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THE ANALYSIS OF RELATIONSHIPS AMONG THE TOTAL PRODUCTIVITY, PROFITABILITY AND ECONOMIC VALUE ADDED

Abstract

The profitability of enterprise activities is one of the evaluation ways of management effectiveness of enterprise operations. The profitability ratios are quite well described in economics and financial literature. The current authors were less focused on the analysis of the ways of how to determine the main factors which influence the level of profitability. This problem is crucial and extraordinary important by the introduction and utilization of new production strategies. The paper defines the Total Productivity and the Total Productivity Break Even Point concept (T_{P_BEP}). It describes the linear model of the Total Productivity Break Even Point with the developed expressions for calculation of a and b regression coefficients. The mathematical models of Total Productivity and EVA were described. Further focus of the paper was on the definition of relationships between Total Productivity an profitability (ROA). The mathematical model of this relationship was developed.

The paper introduces the idea of mutual relationship of Total Productivity (P_T) and Economic Value Added (EVA). The Break Even Point concept of Total Productivity was used by the development of relationship model of EVA and Total Productivity. The final solution was simplified for easy practical utilization.

1. INTRODUCTION

Every enterprise makes efforts how to increase its value and naturally create a profit. The enterprise performance must be evaluated regarding internal and external factors of influence.

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Productivity is one of the most important factors influencing performance and competitiveness of enterprises.

Total Productivity is a measure of internal performance of enterprise [10] and informs about the fact whether the increase of performance is a result of effective management and utilization of internal resources or whether it was caused by changing of external factors [2].

Productivity is a typical internal indicator of enterprise performance. External performance of enterprise is mostly evaluated by price recovery ratio (ratio of sale price and change of purchase price).

Ratio indicators of profitability are most often used for total performance evaluation. Return on assets is the most often used indicator for enterprise management performance. That is a reason why ROA (Return on Assets) indicator is one of main, target indicators of the enterprise. The shareholders most commonly evaluate enterprise performance using ratio indicator ROE – Return on Equity.

If the enterprise wants to increase the value of ROA or ROE, must know, what the construction of the indicator is and it must find appropriate ways of its improvement. In the past the profit was the most commonly used for enterprise efficiency evaluation. Like many analyses have shown, the profit increase of enterprise does not directly ensure the increase of its Economic Value Added (EVA).

EVA belongs among new enterprise indicators [14]. As it will be shown in more detail later, EVA is determined as a subtraction of operating profit and capital costs. Using of this indicator enables better enterprise performance analysis. The value of the indicator signalizes, whether the enterprise creates economic value or not. Another advantage of the indicator is the fact, that it can be used for many decision making tasks [1], for example decision of order acceptance, product rejection from production line etc.

2. THE ANALYSIS METHODS OF THE ACHIEVED PRODUCTIVITY LEVEL

Any company measures its performance on some way. The measurement alone would have no meaning. Good manager has to know changes in company results and long term trends of indicators, he has to be able to analyze the reasons of such development [2] and to answer the question which factors how significantly influence productivity. Only this knowledge helps to determine the right direction of productivity improvement program.

According to [2], from the practical point of view, the following methods belong between the most significant productivity and performance analysis methods:

- Historical (horizontal) analysis – time series analysis, following trends,
- Vertical analysis,
- Regression analysis,
- Benchmarking of productivity ratios,
- Break-Even Point – BEP,
- Total Productivity Break-Even Point – P_{T_BEP}.

There exists a plenty of other methods and approaches which are used in productivity and performance analysis. The detailed information about those methods was published in Slovak Productivity Center materials [2], [10]. Those methods present a broad spectrum from the

simplest, practical up to very theoretically comprehensive methods, difficult to use in practice [4]. The practical examples of approaches for productivity measurement were published in [2], [8], [11], [12].

3. TOTAL PRODUCTIVITY MODEL

This model was developed by Sumanth [13]. He used the name Total Productivity (P_T) or Total Productivity Measure (P_{TM}).

