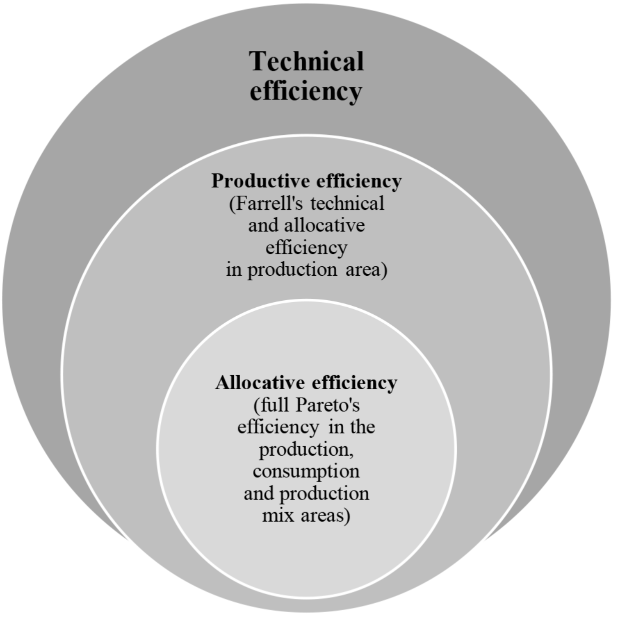

Fig. 2. The relation between technical, productive and allocative efficiencies, the so called Venna's diagram

Source: own elaboration based on [Kozuń-Cieślak 2013].

In a further part of considering the efficiency issue, the author will concentrate on the static grasp of efficiency, namely technical efficiency.

3. Technical efficiency

Technical efficiency is a term more narrow than the term of economic efficiency because it is one of the types of this efficiency. A subject is technically efficient when it is able to achieve a certain, i.e. planned level of effects with the use of minimal input, or when out of the planned level of input it achieves maximal effects. Accordingly, we distinguish input-oriented efficiency that stems from the optimal use of input, and effects-oriented technical efficiency that consists in achieving the optimal level of effects [Ćwiąkała-Małys, Nowak 2009a].

The thus interpreted technical efficiency is based on the technical efficiency concept. This concept was created in the early 1950s. The forerunners of this concept are considered mainly to be T. C. Koopmans (1951), G. Debreu (1951), and primarily M.J. Farrell (1957). Technical efficiency, in Koopmans' understanding, lay in the inability to increase the level of one of the effects or decrease one input without the simultaneous decrease of the level of another effect or the increase of another input, also known as Pareto-Koopmans efficiency. On the other hand, Farrell interpreted technical efficiency as the relation between the productiveness of a given subject and the productiveness of a model subject. In such meaning, the given subject is more productive than the other if it produces the same level of a product with the use of less resources or if it produces more with the same level of resources. In wanting to measure the technical efficiency of a subject it is necessary to make a comparison of its achieved relation of effects to input to those subjects that characterize the best units in a specific trade or branch of economy. Therefore, technical efficiency in this understanding is relative [Ćwiąkała-Małys, Nowak 2009a].

The evaluation of a subject's technical efficiency is closely related to its productivity, but these are not identical terms. Productivity is an economic and social construct. Its goal is to optimize economic, public and administrative, as well as institutional actions taking into account human and social factors. The productivity of the reviewed subject is defined as the relation of manufactured products to the quantity of used input. The analysis of a subject's productivity can be presented on the basis of its input resources (also called input or system input), effects (results, system output) and the processes of transformation turning the possessed resources into effects. In the case of subjects that possess a certain value of input and effects productivity, it is defined as the quotient of the weighted sum of effects to the weighted sum of input, taking into consideration the influence of the given organization's environment [Nazarko et al. 2008]. Such a concept of productivity is graphically presented below (Figure 3).

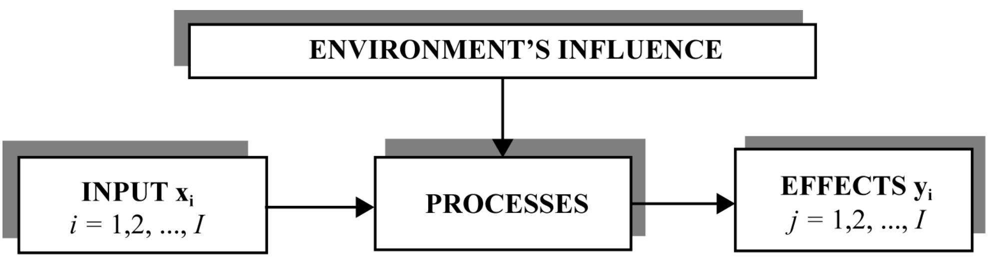

Fig. 3. Productivity concept

Source: own elaboration based on [Nazarko et al. 2008].

