DEVELOPMENT OF VALUE PRODUCTIVITY IN METALLURGICAL INDUSTRY
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Abstract
This paper investigates the level and evolution of productivity (total productivity and partial productivity). The investigation is done on the sample of selected Czech metallurgical enterprises and it uses the time period 2006-2011 which allows the comparison of development before crisis period and during crisis period. It discovers the reaction of these companies during crisis. The paper identifies and analyzes the value productivity which is an indicator of level and changes in technical economic efficiency of production factors. This is an important factor in achieving enterprise objectives. This paper works with the contemporary concept of value productivity which means indicators of the productivity expressing the effect of economic efficiency not only of inputs consumption, but also of inputs binding efficiency. The inputs consumption is expressed as a relation of output value and accounting costs. The inputs binding efficiency is expressed as a relation of output value and binding costs, derived from costs of total capital.

Keywords:
Value Productivity, Economic Efficiency, Czech Republic

1. INTRODUCTION
In practice, the management still use exclusively the traditional criterial apparatus developed to support the functional (operational) optimization, based on a narrow conception of efficiency, although that does not meet the needs of a consistent process optimization in the contemporary sense (e.g. criterion return on costs, return on sales or labour productivity) [1]. The deficiency of this traditional criterial apparatus can be detected especially in insufficient information record of levels and changes of tied-up capital and in the unsystematic, respectively inconsistent, approach to capturing the impact of substitution of inputs and possibly of outputs as well. The criterial apparatus, meeting current and future business needs in the production management, should be based on the rigorous reflection of productivity (especially total productivity) and other factors of the EVA creation and should include factors’ differentiation because it allows direct management at causes and process optimization.

Extensive recent survey among Czech companies performed in 2007 [2] proved the corporate interest in the productivity measurement, including new approaches as well. 94% of respondents evaluate productivity while 74% of the same respondents measure only the traditional labour productivity. Already 20% of respondents answered in 2007 that they have used the new approach (or at least one of its elements) measuring total productivity (TFP) in the connection with the EVA analysis.

The need of (total) productivity indicators arises from the need to know (= distinguish) what the effects of changes are in the technical-rationality of the production processes, which is just expressed as productivity.

The main aim of this paper is to identify the level and development of productivity, expressed as total productivity as well as partial productivity, of selected metallurgical enterprises in the Czech Republic in the time period 2006-2011. The effort is to show the development before the "crisis" and during the crisis, respectively the reaction of these enterprises in the last crisis period. Another paper objective is to provide methodological tools for determining the value productivity in the contemporary sense. It means productivity indicators representing economic efficiency effect not only of the consumption of inputs (based on output
value and accounting costs), but also of inputs binding (based on output value and the costs of binding depending on the amount of total capital employed).

2. METHODOLOGICAL BASE

The productivity can be generally defined as the efficiency of using production factors in manufacturing, or widely in a production process, whose results are tangible as well as intangible outputs [3]. The productivity can be discussed on the macro economical level, detail in [4], or on the level of enterprises, detail in [5]. In this paper we aggregate enterprises’ productivities on the level of industry branch and it could be called as mezzo economic productivity.

We can distinguish between two types of productivity ratios [6] – total and partial productivity. Total productivity is expressed by the equation 1 and partial productivity by the equation 2.

\[
\frac{\text{total output}}{\text{total input}} \quad (1)
\]

\[
\frac{\text{total output}}{\text{partial input}} \quad (2)
\]

The equations 1 and 2 are too general and this pattern is not usable for available variables. The productivity ratios have to be modified and specified for fulfilling the paper aim how it is done in the following parts.

2.1 The total productivity ratio

The total productivity ratio has to take into account all types of outputs as well as inputs. The value of inputs should be expressed as the costs of consumption (and appreciation) as well as costs of binding (components of assets, converted to flow-related capital costs).

\[
\text{Total productivity} = \frac{\text{Total revenues}}{\text{Costs of consumption and binding of inputs}} \quad (3)
\]

Costs of consumption and binding of inputs =

\[
\text{Total costs (accounting)} + \text{interests} + \frac{\text{WACC}}{1-t} \times \text{Total assets} \quad (4)
\]

The ratio 3 represents a modification of variables whose differential expression is close to the economic profit, respectively the indicator EVA – Economic Value Added. In this paper we work with the wide concept of variables. The production and production factors are expressed in the widest sense – not only operating, but also financial and extraordinary activities.

