Comparing the composite indicator Index Corporate Sustainability and the predictive model - an application on Czech manufacturing companies

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ABSTRACT

This paper focuses on a comparison of the *composite indicator Index Corporate Sustainability* I_{CS}, *the predictive model Corporate Sustainability Index* CSI_{MDA} for measuring and evaluating sustainability, and the economic predictive model *Index of Financial Standing IB* for concerns in the manufacturing industry. The aim was to determine the informative ability of these models, to analyse their differing results, and to identify which model is the most suitable. The results produced by these models by means of a comparison of 10 Czech concerns in the manufacturing industry in the period 2011–2013 are depicted in graphic form, and conclusions derived as to whether the given concerns are headed towards sustainability. Models of sustainability are based on environmental, social, corporate governance and economic indicators of performance (I_{ESGEi}) which are expressed in various units. The economic model is based on economic indicators. The results produced by comparison of the models indicates the most suitable model to be the *composite indicator* I_{CS} which shows a high percentage of correctly classified companies on the basis of the Gini index. The subsequent classification of concerns according to the composite indicator is essentially different to the classification of concerns according to predictive models, first and foremost as a result of the construction of this model and the inclusion of environmental, social and corporate governance indicators in contrast to the *predictive model* CSI_{MDA} and *the predictive model IB.* The results of research into the measurement and evaluation of corporate sustainability clearly indicate that, in addition to financial indicators, it is also essential to incorporate non-financial indicators into these models. Models for the measurement and evaluation of sustainability can provide investors and owners with information as to whether the given concern is headed towards sustainability or not.

Keywords: sustainability, composite indicator, predictive models, financial and non-financial indicators.

1. INTRODUCTION

Corporate sustainability can be understood as an approach in enterprise to create long-term value for owners by means of accepting opportunities and managing the risks arising from economic, environmental and social development. Corporate sustainability can be defined as follows: *"sustainability is a corporate strategy which monitors long-term corporate growth, effectiveness, the effectiveness of corporate performance by incorporating integrating environmental, social and economic aspects into the management and evaluation of the corporation*".

An important strategic goal of Czech policy is to support the sustainable development of industrial concerns. Sustainable development in the Czech Republic is covered by the document "The Strategic Framework of Sustainable Development in the Czech Republic" approved by the government of the Czech Republic in 2010. An updated document, The Strategic Framework of Sustainable Development in the Czech Republic 2030, is currently in preparation.

Research into the measurement and evaluation of the sustainability of concerns in the Czech manufacturing industry is being performed by a research unit at the Faculty of Business and Management at Brno University of Technology which has, within the framework of the grant project "Measuring Corporate Sustainability in Selected Sectors", proposed a model for *the composite indicator Index Corporate Sustainability* (I_{CS}) and *the predictive model Corporate Sustainability Index* (CSI_{MDA}) using Multiple Discriminant Analysis. This predictive model has already been published [1].

2. MATERIALS AND METHODS

Industry plays an important and crucial role in the Czech Republic and has long accounted for roughly a third of the national economy. The most important segment of industry is the manufacturing industry which has long accounted for roughly a quarter of the total economy of the Czech Republic. It makes by far the largest contribution to total industry (80 %). The three key

branches of the Czech manufacturing industry are *the production of motor vehicles, the production of metal constructions and metalworking products* and *the production of machinery and equipment*. In 2014, industry accounted for 32.4 % of gross added value in the Czech Republic. In 2015, Czech industry followed on from the growth renewed in the preceding year and its production saw a further year-on-year growth of 4.4 %. Production in the manufacturing industry grew in 2015 in sixteen branches which accounted for 78.4 % of total income in industry. Its performance has been roughly twice that of the Eurozone countries and has greatly exceeded the results of its most important trade and co-operation partner Germany. Industry has a considerable influence on the environment and plays an important role in the area of sustainable development. The principal purpose of the position of industry is to demonstrate its current benefits without threatening the potential for a better quality of life for future generations. If we want to measure and evaluate corporate sustainability, it is necessary to include relevant non-financial indicators alongside standard financial indicators, and this means depicting the relationship between economic, environmental, social and corporate governance performance. Study the process of the development of key performance indicators (KPI) for sustainability performance measurement, and the ways in which sustainability KPIs are used for decision making, planning and performance management. Research results shows that companies integrate not only environmental indicators but also social indicators to their strategic planning, performance measurement, decision making and even risk management [2].