The general form of Total Productivity Model is as follows [13]:

$$P_T = \frac{\text{Total tangible outputs}}{\text{Total tangible inputs}} \tag{1}$$

Then we can write for the Total Productivity:

$$P_T = \frac{O_1+O_2+O_3+O_4+O_5}{I_H+I_M+I_{C,F}+I_{C,W}+I_E+I_X} \tag{2}$$

where outputs are:

O_1 – Finished units completed (for sale and internal use)
O_2 – Partial units completed (for sale and internal use)
O_3 – Dividends from securities
O_4 – Interest from bonds
O_5 – Other income

Physical inputs include:

I_H – Human (workers, managers, professionals, clerical staff)
I_M – Material (raw materials, purchased parts)
$I_{C,F}$ – Fixed capital (land, buildings, machinery, tools and equipment, others)
$I_{C,W}$ – Working capital (inventories, cash, accounts receivable, notes receivable, other receivables)
I_E – Energy (oil, gas, coal, water, electricity, vapour etc.)
I_X – Other expenses (travel, taxes, professional fees, information processing etc.)

Total productivity can be expressed as function of partial productivities. This model has been derived by Hannula [6]:

$$\frac{1}{P_T} = \frac{1}{P_H} + \frac{1}{P_C} + \frac{1}{P_M} + \frac{1}{P_E} + \frac{1}{P_X} \tag{3}$$

where:

P_T – total productivity
P_H – labour productivity
P_C – capital productivity
P_M – material productivity
P_E – energy productivity
P_X – productivity of other inputs

4. BREAK EVEN POINT OF TOTAL PRODUCTIVITY

Productivity is a continually studied phenomenon. Theory and praxis of productivity improvement are relatively well documented [5]. One of almost unknown concepts that can facilitate productivity analysis and planning is the Total Productivity Break Even Point concept. This concept has been designed and theoretically described by Sumanth [13], who realized a series of check calculations in collaboration with the Indian Productivity Centre as well.

In Slovak conditions, M. Gregor has been the first one to apply the Total Productivity Break Even Point [2], [10]. He has elaborated and applied the concept in several projects aimed at productivity improvement realized by the Slovak Productivity Center.

Total Productivity Break Even Point is a relationship of Total Productivity and profit achieved by the enterprise. Total Productivity Break Even Point in a given period of time determines the profitability boundary – that is the profit equals to zero on this level of Total Productivity.

When evaluating or planning productivity growth as well as profits of an enterprise, the Total Productivity Break Even Point concept is a suitable tool. As shown by Sumanth, there is a clear correlation between Total Productivity and profit. Understanding this concept helps the management to plan productivity growth and enterprise performance more effectively.

To observe the principle and meaning of the Total Productivity Break Even Point in a certain period of time consider the following figure.

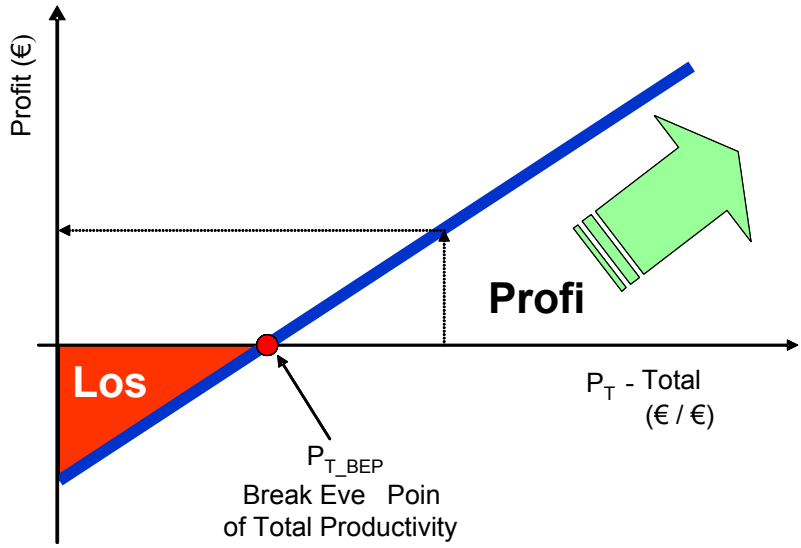

Fig.1 The Principle of the Total Productivity Break Even Point [9]

As shown in the figure, the enterprise starts to create positive profit at a certain (threshold) value of Total Productivity. The value of Total Productivity at which the enterprise achieves the profit of zero is called the Total Productivity Break Even Point.