Therefore, technical efficiency can be expressed with the following math equation [Nazarko et al. 2008]:

$$\text{Technical efficiency} = \frac{\sum_{j=1}^{J} v_j y_j}{\sum_{i=1}^{I} \mu_i x_i}$$

where: x_i – ith component of the input, y_j – jth component of the effect, I – number of input, J – number of effects, μ_i – weights determining the importance of individual input, v_j – weights determining the importance of individual effects.

When wanting to calculate the technical efficiency of a given subject, it is necessary to know its function of production. By contrast, to determine productivity, the data on its input and effects is essential. A collection of all the possible variants of input and effects of the given subject that includes the technologically performed ways of production is called a production set. The boundary of this production set is determined precisely by the production function in the following form: [Ćwiąkała-Małys, Nowak 2009a].

$$y = f(x)$$

We distinguish two types of technical efficiency, namely input-oriented technical efficiency and effects-oriented technical efficiency. Input-oriented technical efficiency is designated as the relation of the minimal level of input that is necessary to provide a specified level of effect by the production function to the actual level of input. Input-oriented technical efficiency ($T\,E_I$) for a given subject (A) can be expressed with the following formula [Ćwiąkała-Małys, Nowak 2009a]:

$$TE_{I,A} = \frac{x_A min}{x_A}$$

$$TE_{I,A} = \frac{x_A min/y_A}{x_A/y_A}$$

where: $x_A min$ – denotes the minimal level of input to obtain y units of a given product, x_A – denotes the actual level of input, y_A – subject A's level of productivity.

Therefore, input-oriented technical efficiency is a quotient of the subject's actual productivity to hypothetical productivity that it achieves using minimal input. Effects-oriented technical efficiency is the relation of the actual level of the subject's product to the maximal level designated by the production function for a specified level of input. Effects-oriented technical efficiency ($T\,E_O$) for a given subject (A) can be expressed with the following formula [Ćwiąkała-Małys, Nowak 2009a]:

$$TE_{O,A} = \frac{y_A}{y_A max}$$

It was assumed that: $y_A \max = f(x_A)$ is the maximal product obtained out of x_A units of input

$$TE_{O,A} = \frac{y_A/x_A}{y_A max/x_A}$$

Effects-oriented technical efficiency is therefore a quotient of the subject's actual productivity to hypothetical productivity that achieves the maximal effect out of a specified input. [Ćwiąkała-Małys, Nowak 2009a].

4. Methods of measuring technical efficiency

In literature on the subject on studying efficiency two fundamental methods of studying efficiency are distinguished: parametric (economic) and non-parametric. The parametric approach consists in utilizing the production function. On the other hand, non-parametric methods lie in linear programming methods out of which the DEA method is primary [Baran 2007].

The parametric methods are most commonly used to describe models with a homogenous and precisely specified structure. The number of estimated parameters depends on the model's structure. These methods are based on the production function and assuming suitable assumptions to it. It is the production function that determines the relation between input and effects. In reality, however, it is immensely difficult to identify all the possible combinations of input and effect and define the mathematical form of the production function. The interpretation of the production function in the case of subjects belonging to public areas or non-profit organizations, e.g. hospitals, public colleges, schools, banks, is problematic as well. For an evaluation of such subjects' efficiency, the non-parametric methods that do not require the knowledge of the production function and have more flexibility are most commonly used. They are used in the case of models with a less complex structure [Ćwiąkała-Małys, Nowak 2009a].

Among the parametric methods we include the stochastic frontier approach (SFA), the distribution-free approach (DFA) and the thick frontier approach (TFA). In turn, the non-parametric methods include the data envelopment analysis (DEA) and the free disposal hull (FDH) methods. The parametric methods are used for cost and income efficiency estimation and are in accordance with the profit criterion. In order to measure technical efficiency the non-parametric methods are used, in particular the data envelopment analysis method – DEA [Ćwiąkała-Małys, Nowak 2009a].

The Stochastic Frontier Approach (SFA) was proposed by two research teams in the 1920s: Aigner, Lovell and Schmit; Meeusen and van den Broeck. These models are characterized in that they are predominantly concentric, which consist of a suitably specified microeconomics function of production or cost for the logarithms of these variables and two random components. One of these random components (symmetrical to zero) shows the effect of random factors and measurement errors. On the other hand, the second (asymmetric and fixed sign) models show potential inefficiencies [Marzec, Osiewalski 1997].

