

# THEORY-METHODICAL ESTIMATION OF EFFICIENCY PRINCIPLES FOR MECHANICAL ENGINEERING ENTERPRISES ON THE INTEGRAL INDICATOR BASIS

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**Abstract.** Nowadays, the work of enterprises occurs in conditions of negative impact of factors of the market environment, which affects the results of functioning. Therefore, there is a need to evaluate the effectiveness of enterprises, which will allow to identify the first manifestations of deterioration in the results of activities in time, the downturn dynamics of indicators, to make effective managerial decisions, to determine the directions of activity. The paper proposes a methodical approach of assessing the effectiveness of the activities for mechanical engineering enterprises. Estimation is based on the integral indicator due to the weighted average cost of capital, which approbation was carried out using the example of the factual enterprise. A number of measures for the researched enterprise have been formed, including: flexible system of criteria and components in accordance with the requirements of the evaluation subject in analytical data, taking into account the interests of interested parties that act as donors and beneficiaries in the activities of enterprises; structure of indicators identifying problems and their potential solutions has been formed. It was established that the implementation of the formed measures will increase the efficiency of the economic activity, will allow to determine areas of activity in priority, to develop measures to improve the work. It is also important to take into account the influence of factors of the internal environment, implementation of suggested steps allows to respond to the influence of factors of the internal environment using the proposed methodological approach and form an effective development strategy.

**Keywords:** performance, integral indicator, weighted average capital value, internal environment, multi-vector valuation.

**JEL Classification:** A10, C18, D29

**Formulas:** 17; **fig.:** 0; **tabl.:** 4; **bibl.:** 9

**Introduction.** The functioning of enterprises takes place in conditions of constant influence of factors of the internal environment, which affects the results of activity. Therefore, there is a need to evaluate the effectiveness of enterprises by taking into account the factors of the internal environment. All this will allow to develop measures to restore performance indicators, form directions of development, make effective decisions and contribute to the achievement of expected results.

**Literature review.** The issue of evaluating the effectiveness of enterprises was investigated in the works of the following scientists: Maslak O., Grishko N., Ishchenko S., Maslak M. [2]; Babmindra D.I., Skull O.G. [3]; Lepyohina O.V. [5]; Nazarov E. [6]; Rasulova U.S. [7]; Tarasenko N.V. [8]; Shiyan A.A. [9].

**Aims.** The purpose of the article is to develop a methodological approach to the effectiveness evaluation for the mechanical engineering enterprises on the basis of the integral indicator due to the weighted average cost of capital, with its approbation on the example of the factual enterprise.

**Methods.** in the process of research the methods of correlation analysis and multiple regression are used, which make it possible to calculate the dependence of the integrated indicator of the efficiency of the production process on individual efficiency indicators. Also used a statistical method of data processing, a method of grouping to analyze performance indicators. The method of observation is used to study the state of financial accounting and control of enterprises.

**Results.** The efficiency of the enterprise, taking into account the use of labor and material resources, through the production process is a general indicator of the efficiency of the enterprise. However, the values of indicators are absolute characteristics of the enterprise. Correct interpretation by the performance indicator of the enterprise according to the evaluation of effectiveness can be carried out only in tight links with other indicators reflecting the funds invested in the enterprise.

Due to that fact the company sets itself the task of determining the degree of economic efficiency of activity in a specific period on which the need for further assessment depends. The result of the evaluation is a conclusion about the efficiency of activities and the adoption of an appropriate managerial decision. Appeal to specialized bodies for scientific and technical expertise, at this stage of evaluation is impractical from the point of view of additional costs allowed. Therefore, there is a need to develop an indicator on the basis of which the enterprise will be able to determine independently the degree of efficiency of the production process.

Methods of correlation analysis and multiple regression, which is offered by modern economic cybernetics, make it possible to calculate the dependence of the integral indicator of evaluating the effectiveness of the production process  $I_{\text{prod}}$  on individual performance indicators. The multiple regression method allows to determine which economic indicators have the greatest impact on the integral performance indicator. The equation representing dependence of the integral indicator  $I_{\text{prod}}$  is calculated by the formula:

$$I_{\text{prod}} = \sum_{i=1}^{i=n} w_i * x_i, \quad (1)$$

where  $I_{\text{prod}}$  – index of efficiency of production process;  $w_i$  – influence coefficient of individual indicators on the integral indicator of efficiency;  $x_i$  – characteristics of economic activity by  $i$ ;  $n$  – number of characteristics of economic activity.