To determine the value of Total Productivity in the Break Even Point, Sumanth has derived the following relationship:

$$P_{T\_BEP} = 1 - \frac{I_{C,W}}{\sum_{i=1}^{n} I_i}, \tag{4}$$

where:

P_{T_BEP} – Total Productivity Break Even Point.

$I_{C,W}$ – Working capital input.

$\sum_{i=1}^{n} I_i$ – Overall inputs.

In our case the following relationship for overall inputs will hold:

$$\sum I = I_H + I_M + I_{C,F} + I_{C,W} + I_E + I_X . \tag{5}$$

It is advisable to use the Total Productivity Break Even Point in the analysis of productivity and profit. Its value defines the minimum level of Total Productivity, which is to be achieved by the enterprise for it not to make a loss.

It is possible to derive another form of the Total Productivity Break Even Point model using the equation (4), formulating a linear relationship between the profit and the Total Productivity of an enterprise:

$$Z = a^* P_T - b \tag{6}$$

As obvious from equation (6), the profit equals the difference of the product of regression coefficient "a" and the Total Productivity and of the regression coefficient "b". This expression represents the equation of the Total Productivity Break Even Point line. (see Fig.2).

The regression coefficients a, b of the linear model are given by the following relationships:

$$a = I_H + I_M + I_{C,W} + I_{C,F} + I_E + I_X , \tag{7}$$

$$b = I_H + I_M + I_{C,F} + I_E + I_X , \tag{8}$$

whereas the regression coefficient "a" represents the total input for the period considered. The regression coefficient "b" equals the total input minus the working capital.

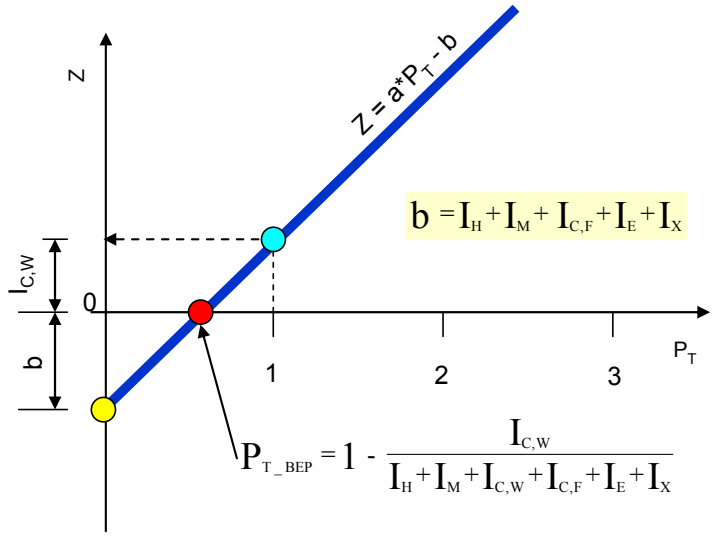

Fig.2 Analysis Model of P_{T_BEP}

As obvious when taking the two boundaries from equation (6), if:

1. The Total Productivity $P_T = 0$

Then the following will hold: $Z = -b$ (9)

2. The Total Productivity $P_T = 1$

Then the following will hold: $Z = a - b = I_{C,W}$ (10)

Then the following must hold for P_{T_BEP}:

$$P_{T\_BEP} = 1 - \frac{I_{C,W}}{\sum_{i=1}^{n} I_i} = 1 - \frac{a - b}{a} \tag{11}$$

The profit is determined by equation (6). Substituting the regression coefficients a, b and the P_{T_BEP} into the equation for income, the following can be obtained:

$$Z = a * (1 - \frac{a - b}{a}) - b = a * (\frac{a - a + b}{a}) - b = 0 \ , \tag{12}$$

that is – the value of the profit in point P_{T_BEP} equals zero.