Empirical research is aimed at companies from the manufacturing industry according to CZ-NACE classification with over 250 employees. The analyzed period was 2011–2013. The analyzed of 88 companies from the manufacturing industry, that have EMS certification according to EN ISO 14001. These performance indicators are determined on the basis of theoretical knowledge from documents and instructions from international institutions such as GRI [3], CFA Institute, EFFAS, IFAC [4] and ASSET4. Twenty-nine I_{ESGEi} performance indicators, are stipulated for the measurement and evaluation of the sustainability of concerns in the manufacturing industry. The relative expression of indicators is used for the measurement and evaluation of corporate sustainability. The EMAS approach is used primarily, though in certain cases it was not possible to use this construction and other quantities were chosen; specifically this involved economic, corporate governance and certain social performance indicators. Data were initially analysed using descriptive statistics, which served for the description and identification of basic information contained in the data. The descriptive statistics (average, standard deviation, minimum and maximum) of this cross section (year 2011-2013). The indicators were evaluated by means of the correlation analysis of Spearman's coefficient. This been published [5]. [6].This predictive model has already been published [1].

The majority of predictive models are based on purposefully selected indicators drawn up on the basis of comparative analytical or mathematical statistical methods. These predictive models focus on the measurement and evaluation of the financial situation at a concern, i.e. on its financial health, or the prediction of financial difficulties [7]. The best known of the bankruptcy models used in practice are Beaver profile analysis, Altman models [8], Taffler model, Beerman Discriminant Function, Zmijewski's model and Ohlson's model. Financial standing indicators reflect the quality of the company based on its performance, and are oriented to owners and investors. Mr and Ms Neumaier with their IN indexes were engaged in the evaluation of financial health of Czech companies [9]. A common feature of these models is the use of proportionate accounting indicators.

Empirical research in 2015 focused on the construction of the *predictive model* CSI_{MDA} for the measurement and evaluation of the sustainability of concerns in the manufacturing industry, involving the inclusion of 29 financial and non-financial indicators of performance in the model. Empirical research is aimed at companies from the manufacturing industry according to CZ-NACE classification with over 250 employees. The analysed period was 2011–2013. The analysed of 88 companies from the manufacturing industry, that have EMS certification according to EN ISO 14001. Methodologically the procedure of the second phase of the calculation of the predictive model CSI_{MDA} using *Multiple Discriminant Analysis* (MDA). The discriminant function sustainable for discriminating between groups of companies:

$$CSI_{MDA} = 0{,}019 + 0{,}179I_{En7} - 0{,}476I_{Eco10} - 0{,}399I_{Cg2} + 0{,}327I_{En6} + 0{,}169I_{En2} + 0{,}183I_{En3} - 0{,}246I_{Eco6} + 0{,}456I_{En1}$$

where: I_{En1}- Non-investment expenditures for the protection of the Environment /Added value; I_{En2}-Total emissions to air / Added value; I_{En3}- Total greenhouse gas emissions / Added value; I_{En6}- Total annual production of waste / Added value; I_{En7}- Total annual production of hazardous waste / Added value; I_{Cg2} - Reports from environmental and social areas; I_{Eco6} – Cash Flow / Total Assets; I_{Eco10} – Total Assets / Total Liabilities;

Explains 70.9 % differences between the companies in both defined groups. Values $CSI_{MDA} < -0{,}588$ refer to the belonging of the company to group 0 "*the company does not tend to sustainability*", values $CSI_{MDA} > 0.523$ define the companies in group 1 "*the company tends to sustainability*". Values CSI_{MDA} from interval <− 0.588; 0.523 > do not give clear information about the belonging to one of the groups. Non-financial I_{En1}, I_{En2}, I_{En3}, I_{En6}, I_{En7}, I_{Cg2} and financial indicators I_{Eco6}, I_{Eco10} enter the prediction model CSI_{MDA} [1].

