Modelling of economic phenomena and dependences for corporate sustainable performance

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Abstract. The determination of corporate sustainability performance and its key performance indicators is very important for company top management. The paper introduces chosen applications of quantitative methods in Maple for modelling of economic phenomena and dependences in an evaluation of company economic performance. There are discussed two examples of the evaluation of the Economic Value Added indicator (EVA) with Maple in the paper.

Keywords: mathematical modelling, economic phenomena, mathematical programming, Maple, key performance indicators, corporate sustainability performance.

JEL Classification: C88
AMS Classification: 90C08

1 Introduction

Verification of economic theory and real manifestations of the current economic practice can currently be seen as a power impulse for companies on market in the whole spectrum of their activity. Determining key performance indicators of companies, methods for their collection, analysis and correction of their measurement allows the modification of their development. They are becoming a solid base for analysis ensuring corporate sustainability of companies at the global market [3], [4], [6], [11]. The goals of the paper is introducing chosen applications of quantitative methods in Maple for modelling of economic phenomena and dependences in an evaluation of company economic performance and discuss them in the examples of the evaluation of the Economic Value Added indicator (EVA) [14], [15].

Maple is powerful mathematical software [1] for the construction of methods for mathematical modelling in economics [17] and finance engineering [18], numerical or graphical evaluation of key performance indicators (KPIs) of economic, environmental, social and corporate governance (ESG) phenomena in nature. Its statistical analysis and modelling of economic phenomena with visualization enable a company top management (e.g. chief executive officer further CEO) to manage and control more efficiently the given company [8]. Therefore, Maple is used in the research project "Construction of Methods for Multifactor Assessment of Company Complex Performance in Selected Sectors" (No. P403/11/2085) of Czech Science Foundation solved by solved by the Faculty of Business and Management of the Brno University of Technology (FBM BUT) and the Faculty of Business and Economics of the Mendel University in Brno (FBE MENDELU). It supports research of mathematical modelling of corporate sustainability performance for better application of project results in economic practice and also in the teaching of economic modelling [5], [7].

The paper introduces some applications of quantitative methods in Maple for modelling of economic phenomena and dependences in an evaluation of economic performance of company and discusses them in the example of the evaluation of the indicator EVA [14], [15].

2 Measurement of economic performance by Maple

In the Czech Republic dominates the classical approach of the measurement of economic performance, based on monitoring of standard indicators as *Return on Equity* (ROE), *Return on Investment* (ROI), *Return on Assets* (ROA), *Return on Sales* (ROS), *Return on Capital Employed* (ROCE), *Earnings before Interest and Taxes* (EBIT), *Earnings before Interest, Taxes, Depreciation and Amortization* (EBITDA), *Earnings after Taxes* or *Net Operating Profit after Tax* (EAT or NOPAT), *Earnings Per Share* (EPS) etc [10].

There exists on line *Benchmarking diagnostic indicators of financial system INFA* [19], which was developed in the collaboration between the Ministry of Industry and Trade (MIT) and the University of Economics, Prague (UEP). The MIT provides a data and programming capacity, and the UEP supports the methodological frame-

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work and analytical work [13]. The INFA system was upgraded in April 2012. This innovation lies in the introduction of the Classification of Economic Activities (CZ-NACE) [20] and treatment algorithms, calculations of the change in the statements of the Czech Statistical Office (CSO).

The CSO collects from companies quarterly following economic data [8]: *Values of assets, liabilities and components; Acquisition of total fixed assets; Total revenues; Turnover; Turnover (revenues) from own goods and services; Turnover (revenues) from merchandise refers to revenues from sales; Total expenses; After tax economic result; Production value; Book value added; Margin; Book value employee; Return on assets (ROA); Return on equity (ROE); Return on sales (ROS); Return on costs; Expense-to-revenue; Inventories turnover time; Environmental protection investment; Non-investment environmental expenditure; Environmental protection expenditure; Expenditure on R&D*. These data are monitored by the CSO questionnaire P 3-04, which covers the entire size range of businesses and trades (calculated for companies with 0-19 employees, selected enterprises with 20-49 employees and all enterprises with 50 or more employees). Status data and selected data are monitored by the CSO questionnaire P 6-04 across the board in companies with significant assets regardless of the number of employees.