The above listed forms of linear regression relationship between the profit and the Total Productivity can be used in when analyzing the relationship of profitability and Total Productivity of an enterprise.

5. PROFITABILITY

The success of an enterprise is often rated by the attained profit. The profit is determined as a difference between the income and the expenses of an enterprise. Thus the profit is a result of relation among accounting items, which makes the amount of information this indicator possesses very limited. The profit belongs to the category of absolute indicators and as such does not convey any information on how much resources were necessary to achieve it. To assess the efficiency of the activities of an enterprise in a more precise way, relative (ratio) indicators are used [15], [16].

The profitability indicators are ratio indicators, relating profit to e.g. the assets of an enterprise, to its turnover, etc. The following profitability indicators are the ones most commonly used in enterprise assessment: ROA (Return on Assets) – the profitability of Total Assets and ROE (Return on Equity) – the profitability of equity capital [7].

ROA is used to assess performance of the management of an enterprise. It is a ratio indicator relating the net profit to the Total Assets of the enterprise. It as well expresses how much profit has the enterprise produced per 1 € invested to its assets.

6. DUPONT PROFITABILITY CHART

There are several strategies to achieve financial success in a firm. On the DuPont profitability chart some of the basic ways of increasing profitability of the enterprise solutions, leading to financial success will be illustrated.

Literature does not provide a unique definition of ROA indicator. A group of authors presents a way to calculate ROA based on the operating profit, that is – as a ratio of operating profit (EBIT – Earnings Before Interests and Taxes) to the Total Assets.

$$\mathrm{ROA} = \frac{\mathrm{EBIT}}{\mathrm{TOTAL\ \ ASSETS}} \tag{13}$$

The more frequent definition of ROA is however the ratio of net profit (PAT-Profit after Tax) to the Total Assets. The second definition of ROA will be used in further examination of the problem. This form is often used for decomposition of the ROA indicator and is as well known as the first DuPont equation.

$$\mathrm{ROA} = \frac{\mathrm{NET\ PROFIT}}{\mathrm{TOTAL\ ASSETS}} = \underbrace{\frac{\mathrm{NET\ PROFIT}}{\mathrm{SALES}}}_{\substack{\mathrm{P.\ M.} \\ \mathrm{Profit\ Margin}}} * \underbrace{\frac{\mathrm{SALES}}{\mathrm{TOTAL\ ASSETS}}}_{\substack{\mathrm{T.A.T.O.} \\ \mathrm{Total\ Asset\ Turnover}}} \tag{14}$$

The first component of ROA decomposition represents profitability (profit margin of proceeds and of sales). Its average value usually ranges from 2% up to 6%. It is also known as

the operating leverage. The other component represents the number of Total Asset turnovers as well as the intensity of Total Assets utilization [3]. Its average value is typically about 2.5 times.

DuPont profitability chart provides a graphical representation of the profitability of Total Assets, ROA, which is a function of profit margin and Total Asset turnover.

The average value of ROA achieved in industry ranges from 8 to 12%. E.g. the value ROA = 15% can be achieved with the profit margin of 15% and Total Asset turnover equal to 1. As obvious from Fig. 3, the value of ROA can be improved by application of the following strategies:

- by growth of profit margin,
- by speeding up Total Asset turnover (increase in number of turnovers), or
- by combining the growth of profit margin and the number of Total Asset turnovers.

