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Evaluation of the effectiveness of manufacturing companies by financial and non-financial indicators

Marie Pavlakova Docekalova[a],*, Alena Kocmanova[b]

[a,b] Brno University of Technology, Kolejní 2906/4, Brno 612 00, Czech Republic

Abstract

The purpose of this paper is to present a model for evaluation of effectiveness of manufacturing companies by financial and non-financial indicators in relation to corporate sustainability. Sustainability is a multidimensional concept based on a balance of environmental, social and economic pillars. It is difficult to evaluate it because it is expressed by many variables which most of them are non-financial ones. Data envelopment analysis is based on assessing the quantity of consumed inputs by the produced outputs and estimation of production possibility frontier; it computes a scalar measure of efficiency and determines potential improvements of inputs and outputs without requiring explicit specification of functional relations between inputs and outputs and setting weights of variables. Based on the computation of the CCR super efficiency DEA model the companies are divided into four groups: sustainable, pro-social, pro-environmental and unsustainable companies. The model outputs allow users to identify the position of a particular company and to reveal weaknesses in the effectiveness of a company, thus the model can serve its users as a basis for decision-making and performance management. The graphic presentation of the results makes the model outputs clear and easy to understand.

Keywords: Corporate sustainability; Non-financial indicators; Effectiveness; Triple-bottom line; Data envelopment analysis.

Introduction

This paper was written as a part of a project solution "Measuring Corporate Sustainability in Selected Sectors" supported by the Czech Science Foundation (GACR). The aim of the project is to design, implement and validate a new model of corporate performance measurement and sustainability in selected sectors. Its methodology is based

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* Corresponding author. Tel.: +420-541-142-638.
  E-mail address: docekalova@fbm.vutbr.cz

on analysis of the value with inclusion of environmental, social and corporate governance (ESG) factors in combination with models of data envelopment analysis (DEA). Current project continues on the results of a previous GACR project "Construction of Methods for Multifactor Assessment of Company complex Performance in Selected Sectors". Sustainable development on a corporate level is seen as a complex set of strategies that allow through economic means to satisfy material, cultural and spiritual human needs, while fully respecting environmental limits. Corporate sustainability is based on a triple-bottom-line which means that environmental, social and economic pillars cannot be perceived separately though the concept of corporate sustainable development stresses harmonious and balanced development of these three pillars (Schaltegger & Wagner, 2006; Elkington, 1998). In addition to these three basic pillars there is a fourth factor of corporate sustainability: corporate governance (Kocmanova & Docekalova, 2012; Hřebíček, Soukopová, Štencl & Trenz, 2011). In such case we refer to ESG (environmental, social, governance) factors of corporate sustainability. The objective of this paper is to present a model for measurement corporate sustainability using data envelopment analysis.

1. Theoretical approach

A number of authors emphasize the need to include non-financial factors into corporate performance evaluations (Ittner & Larcker, 2003; Kaplan & Norton, 1996, 2001). And particularly those factors that will be relevant to corporate stakeholders, such as customers, employees, local communities and which will testify about the company's impact on the environment. In Czech and foreign practice, the most widely used method of assessment of the financial and economic performance is a fundamental or technical analysis, which rates the company from the economic point of view, on the basis of analysis of financial statements (Fisher, 1992; Chow & Stede, 2006). Investors are aware that when deciding on their investment activities, they need examples of financial and non-financial outcomes including: Financial outcomes, i.e. increases or decreases in: cash flows; cost of capital; or asset values. Non-financial outcomes, i.e., factors that hinder or enhance the ability of the company to: implement a strategy and remain competitive with peers or retain its social licence to operate. In the context of the Performance Measurement System, the division of approach performance evaluation is promoted by means of financial and non-financial indicators, which many authors consistently claim (Dixon, Nanni, & Vollmann, 1990; Grigoroudis, Orfanoudaki, & Zopounidis, 2012; Ittner, Larcker, & Randall, 2003). The basic principle of the introduction of non-financial indicators to the company management is the fact that very often the financial indicators for evaluating the company performance are not sufficient. Due to the impact of global markets and global trends there is a need to assess the overall company performance by using the Sustainability Indicators, integrating the strategy into one Integrated Reporting (Cokins, 2009; Bell & Morse, 2008; Eccles & Krzus, 2010). Therefore, the current economic theorists, on the basis of the pressures of the investors and other stakeholders, are going back to the ideas, which are based on sustainability and the economic challenges of our time. These must be addressed through the integration of environmental, social and economic performance in the corporate decision making. Burritt (2012) stated that the environmental, social and economic performance of a company can also be expressed as a triple bottom line. Sustainability cannot be separated from the environmental, social and economic development, but lately not even from corporate governance.

