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THE ROLE OF DEA IN CSR EFFICIENCY EVALUATION

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Measuring CSR has been widely discussed as a problematic issue in business literature. The main reason is its importance for companies' reputation, stakeholders' valuations and academic research. This paper provides an introduction to the problem of measuring CSR (corporate social responsibility) activity effectiveness. The main purpose of it is to apply a non-parametric DEA (Data Envelopment Analysis) methodology for measuring CSR performance taking in accounts specified inputs and output of social business activity
Keywords: *CSR efficiency, corporate social responsibility, Data Envelopment Analysis, CSR input factors, CSR output factors, efficiency estimation, frontier analysis*

Оцінка корпоративної соціальної відповіальності (далі КСВ) широко обговорюється в науковій та професійній літературі. Основною причиною цього є зростання її значення для репутації компаній, зацікавлених сторін і наукових досліджень. В статті досліджено проблему вимірювання ефективності КСВ. З цією метою, авторами запропоновано застосування непараметричного методу аналізу DEA (Data envelopment analysis) як одного із методів вимірювання продуктивності (ефективності) КСВ, враховуючи особливості вхідних та вихідних параметрів соціальної діяльності
Ключові слова: *корпоративна соціальна відповідальність, ефективність КСВ, аналіз середовища функціонування, вхідні фактори КСВ, вихідні фактори КСВ, оцінка ефективності, порівняльний аналіз*

1. Introduction

As long as managers will be under pressure to improve the performance of their organizations the quest for greater efficiency would never end. Performance measurement is the normal way to handle internal and external pressures, by monitoring and benchmarking a company's activity. Productivity and efficiency are important and frequently utilized concepts to measure performance. The effectiveness study is a key area of research by many scientists. Such attention to this concept is due to the fact that the figures of effectiveness are the most comfortable, versatile and objective for determination and comparisons of the activity results. The most common form of performance measures can be expressed as the ratio of any output parameters (outputs) to produce the input parameters (inputs) required to produce these output parameters.

$$\text{Efficiency}=\text{Outputs}/\text{Inputs}. \quad (1)$$

This formula is used to measure economic efficiency, however the measurement of the activity of the firm up until recently was somewhat neglected because different types of activity means different types of outputs and inputs. It's leads to impossibility of CSR comparison and input-output analysis for solving the problems. Activities with different inputs and outputs can't be compared because they don't have the same denominator. In this case, the non-parametric method such as DEA can be used to measure CSR activity. Non-parametric method is mathematical procedure for statistical hypothesis testing which make no assumptions about a probability distributions of the assessed variables.

The main problem to solve in the article is measure the CSR performance of the firm focus on the DEA concept, a non-parametric frontier estimation methodology that means not economic but technical effectiveness. Also it's important to build up a performance framework that covers the key elements of performance measurement, while monitoring and reviewing the CSR activity.

This paper aim is investigation of the applicability of DEA to the CSR efficiency measurement. We first provide CSR efficiency concepts and overarching definition DEA. Following this, we articulate firms' likely motivations for engaging in CSR in order to identify potential benefits. We then discuss the role of DEA and corresponding linkages between DEA and CSR; here, we pay particular attention to measurement the efficiency of CSR activity using non-parametric methods. Finally, we provide some concluding thoughts.

The subject of the research is CSR activity of the firm and the object is efficiency of such activity.

Taking in account the aim of the paper we state two main hypotheses:

1) DEA as a non-parametric analysis method that can be used to measure efficiency of CSR

2) DEA analysis is enough method to measure efficiency of CSR.

2. Theoretical framework of the research and literature review

Current level of research is connected with CSR definition and estimating efficiency as well. CSR is a number of corporate activities that focus on the welfare of stakeholder groups other than investors, such as charitable and community organizations, employees, suppliers, customers, and future generations.

Measure of CSR performance will allow comparing companies' achievements in this sphere and evaluating the effects of these actions that has influence on investors' decisions, clients' choices and firms' overall performance. Investors need data that will allow them to make informed decisions. However, CSR is a multidimensional construction that cannot be assessed by using one quantitative measure. This multidimensionality

has been recognized by numerous authors like Carroll (1979), McWilliams and Siegel (2001), Dahlsrud (2008) and Wood (2010). The early studies related to estimating the CSR efficiency were based on the application of econometric non-frontier models.