2.2 The partial productivity ratios of inputs consumption

The partial productivity ratios are focused only on the selected production factors (inputs). The experimental part is based on following rations and equations.

\[
\text{Productivity of consumption (depreciation)} \text{ of an input} = \frac{\text{Total revenues}}{\text{Costs of consumption of an input}} \quad (5)
\]

The costs of consumption are evaluated as the difference between total accounting costs and interests of debts. The equation 6 contains narrower revenues because the inputs (material and energy) are also narrowed and using only the main part of revenues increases the explanatory power. Operating revenues
are used also in other presented indicators (7, 8, 13). In the case of labour productivity (equation 9) the
operating revenues are even narrower because the numerator is expressed as value added. This shape of
the formula is used in the theory and practice for decades.

Productivity of consumption of material and energy = \frac{\text{Operating revenues}}{\text{Costs of material and energy}} \quad (6)

Productivity of consumption (depreciation) of fixed tangible and intangible assets = \frac{\text{Operating revenues}}{\text{Depreciation of fixed tangible and intangible assets}} \quad (7)

Productivity of consumption (depreciation) and binding of fixed tangible and intangible assets = \frac{\text{Operating revenues}}{\text{Depreciation} + \text{Costs of fixed tangible and intangible assets binding}} \quad (8)

The above mentioned costs of binding are expressed as WACC*(1-t)\textsuperscript{-1} multiplied by the value of fixed
tangible and intangible assets.

Labour productivity = \frac{\text{Value Added}}{\text{Number of employees}} \quad (9)

2.3 The partial productivity ratios of inputs binding

The binding productivity ratios introduced in the following equations are focused on total inputs, fixed
tangible and intangible assets, current assets and inventories. The costs of binding used in the denominator
of formulas are expressed together at the end of the sub-part.

Productivity of inputs binding = \frac{\text{Total revenues}}{\text{Costs of inputs binding}} \quad (10)

Productivity of fixed tangible and intangible assets binding = \frac{\text{Total revenues}}{\text{Costs of fixed tangible and intangible assets binding}} \quad (11)

Productivity of current assets binding = \frac{\text{Total revenues}}{\text{Costs of current assets binding}} \quad (12)

Productivity of inventories binding = \frac{\text{Operating revenues}}{\text{Costs of inventories binding}} \quad (13)

The cost of binding are expressed as WACC*(1-t)\textsuperscript{-1} multiplied by the value of examined assets (equation 10 – total assets, equation 11 – fixed tangible and intangible assets, equation 12 – current assets and finally
equation 13 – inventories).

3. EXPERIMENTAL PART

The experimental part is based on the data sample obtained from the corporate database Albertina. This
data sample enables to analyze 85 metallurgical companies operating in the Czech Republic. The criteria for
selection were belonging to the branch “Manufacture of basic metals”, called as CZ NACE 24, and the total
annual turnover exceeding 50 million CZK. The original sample consisted of 88 companies but 3 companies were excluded because of their discontinuous development. These 85 companies had the aggregated value of total assets 139 515 329 000 CZK and employed 34,847 workers together in the year 2011.

The choice for indicators used in the analysis has been a compromise between the paper's aim presented as a reflection of the value productivity in the contemporary concept and limited data availability. The contemporary concept uses the productivity indicators expressing economic efficiency effect not only of the consumption of inputs (based on output value and accounting costs), but also of inputs binding (based on output value and the costs of binding depending on the amount of total capital employed).

The limited data availability, mentioned above, caused that we did not have detail specified data for the analysis of the development of the value productivity in the Czech metallurgical industry. One way is to use static indicators of value productivity but these indicators do not have a greater explanatory power than the classical and even in practice more used indicators of financial analysis (as it was used by [7]). On the other hand, the dynamic indicators of productivity, which reflect the development in two or more time periods using the index or difference comparison, have also the potential to show the economic value of the effects of changes in productivity separately from other factors creating value, such as changes in production volumes and price changes. For this detailed analysis micro economical input data are required. These data are represented by inputs and outputs expressed not only in financial value but also physical volumes. For further information about this approach and relevant indicators look in [1]. Such specified data are not available on the level of the industry because data inputs should come from the corporate level (micro level of each company in the sample).