Economic predictive models include solvency models that evaluate a concern by means of one synthetic indicator based on selected economic indicators, using this synthetic indicator to determine the financial standing of the concern. The Index of Financial Standing (IB), which is also known as an indicator of solvency, is based on multivariate discriminant analysis. It is used primarily in German-speaking countries:

$$IB = 1.5\frac{CF}{L} + 0.08\frac{A}{L} + 10\frac{EBT}{A} + 5\frac{EBT}{T} + 0.3\frac{St}{T} + 0.1\frac{T}{A}$$

where: *A_Total assets, CF_Cash flow, L_Total liabilities, T_Turnover, St_Stocks, EBT_ Earnings before Taxes.*
Prospering companies: IB ϵ < 3 ; ∞) extremely good economic situation; IB ϵ < 2 ; 3) very good economic situation; IB ϵ < 1 ; 2) good economic situation; IB ϵ < 0 ; 1) problematic economic situation. *Failing companies:* IB ϵ < - 1 ; 0) poor economic situation; IB ϵ < - 2 ; - 1) very poor economic situation; IB ϵ < - ∞ ; - 2) extremely poor economic situation.

It is clear that this method is heavily oriented towards profit and cash-flow, to which it assigns greatest weight. The critical value for the differentiation of concerns is, in this case, zero.

Essentially, there are two approaches to the measurement and evaluation of concerns – evaluation by means of a set of indicators that includes "key indicators" and evaluation by means of a single indicator (a composite indicator) that is a synthesis of individual indicators. The OECD defines a composite indicator as follows:„A composite indicator is formed when individual indicators are compiled into a single index, on the basis of an underlying model of the multi-dimensional concept that is being measured" [10]. The transparency is a priority in the construction of composite indicators, especially with respect to the choice of the methodology and data base. A number of authors deal with the topic of composite indicators [11], [12]. The methodological approach to determine composite indicators [13], [12] can be according to statistical and analytical methods and statistical and descriptive methods. The research is studying the performance of SMEs and the factors affecting performance achieving, to propose performance measurement concept encouraging the sustainable development of SMEs and to suggest performance evaluation approach according to company's life cycle [14]. The measurement and evaluation of sustainability play an important role in the depiction of the sustainable development of a concern. The composite indicator *Index Corporate Sustainability (I_{CS})* is proposed for measuring and evaluating corporate sustainability in view of the lack of existing methods for the measurement and evaluation of the sustainability of a concern. Empirical research into the determination of a composite indicator for the measurement and evaluation of the sustainability of concerns includes a basic set of 29 environmental, social, corporate governance and economic indicators of performance. Survey has been conducted in 211 manufacturing industry companies with more than 250 employees and with an implemented environmental system - ISO 14001 or EMAS. From the non-financial and financial and areas, the data have been collated for the period of 2009-2013. For construction of the *composite indicator* I_{CS}, this set of I_{ESGEi} indicators, numbering 29, must be reduced to a lower number of indicators with the use of statistical methods, i.e. by explorative factor analysis using the principal component analysis (PCA) method. The basic set of non-financial ESG and financial (economic) performance indicators is reduced to 19 indicators, i.e. six I_{NEni} environmental indicators, four I_{NSoci} social indicators, four I_{NCgi} corporate governance indicators and five I_{NEcoi} economic indicators. These performance indicators are assigned individual weightings w_i that are determined on the basis of a component score, see Table 1.

Table 1 Reduced standardized non-financial and financial (economic) performance indicators

Non-financial environmental, social and corporate governance indicators I_{ESGi}	
I_{Eni} - *Environmental indicators*	I_{En1}- Non-investment expenditures for the protection of the Environment /Added value; I_{En2}-Total emissions to air / Added value; I_{En3}- Total greenhouse gas emissions / Added value; I_{En5}- Total annual consumption of water/ Added value; I_{En6}- Total annual production of waste / Added value; I_{En7}- Total annual production of hazardous waste / Added value;
I_{Soci} - *Social indicators*	I_{Soc1}- Number of women / Average number of employees; I_{Soc3}- Number of terminated employments / Average number of employees; I_{Soc5} -Wage costs / Added value; I_{Soc6} - Education and training expenditures / Added value;
I_{Cgi} - *Corporate governance indicators*	I_{Cg1} - Inform about financial results; I_{Cg2} - Reports from environmental and social areas; I_{Cg3} - Code of ethics; I_{Cg4} - Collective agreement;
Economic indicators I_{Eco}	
I_{Ecoi} - *Economic indicators*	I_{Eco1}- EAT / SF (ROE); I_{Eco2} - EBIT / A (ROA); I_{Eco3} - EAT + IP / NCL + SF; I_{Eco4} - EBIT / S (ROS); I_{Eco6} - CF / A;
A_Total assets; SF_Shareholders Funds; IP_Interest paid; CF_Cash flow; NCL_Non Current Liabilities; S_Sales;	