2. Methodology

In this paper, we will draw on the concept of corporate sustainability based on the triple-bottom-line. The aim of the paper is to propose a sustainability measurement model that uses the DEA method. The model contains two non-financial factors, one environmental and the other social, and one financial / economic factor.

Multi-criteria and multidimensional methods must be used for the modelling and measuring the multidimensional phenomenon of corporate sustainability. We use DEA methods to calculate efficiency. Rather than evaluating only one criterion, DEA based models evaluate sets of different criteria that determine the attained level of sustainability. The basic CCR and BCC models measure efficiency against a virtual unit, which is a combination of inputs and outputs of existing units (Banker, Charnes, & Cooper, 1984; Charnes, Cooper, & Rhodes, 1978). In these models, efficient units are assigned an efficiency score equal to one ($\theta^* = 1$). There may, however, be more than one efficient unit, and if the objective is to further rank efficient units, then DEA super-efficiency models need to be

used. In DEA super efficiency models, the original effective units are assigned super efficiency scores greater than one. This allows the ranking of efficient units, which may be important information to the model user (Jablonský & Dlouhý, 2004). All super efficiency models (see e.g. Adler, Friedman, & Sinuany-Stern, 2002) are based on the principle that the weight of the original efficient unit is set equal to zero when the super-efficiency rate is calculated. The consequence of this procedure is that the original efficient frontier will change.

In this paper, the CCR super efficiency DEA model is used. Manufacturing companies are considered as homogeneous production units (decision-making unit, DMU). Each DMU_j, $j=1, 2,…, n$, produces r output, y_{ij} $(i=1, 2, …, r)$ using m input, x_{ij} $(i=1, 2, …, m)$. The efficiency of a specific DMU_q can be evaluated according to the model (Jablonský & Dlouhý, 2004; Andersen & Petersen, 1993):

$$min \, \Theta_q, \tag{1}$$

on conditions:

$$\sum_{j=1,\neq q}^{n} x_{ij}\lambda_j + s_i^- = \Theta_q x_{iq}, \tag{2}$$

$$\sum_{j=1,\neq q}^{n} y_{ij}\lambda_j - s_i^- = y_{iq}, \tag{3}$$

$$\lambda_j \geq 0, \lambda_q \geq 0, \tag{4}$$

$$s_i^+ \geq 0, s_i^- \geq 0. \tag{5}$$

Θ_q is a efficiency score and $\lambda=(\lambda_1, …, \lambda_n)$ is a vector of weights which are assigned to the units. s^+ and s^- are vectors of addition input and output variables.

Two models have been developed. One model evaluates environmental efficiency with respect to economic performance, and the other evaluates social efficiency with respect to economic performance. Variables were defined from literature search and voluntary reporting. For a detailed description of the selection process of variables, see (Dočekalová, 2013; Kocmanová & Dočekalová, 2012). The variables are constructed as ratio variables. In both models, the output variable is x_1 *Added value / Turnover* (%).

Environmental inputs:

y_{1envi} *Total emissions of greenhouse gases/Added value* (t/CZK)
y_{2envi} *Total annual water consumption /Added value* (m^3/CZK)
y_{3envi} *Total amount of waste generated annually / Added value* (t/CZK)

Social inputs:

y_{1soc} *Donations and contributions/Turnover* (%)
y_{2soc} *Employee turnover* (%)
y_{3soc} *Payroll expenses /Number of employees* (number/CZK)

The final model synthesizes results of the environmental and the social models of efficiency. The model was designed and tested on real corporate data of large Czech companies belonging to the group NACE 25 - Manufacture of fabricated metal products, except machinery and equipment. The selected sample includes 11 companies ($n = 11$). The data were obtained from corporate reporting and refer to the year 2012.

3. Results and discussion

When constructing our models, we worked on the assumption that high environmental and social performance has positive affects on economic performance (Orlitzky, Schmidt, & Rynes, 2003; King & Lenox, 2001). Table 1

lists the calculated super-efficiency coefficients *Envi_supereff* and *Soc_supereff*, and values of economic variables for individual companies. The coefficients of efficiency derived from the DEA models are relative. They express efficiency of the company (DMU) within the studied group. If equal or above 100%, the company is effective. If the value of is less than 100%, the company is considered ineffective.

Table 1. Coefficients of effectiveness.