To measure CSR efficiency authors studied the relationship between CSR and profitability of the company taking in account such data as ROI, ROE and others (Manescu, C. Staricad, C., 2010) some form of firm performance as institutional investment (Graves and Waddock, 1994); shareholder proposal activism and managerial response (David et al., 2007); brand value (Melo and Galán, 2010); corporate reputation (Melo and Garrido-Morgado, 2011) and corporate governance (Johnson and Greening, 1999; Bear et al., 2010; and Arora and Dharwadkar, 2011).

The literature review reveals that the techniques employed for estimating efficiency can be divided into two major groups: non-frontier and frontier models. These techniques allow us to measure efficiency absolutely or relatively, respectively. First group includes benefit (output) indicators whose values are compared for individual businesses or groups. It includes private performance indicators of certain resources usage as well (Table 1).

Table 1

Models of efficiency estimation

№	*Type of models*	*Models*
1	Non-frontier	classical linear regression, regression trees, Breiman method
2	Frontier	DEA

In this study we would like to analyze the application of DEA to CSR. The methodology of frontier analysis is the next. Enterprises that provide maximum output on input, takes as the "standard" for comparison with. The process also include determination of production function on the basis of top companies or in other words, efficient enterprises form the so-called "production efficiency border". Thus, performance measurement is determining as the distance between the studied enterprises and efficiency broad. Measuring the efficiency frontier in literature carried out mainly by two methods:

1) Constructing a function of production capacity for advanced, most efficient enterprises by methods of mathematical Statistics - stochastic frontier production function

2) Determination of the maximum output possible by comparing indicators of efficient usage of resources of the enterprise with indicators of other firms and build the so-called "data shell" method by line programming method. This "data shell" defines the boundary of production possibilities, that is the maximum possible yield at any resource combination. This is DEA.

3. Research methodology

The system of measuring CSR is based on traditional indicators which include ROI and ROE (Manescu et al., 2010) as well as utilitarian methods, such as cost-benefit analysis. However as was proved (Botsian, 2014) they are not enough appropriate. In this research we use a common approach to measuring performance based on the concept of the efficiency frontier. DEA is a non-parametric frontier estimation methodology originally introduced by Charnes, Cooper, and Rhodes (1978), that compares functionally similar entities described by a common set of multiple numerical attributes. We used in this study a multiple-stage DEA model to determine CSR efficiency. For the purpose of this analysis we composed all information into three outputs, e.g. we considered three types of activity: social, environmental and economic.

To measure efficiency, DEA is the choice here because it does not require us to specify the functional form or distributional forms for errors. In essence, it is more flexible than the parametric approach (Aleksander Aristovnik, et al., 2013). Further, DEA is used because it is easy to draw on diagrams and easy to calculate.

4. Measurement the efficiency of CSR

CSR efficiency concepts

Performance measurement plays an essential role in evaluating production because it can define not only the current state of the system but also its future. Performance can be measured by two main characteristics: productivity and efficiency. As far as CSR is not a production activity we will take in account just efficiency. There are some times of efficiency.

1. Technical Efficiency in economics includes output- and input-oriented technical efficiencies, then the producer can either improve output given the same input (output-oriented) or reduce the input given the same output (input-oriented) by improving technology

2. Scale Efficiency relates to a possible divergence between actual and ideal production size

3. Allocate efficiency produces a given quantity of output at minimum cost given the prevailing input prices.

Among these efficiencies the technical one is the most appropriate for CSR. In its turn technical efficiency DEA method is the easiest flexible one. In the DEA methodology (Charnes, Cooper and Rhodes, 1978) efficiency is defined as a weighted sum of outputs to a weighted sum of inputs, where the weights structure is calculated by means of mathematical programming and constant returns to scale (CRS) are assumed.