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The *composite indicator* I_{CS} is constructed by means of the aggregation of I_{NESGEi} sustainable performance indicators:

$$I_{CS} = I_{SEco} + 0.522I_{SEn1} + 0.478I_{SEn2} + I_{SSoc} + I_{SCg}$$

where: I_{Sj} are sub-indices of sustainable performance of the group j = {*Eco, En, Soc, Cg*}; I_{SEco} – *Profitability*; I_{SEn1} – *Source consumption and Emissions*; I_{SEn2} – *Waste*; I_{SSoc} – *Labour practices and Decent Work and Human rights;* I_{SCg} *-Monitoring and reporting corporate governance*

Environmental performance is influenced by two sub-indices: sub-index I_{SEn1}-*Source consumption* and *Emissions* (weight 0.522) and sub-index I_{SEn2}-*Waste* (weight 0.478):

$$I_{SEn1} = 0.160I_{NEn2} + 0.456I_{NEn3} + 0.492I_{NEn5} + 0.145I_{NEn9} - 0.180I_{NEn10} - 0.248I_{NEn11}$$

$$I_{SEn2} = 0.148I_{NEn2} - 0.197I_{NEn3} - 0.243I_{NEn5} + 0.161I_{NEn9} + 0.476I_{NEn10} + 0.521I_{NEn11}$$

Social performance is influenced by the sub-index I_{SSoc} - *Labour practices and Decent Work and Human rights*:

$$I_{SSoc} = -0.545I_{NSoc1} + 0.525I_{NSoc6} + 0.290I_{NSoc9} + 0.209I_{NSoc7}$$

Corporate governance performance is influenced by sub-index I_{SCg}-*Monitoring and reporting corporate governance*:

$$I_{SCg} = 0.310I_{NCg1} + 0.456I_{NCG5} + 0.480I_{NCg4} + 0.279I_{NCg6}$$

Economic performance is influenced by the sub-index I_{SEco}-*Profitability*.

$$I_{SEco} = 0.244I_{NEco1} + 0.283I_{NEco2} + 0.262I_{NEco3} + 0.271I_{NEco4} + 0.132I_{NEco11}$$

The composite indicator I_{CS} is one way of creating a tool for measuring and evaluating the sustainability of a concern that makes it possible to assess the concern with a view to its sustainability.

3. RESULTS AND DISCUSSION

The empirical research incorporates data on environmental, social, corporate governance and economic indicators of performance (I_{ESGEi}). This data is on companies in the manufacturing industry in the period 2011–2013 according to CZ_NACE. Ten companies with more than 250 employees that hold EMS certification in accordance with the standard ČSN EN ISO 14001 were selected for comparative analysis. Companies engaged in activity 25 – the manufacture of fabricated metal products, except machinery and equipment – were analysed and evaluated. Within the empirical research, we focused on an evaluation of various approaches to the measurement and evaluation of corporate sustainability – the composite indicator Index Corporate Sustainability I_{CS}, the predictive model Corporate Sustainability Index CSI_{MDA} and the economic predictive model Index of Financial Standing IB. The first step gives the results of model calculations and their classifications, see Table 2. Subsequently, various approaches and classifications of companies, such as their sustainability and economic performance, may be evaluated on the basis of these results (Figures 1 to 3).

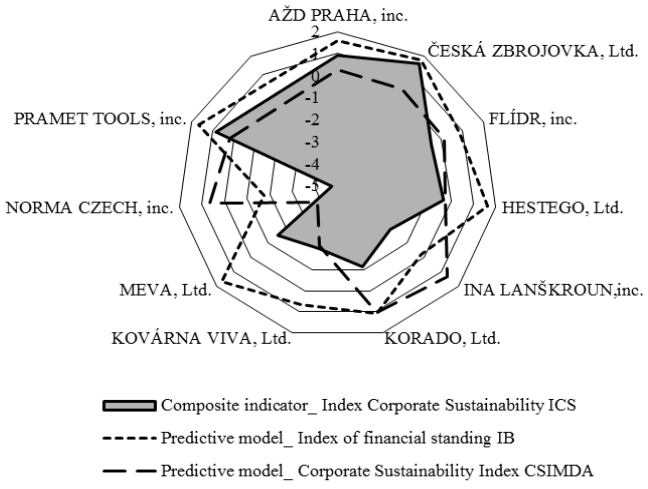

Figure 1 Comparison of predictive models *IB*, CSI_{MDA} and composite indicator I_{CS} (2011)