Company	Envi_supereff (%)	Soc_supereff (%)	Value added/Turnover
A	736,3	83,5	0,324
B	248,8	104,2	0,437
C	70,5	98,4	0,330
D	103,8	41,1	0,236
E	134,7	132,6	0,418
F	63,47	821,5	0,315
G	74,1	71,6	0,407
H	40,6	64,4	0,272
I	398,8	53,4	0,263
J	11,17	182,8	0,295
K	18,27	80,9	0,273

Based on the results, we can classify companies into groups. We created a Sustainability Performance Matrix, which visualizes the results of the models, see Fig. 1.
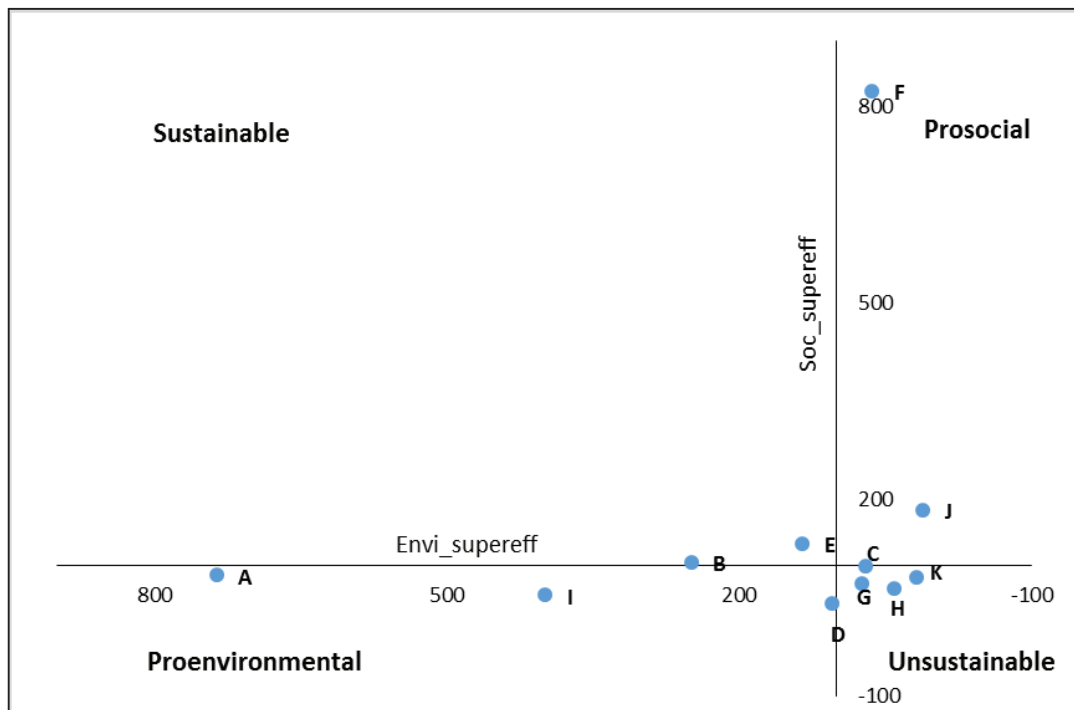

Fig. 1. Sustainability performance matrix

The matrix shows the relationship between environmental and social efficiency and economic performance. Axes of the matrix representing environmental efficiency (*Envi_supereff*) and social efficiency (*Soc_supereff*) intersect at a value of 100%, i.e. the limit value that separates efficient companies from the inefficient ones. According to the proposed matrix, companies are classified into four groups, which are represented by individual matrix quadrants. The farther away from the intersection of the axes the company is, the more it belongs to that category.

I.   <u>Sustainable</u> – companies that operate at the production possibility frontier and are efficient in terms of both environmental and social inputs per economic output.
II. <u>Pro-social</u> – companies efficient in social issues but inefficient in environmental issues.
III. <u>Pro-environmental</u> – companies efficient in environmental issues but inefficient in social issues.
IV. <u>Unsustainable</u> – companies that utilize both environmental and social inputs inefficiently. To become sustainable, these companies would have to either reduce inputs or improve their economic performance.

Visualization of results in one figure makes them clear and easy to understand. Fig. 1 clearly shows that there is only one company with sustainable performance in the analyzed group of companies. Company "E" can be rated as weakly sustainable because it is near the intersection of the axes.

Conclusions

The paper aims to propose a model for corporate performance evaluation using financial and non-financial indicators. For the construction of the model, the authors used data envelopment analysis. This method is useful because it evaluates multiple criteria, which corresponds to the multidimensional concept of corporate sustainability. The potential of this method also lies in the identification of target indicator values, when the values of sustainable, i.e. efficient, companies can be considered the benchmark.

The output of the model is the Sustainability Performance Matrix dividing companies into four groups. The model output facilitates a quick orientation in the position of individual companies. Visualization of results allows to clearly and efficiently communicate corporate performance data to stakeholders. The graphic presentation of the results makes the model outputs clear and easy to understand because it is obvious at a glance which companies are effective – sustainable and which are not. Last but not least, the model and the Sustainability Performance Matrix serve as a basis for decision-making and performance management.

The paper brings innovative perspective on sustainability measurement in terms of environmental and social inputs needed to ensure economic results. The use of financial indicators for evaluating corporate performance is limited though and it is no longer adequate for corporate stakeholders who are increasingly interested in the company's impact on the environment and society.

Acknowledgements

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