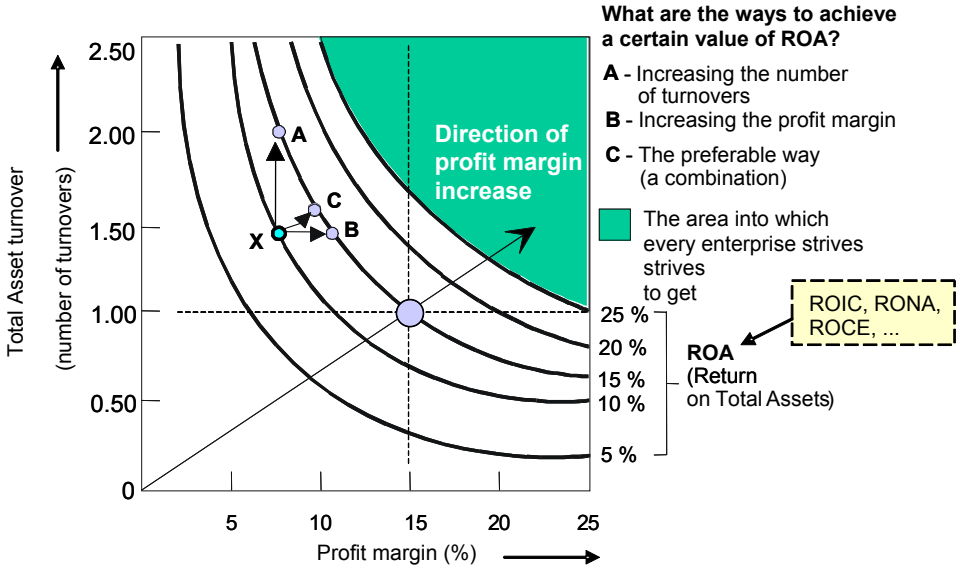

Fig. 3 DuPont Profitability Chart [3]

7. THE WAYS OF INCREASING PROFITABILITY

The following figure shows several ways in which the desired ROA value can be achieved.

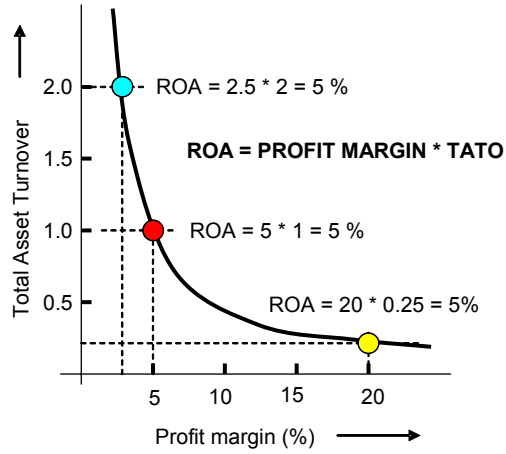

Fig. 4 Various Ways of Achieving a Constant ROA Value

It is obvious that there are various ways to achieve the same ROA value, in this case ROA = 5% (a product of profit margin and Total Asset turnover). Three different ways to achieve the same ROA value are shown. The next figure shows how to increase ROA value (using a combination of profit margin and Total Asset Turnover).

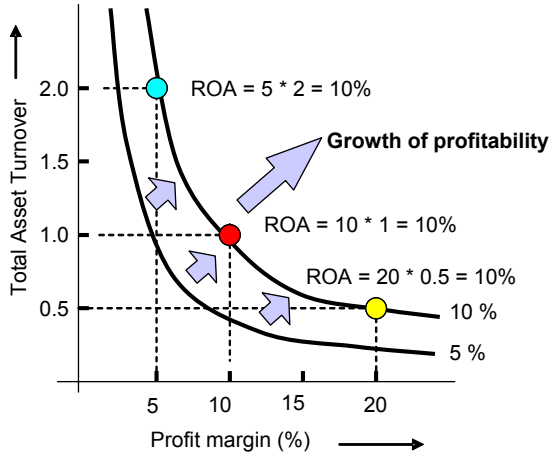

Fig. 5 Increasing Profitability

A transition to the higher levels of ROA can come as a result of growth in net income, of a decrease in the value of Total Assets, or as a combination of both. As sales occurs in both components of ROA decomposition (in the denominator of profit margin and in the numerator of Total Asset Turnover), it has no direct impact on the growth of ROA value. Thus the relevance of sales only becomes clear when studying the respective roles of the individual

factors directly influencing the ROA value. The importance of sales is also obvious when computing the profit.