Stochastic boundary analysis allows describing relationships in a given industry by comparing expenditures and the effects of business activity, taking into account two components in the data: random factor and inefficiency. The Stochastic Frontier Approach is a method used in benchmarking. It is applied to holistic methods, mainly used to evaluate the overall activity of a particular enterprise by determining the relationship between inputs and outputs. SFA is a boundary method based on the assumption that all units are capable of operating at a certain level of efficiency. This level is a boundary level and is determined by the model, effective units of the sector. These units are a reference to others and point to the ultimate goal of improving their efficiency. These are so-called benchmarks that produce the best performance, which means that with the smallest inputs they deliver the best results or at the lowest cost. The SFA, because it is a parametric method for determining the function of production or cost, serves the functional form of limit values. Parametric methods require a more thorough knowledge of production and costs. The SFA estimates the effective cost or production taking into account the stochastic nature of the input data [Wardzińska 2012].

The Stochastic Frontier Approach (SFA) is based on most parametric models using econometric models that have a suitably constructed, complex random component and are formulated using logarithmic dimensions. Scholastic border analysis has the form: [Marzec, Pisulewski, Prędki 2015].

$$lnQ_{jt} = h(x_{jt};\beta) + v_{jt} - z_j$$

$j = 1, ..., J$;
$t = 1, ..., T$

where: Q_{jt} – volume of observed production of j-th enterprise in period t, x_{jt} – vector-line of exogenous variables, h – logarithmic ally defined output function, v_{jt}, z_j – independent random variables.

Additionally, the classic methods of studying efficiency, also called indicative (indicative analysis) are mentioned. In the case of those methods the measurement of efficiency is carried out with financial indicators on the profitability, liquidity, rotation or liabilities of a company. These indicators are calculated with the data included in financial reports and subsequently serve for comparing a given subject in time (what the indicators' values were in the successive periods of time) or for mutual comparison between organizations in one trade, or for comparison with the best subject in the trade, so called competitive benchmarking [Czyż-Gwiazda 2013]. Businesses' efficiency in this field consists in the constant ris of market position and achieved financial goals with regard to competition. Indicative analysis analyzes individual economic indicators that have an influence on the subject's economic efficiency. Fragmentary indicators that describe the efficiency of production factors data (e.g. work productivity, capital productivity) or synthetic indicators denoting the financial condition of the whole business (profitability of capital, property, sales indicator) are distinguished [Skrzypek 2012]. However the adopted specified indicators in the indicative analysis measure only the relations between elements of one financial report or various reports. Such a construction of indicators, most commonly in the quotient form, does not allow to simultaneously grasp many dimensions of one subject's agenda. It is also worth noting that in reality, the subjects work in distorted markets where regulations of prices occur, the subjects receive donations from the state and there is often a lack of competitiveness. As a result of the subjects' functioning in such an environment, the classic financial indicators do not specify the economic efficiency of a given subject precisely [Ćwiąkała-Małys, Nowak 2009a].

Benchmarking methods used in benchmarking include DEA (Data Envelopment Analysis), Corrected Ordinary Least Squares (COLS), and Stochastic Least Squares (SFA – Stochastic Frontier Analysis) [Wardzińska 2012].

In a further part of deliberations the author will focus on explaining the data envelopment analysis method – DEA, which is the most commonly used method in technical efficiency studies.

The data envelopment analysis method – DEA is widely used for studying the efficiency of subjects both in public and private areas. It is used for studying the efficiency of such subjects as [Guzik 2009]: banks and financial institutions, homes, insurance institutions, educational institutions, military institutions, cultural institutions, hospitals and other medical treatment facilities, sport activities, tourist, hotel and recreational companies, commercial businesses, transport and logistic companies, production plants, law assessment, crime detection, enterprise or product rankings, and stock companies.

The data envelopment analysis method – DEA in domestic literature is also called data borderline analysis. It is a modification of the basic CCR model. In 1978 it was presented by A. Charnes, W.W. Cooper and E. Rhodes who originally used this method in their work titled "Measuring the efficiency of decision-making units". This method is based on the concept of productivity specified by Depreu and Farell as a quotient of a single effect to a single input. In reality such a situation is scarcely encountered. Therefore, the DEA method had been used in a multidimensional situation in which there occur more than one input and more than one effect, for it enables studying the relation between multiple inputs and multiple effects. Efficiency in the DEA model can be expressed with the following formula [Baran 2012]:

$$Efficiency_{DEA} = \frac{\sum_{r=1}^{s} \mu_r Effect_r}{\sum_{i=1}^{m} v_i Input_i}$$

where: s – number of effects, m – number of inputs, μ_r – weights for individual effects, v_i – weights for individual inputs.