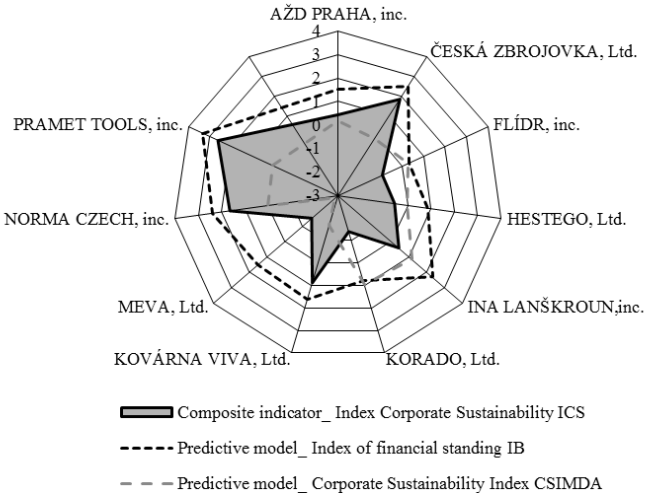

Figure 2 Comparison of predictive models *IB*, CSI_{MDA} and composite indicator I_{CS} (2012)

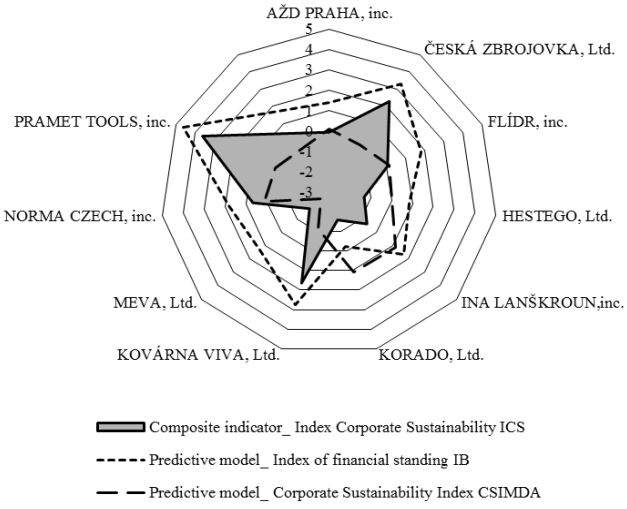

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Figure 3 Comparison of predictive models *IB*, CSI_{MDA} and composite indicator I_{CS} (2013)

From the graphic visualisation, we can see, for example, that the best evaluation was achieved by the company PRAMET TOOLS, inc. in 2012 and 2013 (the value of the composite indicator I_{CS} amounts to $I_{CS\ 2013}$ = 3.62; $I_{CS\ 2012}$ = 2.62; sustainability of the company is positively influenced by the economic performance indicator and by the corporate governance performance indicator. The social performance indicator of the company and the environmental performance indicator has a low value). This company is headed for sustainability. The worst results were shown by the company MEVA, Ltd. in 2012 and 2013 which recorded a negative value of the composite indicator I_{CS} amounting to $I_{CS\ 2013}$ = -1.77; $I_{CS\ 2012}$ = -1.51. The company is influenced by negative values of the indicators of economic, environmental and social performance. This company achieved negative values, i.e. it has problems in all areas and cannot be anticipated to be sustainable. We also see that a significant reclassification of companies occurred by comparison of the predictive model CSI_{MDA} and the composite indicator I_{CS} on a select sample of 10 concerns in the manufacturing industry according to CZ_NACE. We also deduce the classification of companies into groups from the results (1 = company headed for sustainability, 0 = company not headed for sustainability) by *Corporate Sustainability Index* CSI_{MDA}, *Index Corporate Sustainability* I_{CS} comparison with the economic predictive model IB, see Table 2.