It is apparent that it is possible to identify two regions (zones) of ROA increase in the DuPont chart, which have their respective dominant ways of ROA growth.

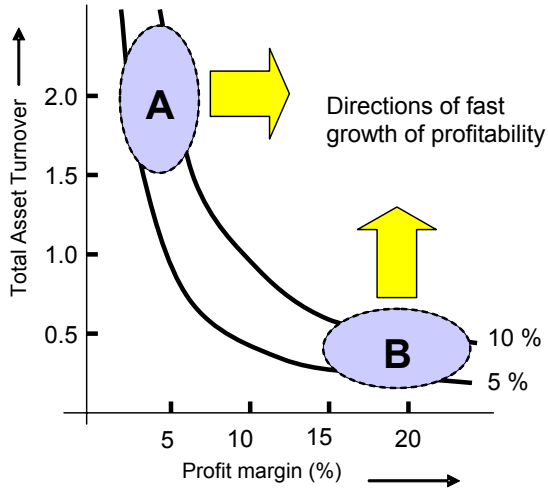

Fig.6. Increasing Profitability

The first zone (A) is characteristic for production achieving a high level of Total Asset Turnovers. Zone A is typical for highly repetitive production, outputting relatively simple products with short production times. The level of Total Assets is low and their turnover fast for enterprises in this zone. In zone A, fast growth of ROA can be achieved by increasing the profit margin as shown by the (transition to higher levels of ROA).

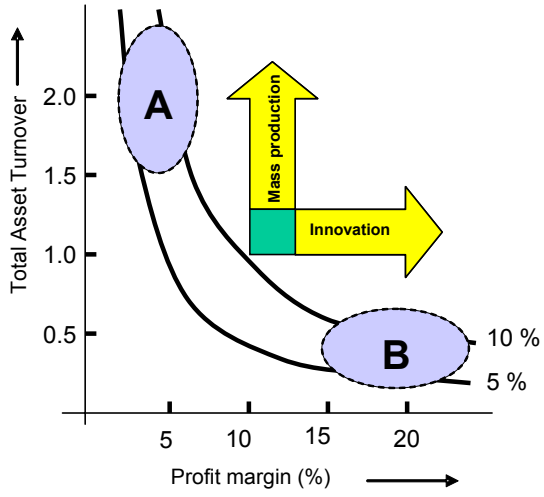

Fig.7. Main Forms of Increasing Profitability

Zone B is then typical especially for unique products (high level of profit margin required). Fast growth of ROA can be achieved by increasing the number of Total Asset Turnovers.

As shown in the following figure, it also possible to identify typical zones of innovative products and of mass production in the DuPont chart, between which every enterprise migrates.

8. PIMS – PROFIT IMPACT ON MARKET STRATEGY

Analyses of some of the most successful Japanese manufacturing enterprises in the entire world, the strategy of speeding up Total Asset turnover has become one of the dominant competitive strategies. Toyota has presented its excellence in this strategy in its Toyota Production System (TPS), also known as Lean Production.

The results of the worldwide project PIMS (Profit Impact of Market Strategies) have drawn attention to some other interesting facts. Another form of expressing profitability has been analysed in the PIMS project – ROI indicator (Return on Investment), which is given as a ratio of net profit to the total capital employed. Every prosperous enterprise strives to achieve the maximum value of ROI possible. The factors having the greatest influence on ROI have been analysed in the PIMS project [2]. The main factors are summarized in th

Tab. 2. The main factors influencing ROI (according to PIMS)