Subsequently the plurality of effects and inputs is brought to the quantity of a synthetic effect and synthetic input. This is necessary to calculate the indicator of efficiency of a given object that in linear programming is the goal function. In the DEA method two forms of the goal function are distinguished, namely the maximization of effect with given input and the minimization of input with given effects. The goal function in this model can be expressed as follows [Baran 2012]:

$$function\ of\ goal = max_{u,v} \frac{\sum_{r=1}^{s} \mu_r y_{ro}}{\sum_{i=1}^{m} v_i x_{io}}$$

assuming that:

$$\frac{\sum_{r=1}^{s} \mu_r y_{rj}}{\sum_{i=1}^{m} v_i x_{ij}} \leq 1 \ (j = 1, \dots, n)$$

$$\mu_r, v_i \geq 0$$

$$r = 1, \dots, s$$

$$i = 1, \dots, m$$

where: s – number of effects, m – number of inputs, μ_r – weights for individual effects, v_i – weights for individual inputs, y_{rj} – quantity of type r effect (r =1,..., R) in object j, x_{ij} – quantity of type i input (n =1, ..., N) in object j (j = 1, ..., J).

The optimised variables are u_r and v_i, i.e. weights of effects and inputs respectively, while the quantities of effects and inputs are empirical data. The non-linear DEA model above can be converted into a linear programming task using the transformation technique, expressed as follows [Baran 2012]:

$$max_{u,v} = \sum_{r=1}^{s} \mu_r y_{ro}$$

assuming that:

$$\sum_{i=1}^{n} v_i x_{io} = 1$$

$$\sum_{r=1}^{s} \mu_r y_{rj} - \sum_{i=1}^{m} v_i x_{ik} \leq 0$$

$$\mu_r \geq \varepsilon, \ v_i \geq \varepsilon$$

The division of DEA models is illustrated in Figure 4.

Solving a linear programming task in such a form allows to determine an efficiency curve with the most efficient units of thew studied corporate body placed in it [Baran, Pietrzak. Pietrzak 2015].

The examined subjects are technically efficient if they fit into the efficiency curve (Figure 5), i.e. their efficiency indicator equals 1. In the case of the input minimization-oriented model, hist means that there are no more profitable combinations of input allowing to achieve the assumed effects. If the objects are outside of the efficiency curve they are considered technically inefficient. Their efficiency level is less than 1, in such a case there exists a more efficient combination of input that allows to achieve the same effects. The efficiency of the examined object is measured in relation to other objects in a given group assuming its values in the (0,1) range. In the DEA method such objects are called decision making units (DMU). With this

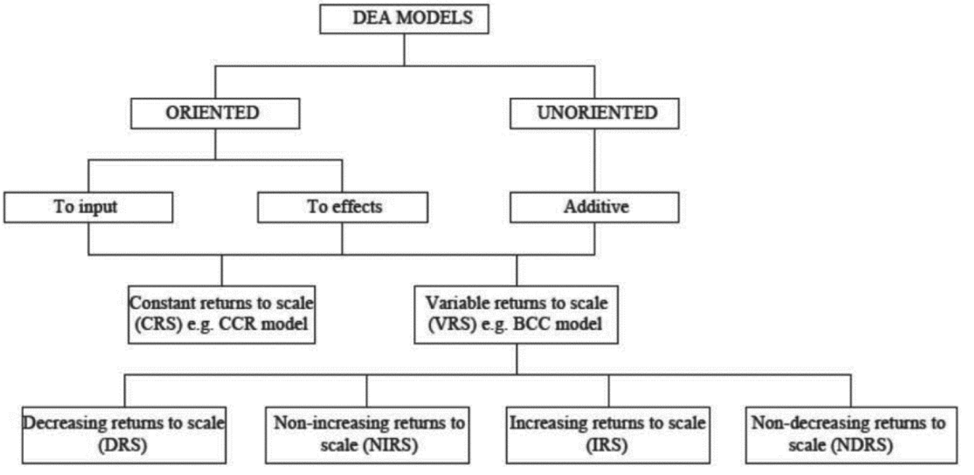

Fig. 4. DEA models classification in relation to orientation and economies of scale

Source: own elaboration based on [Ćwiąkała-Małys, Nowak 2009a].