Kocmanová and Doležalová proposed the *Key Performance Indicators* (KPIs) in [11] for the measurement of economic performance of company in relation to the environmental, social and governance (ESG) indicators [6]. They established these economic KPIs on the basis of the results of empirical research of the project No P403/11/2085 in the last year. The economic KPIs in Tab. 1 provide quantitative forms of a feedback which reflect the company results in the framework of its corporate strategy. These KPIs can also help to the company Chief executive officer (CEO) to plan and manage company economic priorities, in particular, when these indicators are focused on the core business strategy, by means of operational plans, which include corporate performance targets.

No	Indicator name	KPI	Measurement
	Profit	EBIT	Earnings before Interest and Taxes
		EBITDA	Earnings before Interest, Taxes, Depreciation and Amortization.
		EAT	Earnings after Taxes or Net profit after Taxes
		EPS	Earnings Per Share, Price Earnings / (P/E Ratio).
EC2	Cash Flow	Free Cash Flow	EBIT - Taxes + Amortization - expenditure on the acquisition of fixed assets + /-increases in working capital.
		Operating Cash Flow	All the cash flows arising from the main activity of the company, which is the subject of its business (the movement of stocks, receivables, obligations).
EC3	Revenues	Total revenues	Revenues from own goods and services + Revenues from sale of merchandise (goods for resale) + Revenues of fixed assets + Revenues from sale of materials + Revenues of securities.
EC4	Turnover size	Turnover size	Revenues from own goods and services + Revenues from sale of merchandise (goods for resale) + Revenues of securities
EC5	Profit margin	Profit margin	The difference between turnover (revenues) from sales of goods and expenses on merchandise sold (i.e. on goods sold in the same condition as received).
EC6	Indicators of economic performance	Return on Equity	ROE = EAT / Equity
		Return on Investment	ROI = EBIT / Total capital
		Return on Assets	ROA = EBIT / Assets
		Return on Sales	ROS = EAT / Revenues
		Return on Capital Employed	ROCE = EBIT / Equity + Long-term liabilities
EC7	EVA	Economic Value Added	EVA = (ROE – Cost of Equity) * Equity

Table 1 KPIs of economic performance

The last indicator EVA in Tab. 1 presents the analysis of the *Economic Value Added* [13], [14], [15] an advanced evaluation method that measures the performance and the profitability of the company, taking in account the cost of capital that the company employs. This method, invented by Stern Stewart & Co. [21] is used today by more and more companies as a framework for their financial management and their incentive compensation system for the managers and the employees.

We developed Maple program [6], [16], where the indicator EVA is calculated with using indicators in Tab. 1 and data collected by the CSO. We issued from the following formula:

$$Economic\ Value\ Added = (Return\ on\ Equity - Cost\ of\ Entity) * Equity,$$

which can be reformulated to:

$$EVA = EAT - C * WACC = EBIT * (1 - t) - C * WACC,$$

where C denotes *Capital Employed,* t is *Corporate tax rate* and

$$EAT = NOPAT = Operating\ Profit * (1 - Tax\ Rate)$$

The parameter *WACC* (*Weighted Average Cost of Capital*) is calculated by:

$$WACC = (r_d * (1 - t) * D + r_e * E) / C,$$

where D denotes *Total debt and leases*, E is *Total market value of equity and equity equivalents or market capitalization*, $C = E + D$, r_d is *Required or expected rate of return on borrowings before taxes (cost of debt)* and r_e denotes *Cost of equity*.

We will use in Maple the *Capital Asset Pricing Model* (CAPM) [22] to calculate the *Cost of equity*. This model can be considered as a special case of *Markowitz Portfolio Model* [12]:

$$r_e = r_f + \beta\,(r_m - r_f)\,,$$

where denotes r_f – *Risk free rate*, r_m – *Expected market rate of return*, $(r_m - r_f)$ – *Market risk premium*, and β is a coefficient that measures the part of the asset's statistical variance that cannot be mitigated by the diversification (beta of a stock is or portfolio is a number describing the relation of its returns with that of the market as a whole).

We compared our above approach for the modelling of EVA indicator with EVA indicator calculated by the system INFA of the MTI (abbreviated EVA MIT) for a chosen anonymous company A. The complete description of Maple calculations and their visualization was made in Vecheta's master thesis [16]. The chosen results of this comparison are in Table 2.

year	2002	2003	2004	2005	2006	2007	2008
EVA MIT	11 673	11 673	11 673	11 673	11 673	11 673	11 673
EVA	11 673	7 217	7 880	4 577	24 117	10 530	-3 462
Relative difference	6%	53%	6%	20%	32%	6%	21%

Table 2 Comparison of EVA and EVA MIT indicators for company A [16]

The difference between both methods of calculations of the EVA indicator is caused by the different approach while calculating the *Costs of equity* because the CAPM method is based on subjective view of the analyst estimation apart from MIT method [13].