Factors with the greatest influence on ROI (making ROI variation for up to 80%)	
1. Market attractiveness • Market growth (short and long term) • Export ratio • Concentration degree (supplier – customer)	**4. Cost attractiveness** • Marketing expenses / turnover • R&D expensed / turnover • New products ratio
2. Relative competitive position • Absolute market share • Relative market share (in comparison to the three main competitors) • Relative salaries level • Relative products quality	**5. General characteristics** • Enterprise size • Diversification degree
3. Investment attractiveness • Investment intensity • Value creation / turnover (vertical integration) • Turnover/ workforce (productivity) • Capacity utilisation	**6. Changes of 1 to 5 quantities** • Change of market position • Change of vertical integration • Relative change of prices • Change of products quality • Change of capacity

9. PROFITABILITY AND THE TOTAL PRODUCTIVITY BREAK EVEN POINT

As obvious from equation (2), total capital (Total Assets) of an enterprise is represented by fixed and working capital. Thus the following relationship holds for the total capital (expressed in terms of the Total Assets):

$$TA = I_{C,F} + I_{C,W} \tag{15}$$

Equation (6) has been derived to express the relationship between the profit and Total Productivity.

The equation of Total Productivity can afterwards be modified into the following form:

$$P_T = \frac{\sum_{i=1}^{5} O_i}{I_H + I_M + I_{C,F} + I_{C,W} + I_E + I_X}. \tag{16}$$

As obvious from equation (16), denominator of this expression of Total Productivity is equal to the value of regression coefficient a.

The value of ROA is defined by equation (14), as follows:

$$ROA = \frac{\text{NET PROFIT}}{\text{TOTAL ASSETS}}. \tag{17}$$

We can then substitute the profit in equation (17) by equation (6) a substitute the Total Assets by Total Assets from equation (15):

$$ROA = \frac{a * P_T - b}{I_{C,F} + I_{C,W}}. \tag{18}$$

If we express the Total Productivity in equation (18) by Total Productivity from equation (16), the following can be obtained:

$$ROA = \frac{a * \left(\frac{\sum_{i=1}^{5} O_i}{I_H + I_M + I_{C,F} + I_{C,W} + I_E + I_X}\right) - b}{I_{C,F} + I_{C,W}}. \tag{19}$$

Substituting the denominator of the expression of Total Productivity in equation (19) by the symbol of the regression coefficient a, we can write:

$$ROA = \frac{\frac{a * \sum_{i=1}^{5} O_i - b * a}{a}}{I_{C,F} + I_{C,W}}. \quad (20)$$

And thus we can create the final form of the relationship for ROA:

$$ROA = \frac{\sum_{i=1}^{5} O_i - b}{I_{C,F} + I_{C,W}}. \quad (21)$$

Or – if we substitute the regression b, we can write:

$$ROA = \frac{\sum_{i=1}^{5} O_i - I_H - I_M - I_{C,F} - I_E - I_X}{I_{C,F} + I_{C,W}}. \quad (22)$$

It is possible to use the formulas listed above when studying the relation of ROA and Total Productivity. Every input and output of the enterprise constitutes a factor of this model.

10. ECONOMIC VALUE ADDED (EVA)

EVA compares Net Operating Profit After Tax (NOPAT) and capital costs. Capital costs (CC) represent the expected efficiency of own and foreign capital. They are determined as a product of rate of capital costs, or the Weighted Average Cost of Capital (WACC) and Capital Employed (CE).

$$EVA = NOPAT - CC \quad (23)$$
$$CC = WACC * CE \quad (24)$$

Net operating profit after tax is:

$$NOPAT = EBIT * (1-T), \quad (25)$$

where: EBIT is Earning Before Interest and Taxes,
T is the tax rate.

The EVA value can be determined using relative ratios, for example ROCE [1] (Return on Capital Employed). Multiplying EVASpread by Capital Employed, EVA value will be obtained:

$$EVA = EVASpread \times CE, \quad (26)$$

$$EVASpread = ROCE - WACC. \quad (27)$$

11. RELATIONSHIP BETWEEN EVA AND TOTAL PRODUCTIVITY

No relationship relating the EVA to the Total Productivity has so far been derived in the literature. Such solution, developed by the authors of this article, is suitable for a more detailed study of the mutual relationship between EVA and Total Productivity and of their influence on the performance of an enterprise.