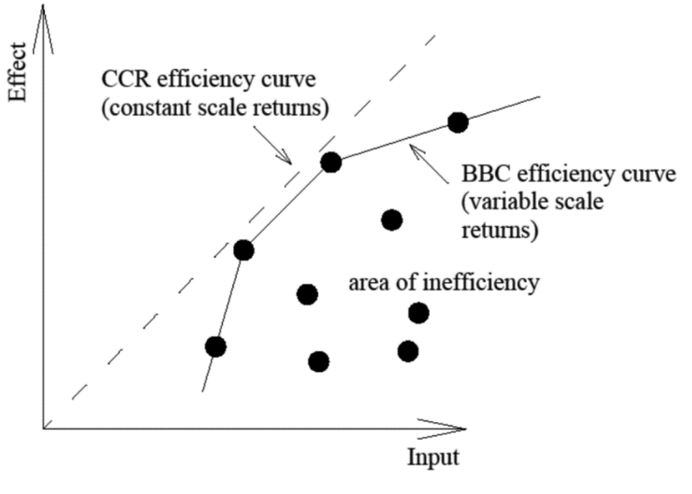

Fig. 5. CCR (constant scale returns) and BBC (variable scale returns) efficiency curve

Source: own elaboration based on [Baran, Pietrzak, Pietrzak 2015].

method it is possible to compare (benchmarking) a given object with the best in the trade and it allows to determine the optimal technology for an inefficient object. The optimal technology for an inefficient object is determined on the basis of the technology of objects with the highest relative efficiency in the examined group. This is presented with the following formula: [Baran, Pietrzak, Pietrzak 2015]:

$$T_o^* = \sum_{j=1}^{N} \lambda_{oj} \times t_j$$

where: T_o^* – optimal technology for object o, t_j – empirical technology of object j, λ_{oj} – the share of object j's technology in technology optimal for object o.

Summarizing the contemplation on the data envelopment analysis – DEA method, most commonly used to study technical efficiency, it is necessary to mention that there exist many various modifications of this method. The first DEA method modification and the most commonly referred to, is the BBC model. This is also a model oriented both to input and effect, it differs by the entered extra restriction that enables analyzing scale efficiency. Another model is the ADD (Additive Model), it is characterised by being oriented neither to effects nor input, it does not specify the efficiency level and utilizes the non-reactive measure of efficiency. The SBM (Slack-Based Measure) model is an extension of the ADD model and can be both oriented and unoriented, it determines the unequivocal measure of efficiency and utilizes the non-reactive measure of efficiency. The FDH (Free Disposal Hull) model does not make an approximation of the efficiency border, the efficiency of a given object is determined only in relation to the effects of the best objects [Domagała 2007].

5. Conclusion

Summarizing, the efficiency of all forms of human endeavour and attempts to measure it from the very beginning had been pursued by the mankind primarily due to the limitation and finality of the resources at its disposal. The efficiency issue and methods of measurement related to it became a tool through which mankind tries to optimise and rationalise its decisions and economic choices that it is forced to make in today's world nearly every day. The problem of efficiency concerns almost all manifestations of human activities, both in public and private areas. [Ćwiąkała-Małys, Nowak 2009b].

Therefore the meaning of the term efficiency is considered both in the economic and financial spheres and examined with the use of financial indicators or parametric methods. They are employed primarily in research on organizations the main goal of which is maximizing profit. However efficiency can also express ecological, social and cultural values as well as other aspects of organizations' agenda that are not among measurable values. An example used here can be public or non-profit organizations. In this case the non-parametric models, of which the Data Envelopment Analysis – DEA method is currently in the leading exponent, are primarily applicable [Skrzypek 2012]. The fundamental advantage of this method is the ability to survey objects described with numerous inputs and numerous effects, it does not require as much detailed information as the indicator methods or the econometric models, the input and effects do not necessarily have to be expressed in monetary units, they may be expressed in natural units. On the other hand, as the flaws of this method can be considered to be a large sensitivity of the effects to atypical observations in objects considered efficient, then the remaining objects lose their efficiency, it is essential that the examined objects are of a homogeneous character; instability of effects in the case of a strong correlation and relation of linear input or effects, too large quantity of efficient objects compared with all objects, and there is also a problem with inputs equalling zero [Guzik 2009].

The concept of efficiency is a concept broad and ambiguous enough that interpretive differences may result, among others, from the grasp in which efficiency is being considered and with what type of efficiency we are dealing with. This multidimensionality of the term makes formulating one universal definition of efficiency practically impossible. Therefore the methods for its measurement are diverse and depend on the type of the examined efficiency and the specific character of the subjects of study.

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