DEA as a method to measure efficiency

DEA is a nonparametric method in operations research and economics to measure the efficiency of a structure with multiple inputs and outputs.

The main purpose of DEA is to construct an index (score) of relative (to the other units) performance. To obtain this, the first step is to construct a virtual input and a virtual output by using a set of weights:

$$\text{Virtual input}=V1X1+..+VmXm; \quad (2)$$

$$\text{Virtual output}=U1Y1+...+UsYs, \quad (3)$$

where v and u are weights and x and y are inputs and outputs, respectively.

The efficiency score as main part of DEA in the presence of multiple input and output factors is defined as:

Efficiency=
=weighted sum of inputs/weighted sum of outputs. (4)

The scale for estimation the parameters are from 0 to 1 (from min to max). The criterion for identifying efficiency in DEA is to achieve optimum or Pareto, respectively, Pareto efficiency. This means that the combination of the CSR activities is optimal. Note that optimal here does not mean "best", just "not obviously inferior to some other outcome".

The main advantage to this method is its ability to accommodate a multiplicity of inputs and outputs.

Some characteristics that make DEA a powerful tool also states as its limitations and measurement error can cause significant problems. The main problems are (Quantitative Methods, 1998):

1) DEA is good at estimating "relative" efficiency, but not "absolute" one

2) Since DEA is a nonparametric technique, statistical hypothesis tests are difficult and are the focus of ongoing research

3) Since standard formulation of DEA creates a separate linear program for each decision making unit, large problems can be computationally intensive.

4) DEA is not always the right tool for a problem, but only is appropriate in certain cases.

5) Since DEA is an extreme point technique, noise (even symmetrical noise with zero mean) such as measurement error can cause significant problems.

As far as DEA use "relative" efficiency but not "absolute" one 100 % of "relative" efficiency can be reached by business in the case there is no basis for non-efficiency to one or some inputs or outputs. Performance measurement in DEA for relevant enterprises is going through optimal weight relations between output and input factors.

CSR efficiency from the DEA point of the view

So, the efficiency can be determined as (Lissitsa, A., Babiéceva, T.,2003):

1) None of the output parameters cannot be increased without increasing one or more input factors, or other output parameters reduction

2) None of the input factors cannot be reduced without reducing one or more output parameters or other input factors increase

The DEA compares the relative efficiency of "units". These units utilise similar resources, referred to as inputs, to generate similar outputs.

5. Application of DEA to measure the efficiency of CSR

DEA allows you to take account of all the important factors that affect a unit's performance to provide a complete and comprehensive assessment of efficiency. Frontier Analyst does this by converting the multiple inputs and outputs into a single measure of productive efficiency. By doing so it identifies those units which are operating relatively efficiently and those which are not. The efficient units, those making best use of resources, are rated as being 100 % (or 1) efficient whilst the inefficient ones obtain lower scores.

In a case of CSR DEA generates efficiency scores for all units being analysed. It shows how much inefficient units need to reduce their inputs or increase their outputs in order to become efficient. DEA helps managers answer the question "How well are the units doing?" but also "How much could they improve?".

1. DEA applying in the CSR sphere can give us next advantages among others states Russian scientists (Lissitsa A. et al., 2003):

1) Make a diagnostic of the CSR activity and see the whole picture of the CSR sector

2) To differentiate efficient and inefficient enterprises through digital measure of such efficiency

3) To envelope etalon aims for each business and ways to assess these aims

4) To analyse the optimal ways of CSR activity

To measure total CSR activity we have to analyze a lot of input factors and a lot of output factors, meanwhile we cannot talk about affectivity of the CSR without taking in account economical, juridical and political environment of the firm. To make this task easier we can use computer programs some of them are DEAP 2.14 and EMS 1.45. 4 (the sites are http://www.uq.edu.au/economics/cepa/software.htm and http://www.wiso.uni-dortmund.de/LSFG/OR/scheel/ems respectively)

CSR efficiency can be also be calculated by ratio DEA analysis (Botsian, 2014).