Table 2 Predicted groups and model Corporate Sustainability Index CSI_{MDA}, Index Corporate Sustainability I_{CS} and Index of financial standing *IB*

Company	*Year*	*Predicted group IB*	*Predictive model IB*	*Predicted group* CSI_{MDA}	*Predictive model* CSI_{MDA}	*Predicted group* I_{CS}	*Composite indicator* I_{CS}	*Company*	*Year*	*Predicted group IB*	*Predictive model IB*	*Predicted group* CSI_{MDA}	*Predictive model* CSI_{MDA}	*Predicted group* I_{CS}	*Composite indicator* I_{CS}
AŽD PRAHA, inc.	2011	1	1,59	1	0,28	1	0,92	KORADO, Ltd.	2011	1	1,06	1	1,05	0	-1,14
	2012	1	1,53	1	0,18	0	0,43		2012	0	0,81	1	0,97	0	-1,39
	2013	1	1,39	1	0,11	0	-0,06		2013	0	-0,2	1	1,08	0	-1,58
ČESKÁ ZBROJOVKA, Ltd.	2011	1	1,78	1	0,21	1	1,59	KOVÁRNA VIVA, Ltd.	2011	0	0,66	0	-2,14	0	-2,01
	2012	1	2,53	1	-0,15	1	1,86		2012	1	1,62	0	-1,67	0	0,88
	2013	1	3,3	1	-0,26	1	2,29		2013	1	2,74	0	-1,11	1	1,64
FLÍDR, inc.	2011	0	0,83	1	0,11	0	-0,5	MEVA, Ltd.	2011	1	1,68	0	-3,82	0	-1,53
	2012	0	0,31	1	0,29	0	-0,93		2012	1	1,52	0	-2,83	0	-1,51
	2013	1	1,79	1	0,14	0	0,05		2013	1	1,36	0	-2,49	0	-1,77
HESTEGO, Ltd.	2011	1	1,61	1	-0,23	0	-0,32	NORMA CZECH, inc.	2011	0	-1,75	1	0,66	0	-4,74
	2012	0	0,86	1	-0,04	0	-0,57		2012	1	2,38	1	0,03	1	1,65
	2013	0	0,84	1	0,01	0	-1,32		2013	1	1,8	1	0,13	0	0,66
INA LANŠKROUN, inc.	2011	0	-0,18	1	1,35	0	-1,95	PRAMET TOOLS, inc.	2011	1	1,67	1	0,19	0	0,85
	2012	1	2,31	1	1,16	0	0,42		2012	1	3,34	1	0,06	1	2,62
	2013	1	1,67	1	1,15	0	-0,62		2013	1	4,62	1	-0,17	1	3,62
Index of financial standing *IB*; Corporate Sustainability Index CSI_{MDA}; Index Corporate Sustainability I_{CS}															

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If we also compare the given models by means of the Gini index, the value for the predictive model CSI_{MDA} amounts to 0.251 and the value for the composite indicator I_{CS} 0.914. The closer this value is to 1, the better the separation between sustainable concerns and non-sustainable concerns. It can be said on the basis of the calculated comparative characteristics that the best method for measuring sustainability is the composite indicator I_{CS} which shows the highest Gini index value and the highest percentage of correctly assigned companies. It can be said, on the basis of comparison of sustainable models with the economic predictive model IB, that non-financial indicators have a significant influence on the overall performance of a company. It can, therefore, be anticipated that the incorporation of such non-financial indicators into the measurement and evaluation of sustainability may mean that a company is headed for sustainability or that it has fundamental problems in respect of certain non-financial indicators and is headed for non-sustainability.

Models for the measurement and evaluation of corporate sustainability using financial and non-financial indicators are essential, particularly in view of the fact that evaluation based on financial indicators has become inadequate.

4. CONCLUSIONS

This paper concerns comparison of the predictive model *Corporate Sustainability Index* CSI_{MDA}, the composite indicator *Index Corporate Sustainability* I_{CS} for measuring and evaluating sustainability, and the economic predictive model *Index of Financial Standing IB* on ten selected industrial concerns engaged in activity 25 – the manufacture of fabricated metal products, except machinery and equipment – during the period 2011–2013. The predictive model CSI_{MDA} was constructed using the Multiple Discriminant Analysis method, while the Principal Component Analysis method (PCA) was used to determine the composite indicator I_{CS}. These models are based on the stipulation of financial and non-financial indicators. These models are important to owners and investors with a view as to whether a company is headed for sustainability. These models may influence decision-

making related to a company's long-term strategy and may give an indication of whether a company has adopted comprehensive performance evaluation. It can be said, in conclusion, that models for the measurement and evaluation of sustainability, no matter what method is used in their creation, will never be able to predict the direction of sustainability with a probability of 1, i.e. 100 %, as this will always depend on the development of and demands on financial and non-financial indicators. However, if a company implements new information in models that have already been created, it will be capable of evaluating whether the company is headed for sustainability or not with an adequate level of precision.

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