2.1 Statistical support of Maple for EVA

The *Statistics package* of Maple is a collection of tools for mathematical statistics, data analysis and statistical diagnosis [2]. Statistical computations in Maple combine the ease of working in a high-level, interactive environment with a very large and powerful set of algorithms. Large data sets can be handled efficiently with 35 built-in statistical distributions, sampling, estimations, data smoothing, hypothesis testing, and visualization algorithms. In addition, integration with the Maple symbolic engine means that you can easily specify custom distributions by combining existing distributions or simply by giving a formula for the probability or cumulative distribution function. The Statistics package also includes the *Data Analysis Assistant*, a graphical interface to the data analysis tools in this. It provides various commands for fitting models to data points and performing regression analysis based on least - squares methods.

We used *Curve Fitting Assistant* of Maple for least square fitting of EVA data and its visualization. This enabled us to analyze EVA trends of chosen company A from 2002 to 2008 year, Fig. 1.

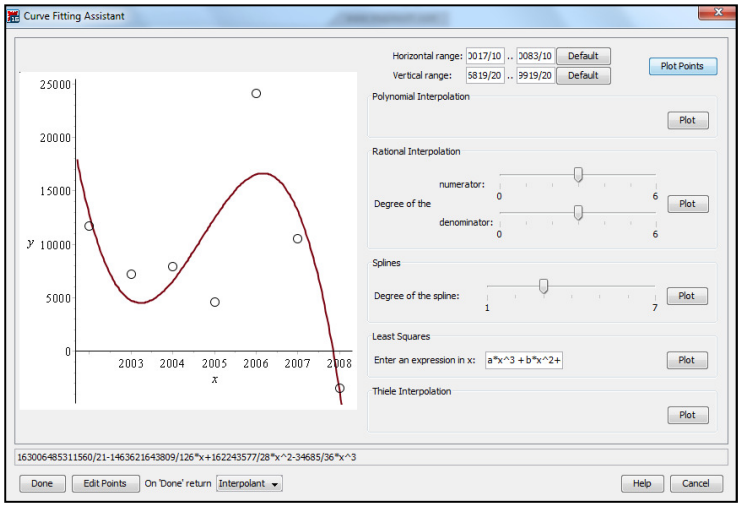

Figure 1 Fitting EVA data by least squares method

2.2 Use of neural networks in Maple at modelling EVA

The EVA indicator as a measure of surplus value created on an investment is based on the idea that a business has to cover both, the operating costs and the costs of capital. It stems from the estimate of economic, not the accounting profit.

We modified Maple program *A Feedforward Neural Network Forecasting Exercise from Application Centre* [23] from Maplesoft Application Centre based on methods published by Kendrick, Mercado and Amman [9] and applied this to our Maple program for calculation of EVA indicators [1], [5].

We divided input data of the given anonymous company B for our Maple program into three groups (teaching, testing, verifying). The output of Maple program was the value computed by using of neural network, which process was copying the process of computing of values of EVA indicator. The basic architecture of the neural network consists of a six layered perceptron working in the area of real numbers with linear rating of neurons. The neural network was created in Maple and it was composed of three coherent modules. The neural network used for storage of necessary data and intermediate calculations vectors and matrix. The matrix and vector character of data enables a simple using of cycles. At learning of the network for EVA indicator was made as a whole 20 223 study epochs, [1], [5].

Years	2002	2003	2004	2005	2006	2007	2008	2009
EVA MIT	2072	5749	14415	24179	32092	36658	22761	42265
EVA neural network	1927	7548	12672	22147	34445	43689	18961	36314
Relative Difference	7 %	31 %	12 %	8 %	7 %	19 %	16 %	14 %

Table 3 The comparison of EVA MIT and EVA neural network indicators for company B

3 Conclusion

The measurement of company performance is very important for company top management. The combination of suitable information technology, the use of economic and quantitative methods and the correct interpretation of results can improve the CEO decision making processes. Application of scientific quantitative methods in business companies has interdisciplinary impact. Modern enterprise information systems contain large amount of data and information that can be used more efficiently thanks to the use of Maple. We introduced this on the calculation the indicator EVA in two examples. We can see that the sophisticated financial analysis of the company and the comparison with its competitors in Maple is valuable source of information for company managers.

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