6. Conclusions

So, DEA analysis can be used to measure the efficiency of CSR. However it can be taking just in a case we would like to see the frontier results for the branch or for firms with the same types of CSR activity. This conclusion comes from that fact, the inputs and outputs for the DEA analysis should be the same. That leads us to the approving the 1st hypotheses of the paper with one addition: DEA as a non-parametric analysis method that can be used to measure efficiency of CSR, if the firms for such analysis have the same CSR activity.

As far as DEA is a technical method of analysis it can be used to see the leader of the group and the position of certain enterprise among the others entities. That is why we cant prove the 2nd hypotheses of the paper: DEA analysis is NOT enough measure efficiency of CSR.

References

1. Aristovnik A. Relative efficiency of police directorates in Slovenia [Text] / A. Aristovnik, J. Seljak, J. Mencinger // A non-parametric analysis Expert Systems with Applications. – 2013. – Vol. 40, Issue 2 – P. 820–827. doi: 10.1016/j.eswa.2012.08.027

2. Botsian, T. V. Utylitarystyczne podejście do oceny moralności społecznej odpowiedzialności biznesu [Text] / T. V. Botsian // Economichnii ta socialnii rozvitok Ukrainu v XXI stolitti: natcionalna viziya ta vikliki globalizatcii. Proceding of 11th international Conference of Young Scientists "Economic and social development of Ukraine in the twentieth century: a national vision and challenges of globalization". – Ternopil (Ukraine), 2014 – P. 211–213.

3. Botsian, T. V. Data envelopment analysis in the CSR efficiency measurement (case study) [Text] / T. V. Botsian // Proceding of international Conference "Prospects for the accounting, control and analysis in the context of European integration". – 2014. – P. 201.

4. Banker, R. D. Some Models for Estimating Technical and Scale Inefficiencies in Data Envelopment Analysis [Text] / R. D. Banker, A. Charnes, W.W. Cooper // Management Science. – 1984. – Vol. 30, Issue 9. – P. 1078–1092. doi: 10.1287/mnsc.30.9.1078

5. Charnes, A. Measuring the efficiency of decision-making units [Text] / A. Charnes, W. Cooper, E. Rhodes // European Journal of Operational Research. – 1978. – Vol. 2, Issue 6. – P. 429–444. doi: 10.1016/0377-2217(78)90138-8

6. Daraio, C. Introducing environmental variables in non-parametric frontier models: a probabilistic approach [Text] / C. Daraio, L. Simar // Journal of Productivity Analysis. – 2005. – Vol. 24, Issue 1. – P. 93–121. doi: 10.1007/s11123-005-3042-8

7. Vitaliano, F. D. Special issue on Corporate Social Responsibility (CSR) and Economic Performance [Text] / F. D. Vitaliano, P. S. Gregory // Journal of Productivity Analysis. – 2006. – Vol. 26, Issue 3 – P. 235–244. Available at: http://www.jstor.org/stable/41770250

8. Emrouznejad, A. Evaluation of research in efficiency and productivity: a survey and analysis of the first 30 years of scholarly literature in DEA [Text] / A. Emrouznejad, B. Parker, G. Tavares // Journal of Socio-Economics Planning Science. – 2008. – Vol. 42, Issue 3. – P. 151–157. doi: 10.1016/j.seps.2007.07.002

9. Kuntz, L. Incorporating Efficiency in Hospital Capacity Planning in Germany [Text] / L. Kuntz, S. Scholtes, A. Vera // The European Journal of Health Economics. – 2007. – Vol. 8, Issue 3. – P. 213–223. doi: 10.1007/s10198-006-0021-6

10. Lissitsa, A. Analiz obolochki dannyh (DEA) – sovremennaja metodika opredelenija jeffektivnosti proizvodstva [Текст] / A. Lissitsa, T. Babiéceva // Institute of Agricultural Development in Central and Eastern Europe. – 2003. – Vol. 50. Available at: http://nbn-resolving.de/urn:nbn:de:gbv:3:2-23263

11. Manescu, C. Economic Implication of Corporate Social Responsibility and Responsible Investments [Text] / C. Manescu // University of Gothenburg, Sweden. – 2010. – 14 p.