The effects of price changes and the impact of changes in production volumes were removed at least partly. The target was achieved by selecting only productivity ratios and comparison of indices. The effects of prices were partly compensated as much as it is a similar trend in input and output prices. Further the effect of prices was moderated thanks to the fixation of the value of binding costs. This contribution uses constant rate of the inputs binding costs for all reporting periods. This constant rate is equal to WACC for the year 2011 for manufacturing industry whose value was taken from [8]. The constant value of WACC is 13.66% and the level of taxation is equal to 19%.

For the expression and development of productivity, we used standard time base indices and standard time chain indices, whose specific content is evident from the table headings in the chapter Results.

4. RESULTS

Results obtained by the deep analysis are presented in following figures. Figure 1 displays the total productivity. The peak was in the year 2006, on the other hand the bottom was reached in 2009. Gradual improvement can be seen in the years 2010 and 2011. These changes were probably because of lower demand which caused reducing of quantities produced and sold. The development of the value of output (total revenues), the value of inputs (the value of consumption and binding) and their difference called as modified EVA can be seen in the figure 2. The economic profit decreased from 1.4 billion CZK in 2006 (in tax free format) to a negative value of -21.2 billion CZK in 2009 and the economic loss was moderated (-18.2 billion CZK in 2010 and -17.2 billion CZK in 2011). This indicator is stricter than the traditional gross (accounting) profit (EBT) which was negative only in 2009 (20.9 billion CZK in 2006, 20.3 billion CZK in 2007, 13.3 billion CZK in 2008, -0.8 billion CZK in 2009, 4 billion CZK in 2010 and 5.6 billion CZK in 2011).

The changes of productivity are shown in figures 3, 4 and 5. The changes of productivity are expressed as base indices (year 2006 = 100). It is possible to view and compare different significant decrease and subsequent various fast recovering of different types of productivity in the context of the crisis around the year 2009. Curves containing similarly large slump as the curve of revenues indicate a low flexibility of these production factors. This shape of the curve is typical for the labour productivity or the productivity of the use
of fixed assets. On the other hand, curves which are flat show greater flexibility of their production factors. The flatter shape is characteristic for the productivity of material consumption or energy consumption. Evaluating these differences we must not forget the fact that these characteristics are relative. The influence of each production factor does not depend only on the flatter or deeper and faster or slower response but also on the consumed amount of the factor (expressed as costs or share of these costs on the total costs). This difference can be seen in the different value of consumption and costs of binding (owning of assets). For example, the average share of costs of consumption on the costs of consumption and binding of inputs was 86.8% in the whole analysed period. It co-determines significant differences in the impact of changes these partial productivities on the absolute enrichment or impoverishment.

Fig. 1 Total productivity (The value of output in CZK / the value of consumption and binding of inputs in CZK)

Fig. 2 Revenues, costs of consumption and binding and modified economic profit (in thousand CZK)

Fig. 3 Total productivity changes (base indices, the year 2006 = 100)

Fig. 4 Changes of total productivity, input consumption and binding productivity (base indices, the year 2006 = 100)
5. DISCUSSION

The results of the analysis proved that some production factors were more fixed and others more variable in the analysed time period and industry branch. This conclusion is not surprising because the factors which are traditionally perceived as fixed were even more fixed due to the time period and the industry branch. We can come to the same conclusion in the case of variable factors. The evidence of this kind may be significantly beneficial in the case of a comparison among companies or different parts of the same enterprise. It is not included in this paper because of its page limitation but it opens future possibilities for an additional research.

6. CONCLUSION

This paper described the level and development of productivity in the metallurgical industry in the time period 2006-2011. This time period is specific because of the start, duration and consequences of the last global economic crisis. The difference of this paper in comparison of other contributions is that this paper did not use the traditional criterial apparatus and the narrow concept of efficiency. Instead of traditional financial ratios or static indicators of productivity it reflects the value productivity in the contemporary concept. Calculated indicators took into account also changes in price and physical volumes. Although this analysis is typical for the micro level (the level of an individual enterprise) this contribution proves that the analysis with the explanatory power can be done also on the level of one industry branch.

Another paper objective was providing methodological tools for determining the value productivity in the contemporary sense. These methods and tools were presented and after practically implemented in the analysis.

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