Using the equations (23) and (24) EVA is as follows:

$$\mathbf{EVA = NOPAT - WACC*CE.} \quad (28)$$

As obvious, the model of EVA uses net operational profit. We can thus form a simple relationship between NOPAT and net profit:

$$Z = NOPAT *(1\text{-}I)= EBIT * (1 - T)* (1\text{-}I), \quad (29)$$

where:
T – is the tax rate (according to actual legislation 19 %, or 0.19).
I – interest rate of capital employed.

Using the relationship between net profit and NOPAT from equation (29) the following can be derived:

$$NOPAT = \frac{Z}{(1\text{-}I)} \quad (30)$$

Substituting expression (30) into equation (28), the following can be obtained:

$$EVA = \frac{Z}{(1\text{-}I)} - WACC * CE \quad (31)$$

and from this:

$$EVA = \frac{Z - WACC * CE * (1\text{-}I)}{(1\text{-}I)} \quad (32)$$

Substituting the expression of Z from equation (6) into equation (32), the relationship between EVA and Total Productivity can be derived:

$$EVA = \frac{a * P_T - b - WACC * CE * (1\text{-}I)}{(1\text{-}I)} \quad (33)$$

This relationship can be further modified by substituting for P_T and expressing the regression coefficient a using the equation (7):

$$EVA = \frac{a * \frac{\Sigma O}{a} - b - WACC * CE * (1 - I)}{(1 - I)} \quad (34)$$

Then:

$$EVA = \frac{\Sigma O - b - WACC * CE * (1 - I)}{(1 - I)} \quad (35)$$

Using the regression coefficient b, a final form of model will be obtained:

$$EVA = \frac{\Sigma O - I_H - I_M - I_{C,F} - I_E - I_X - WACC * CE * (1 - I)}{(1 - I)} \quad (36)$$

The above mentioned formulas can be used for studying of EVA and Total Productivity relationships. Using this model, the influence of selected factors on EVA value can be studied.

12. CONCLUSION

Undertaking is a continuous process of development and realization of innovations. These concern products, processes as well as systems. Every enterprise must make profit. The general measure of enterprise performance is the profitability of Total Assets, profitability of Equity and the Economic Value Added. Enterprises are therefore required to strive for continuous increase of ROA, ROE and EVA values.

The problem of measuring and evaluating productivity is very broad. This paper summarizes information concerning the concept of Total Productivity and the Break Even Point of Total Productivity.

The profitability of Total Assets is a measure of total performance of the enterprise and provides information about efficiency of its management. There are many practical examples in which the profitability indicator shows satisfactory development in the observed period of time, and the enterprise has – in spite of this – problems in the long run. Such situation most frequently occurs when the growth of an enterprise is stimulated by external factors and not by improvement of the internal performance of the enterprise. The level of internal performance of an enterprise is determined by its Total Productivity.

As shown by Gregor [2], every enterprise must continuously monitor and evaluate its own profitability as well as its level of productivity. Such analyses are required to gain understanding of the development which profitability and productivity undergo as well as of the factors influencing them.

The paper provides the theoretical basis required to determine the Total Productivity, the Total Productivity Break Even Point, ROA and EVA. It also presents the results of the research done by the authors concerning the study of relations between the Total Productivity, ROA and EVA and utilization of the acquired knowledge on the improvement of Total Productivity as well as of ROA and EVA values.

Manufacturing practice appreciates simple, comprehensible and readily applicable solutions, which is why this paper retains a comprehensible form. More detailed information is available in the referenced literature.

The Department of Industrial Engineering of the University of Žilina is, in cooperation with the Ministry of Economy of the Slovak Republic, currently performing a practical verification of the proposed theoretical models.

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