12. Manescu, C. Do Corporate Social Responsibility scores explain profitability? A case study on the publishers of the Dow Jones Sustainability Indexes. In Economic Implications of Corporate Social Responsibility and Responsible Investments [Text] / C. Manescu, C. Staricad. – Sweden: University of Gothenburg, 2010. – 125 p.

13. Waddock, S. A. The Corporate Social Performance-Financial Performance Link [Text] / S. A Waddock, S. B. Graves // Strategic Management Journal. – 1997. –Vol. 18, Issue 4. – P. 303–319. doi: 10.1002/(sici)1097-0266(199704)18:4<303::aid-smj869>3.0.co;2-g

References

1. Aristovnik A. Seljak J., Mencinger J. (2013). Relative efficiency of police directorates in Slovenia.A non-parametric analysis Expert Systems with Applications, 40 (2), 820–827. doi: 10.1016/j.eswa.2012.08.027

2. Botsian, T. V. (2014). Utylitarystyczne podejście do oceny moralności społecznej odpowiedzialności biznesu. Proceding of 11th international Conference of Young Scientists "Economic and social development of Ukraine in the twentieth century: a national vision and challenges of globalization". Ternopil (Ukraine), 211–213.

3. Botsian, T. V. (2014). Data envelopment analysis in the CSR efficiency measurement (case study). Proceding of international Conference "Prospects for the accounting, control and analysis in the context of European integration". Odessa (Ukraine), 201.

4. Banker, R. D., Charnes, A., Cooper, W. W. (1984). Some Models for Estimating Technical and Scale Inefficiencies in Data Envelopment Analysis . Management Science, 30 (9), 1078–1092. doi: 10.1287/mnsc.30.9.1078

5. Charnes, A., W. Cooper, Rhodes, E. (1978). Measuring the efficiency of decision-making units. European Journal of Operational Research, 2 (6), 429–444. doi: 10.1016/0377-2217(78)90138-8

6. Daraio, C., Simar, L. (2005). Introducing environmental variables in nonparametric frontier models: a probabilistic approach. Journal of Productivity Analysis, 24 (1), 93–121. doi: 10.1007/s11123-005-3042-8

7. Vitaliano, D. F., Gregory, P. S. (2006). Special issue on Corporate Social Responsibility (CSR) and Economic Performance. Journal of Productivity Analysis, 26 (3), 235–244. doi: http://www.jstor.org/stable/41770250

8. Emrouznejad, A., Parker, B., Tavares, G. (2008). Evaluation of research in efficiency and productivity: a survey and analysis of the first 30 years of scholarly literature in DEA. Journal of Socio-Economics Planning Science, 42 (3), 151–157. doi: 10.1016/j.seps.2007.07.002

9. Kuntz, L., Scholtes, S., Vera, A. (2007). Incorporating Efficiency in Hospital Capacity Planning in Germany. The European Journal of Health Economics, 8 (3), 213–223. doi: 10.1007/s10198-006-0021-6

10. Lissitsa, A., Babiéceva, T. (2003). Analiz obolochki dannikh (DEA) – sovremennaya metodika opredeleniya effectivnosti [Analyz shell data (DEA) - Modern Methods of definitions of the effectiveness of production]. Institute of Agricultural Development in Central and Eastern Europe, 50. Available at: http://nbn-resolving.de/urn:nbn:de:gbv:3:2-23263

11. Manescu, C. (2010). Economic Implication of Corporate Social Responsibility and Responsible Investments. University of Gothenburg (Sweden), 14.

12. Manescu, C., Staricad, C. (2010). Do Corporate So-cial Responsibility scores explain profitability? A case study on the publishers of the Dow Jones Sustainability Indexes. In Eco-nomic Implications of Corporate Social Responsibility and Re-sponsible Investments, University of Gothenburg (Sweden), 125.

13. Waddock, S. A., Graves, S. B. (1997). The Corporate Social Performance- Financial Performance Link. Strategic Management Journal, 18 (4), 303–319. doi: 10.1002/(sici)1097-0266(199704)18:4<303::aid-smj869>3.0.co;2-g

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