The proposed indicator reflects the degree of effectiveness of all characteristics of partial indicators of economic activity, taking into account their impact on the integral performance indicator. The highlighted characteristics are proposed to be used as the basic features of the economic activity of the enterprise. However, the composition of each group may vary depending on the object of evaluation of activities and the characteristics of the market in which it operates. Due to the heterogeneity of the selected characteristics in their essence and practical significance, the main task is the formation of a single indicator of the effectiveness of economic activity.

The multi-vector nature of the evaluation also causes flexibility of composition and content filling of criteria with indicators for each of the areas of determination, in accordance with the sphere of influence on a certain interested party. This study developed a system of indicators according to the composition of criteria, the value of which varies from 0 to 1. It is established that achieving the maximum possible value is almost impossible, but each of the indicators should strive for it.

Thus, from the position of the enterprise, the assessment is carried out according to the criteria of economic efficiency, which reveals such basis the signs of the enterprise's activity as profitability and optimality of the production cycle in terms of cost optimization. As stated earlier, the most common indicator of the effectiveness of economic activity is its profitability, which is the ratio of profits from the activities of the enterprise to the costs of its implementation [3, c. 223].

Assessing the effectiveness of economic activity, it is advisable to determine the degree of its growth compared to the change in profitability level:

$$I_n^{\text{change}} = 1 - \frac{R_{n-1}^{\text{basic}}}{R_n^{\text{change}}}, \quad (2)$$

where  $I_n^{\text{change}}$  – index of profitability of activity after changes;  $R_{n-1}^{\text{basic}}$  – profitability of the enterprise in the period before the introduction of the change (n-1);  $R_n^{\text{change}}$  – profitability of the enterprise in the n-th period.

In case of changes within the industry, it is advisable to determine the profitability of the enterprise. It is noted that in order to ensure a single dimension of the evaluation results on the principle of formality, the traditional profitability formula was transformed as follows:

$$I_{\text{ech}} = 1 - \frac{B_{\text{ch}}}{P_{\text{ch}} - E_{\text{ch}}}, \quad (3)$$

$I_{\text{ech}}$  – index of profitability of changes;  $B_{\text{ch}}$  – costs for achieving a change in production activities;  $P_{\text{ch}}$  – income from the implementation of changes in the production activities of the enterprise;  $E_{\text{ch}}$  – development and implementation costs of the change.

In the case when the implementation of changes is reflected in the internal processes of the enterprise, it is advisable to calculate an additional cost savings indicator:

$$I_{\text{ec}} = \frac{\sum Bu * Ru}{E_w}, \quad (4)$$

where  $Bu$  – expenses for resource unit;  $Ru$  – the amount of freed resources as a result of the implementation of the change;  $E_w$  – total mass of direct costs;  $u$  – type of resource.

Basing on the fact that the company under consideration is a joint stock company in the state of sale consider the indicator calculated as the ratio of the market value of the company's assets according to their renewable value. At the same time, the market value of the enterprise will be seen as the price at which

this enterprise can be sold on the market. The revolving cost is considered as the cost that this enterprise would have provided that its entire capital (cars, buildings, equipment, etc.) was replaced by new capital equipment at the prices that have developed at the current time on the market. Thus, if the market value of the company's assets exceeds the renewable value, i.e.  $K > 1$ , it means that the company has received a positive economic profit, or expects it to [2]. The market value of the enterprise is presented through the formula (5):

$$K_{\text{mark}} = 1 - \frac{P_{\text{bas}}}{P_{\text{ch}}} = 1 - \frac{P_{\text{bas}} * Q_{\text{bas}}^{\text{pwh}}}{P_{\text{in}} * Q_{\text{ch}}^{\text{pwh}}}, \quad (5)$$

where  $P_{\text{ch}}$  – profit from the sale of products after the introduction of the change;  $P_{\text{bas}}$  – profit from the sale of products in common conditions;  $P_{\text{in}} * Q_{\text{ch}}^{\text{pwh}}$  – the volume of products sold subject to changes in the market;  $P_{\text{bas}} * Q_{\text{bas}}^{\text{pwh}}$  – volume of products sold.

Thus, if this coefficient has a value of 1 or seeks it, this will indicate the possibility of the enterprise receiving super profits and monopolizing the specified market segment. Accordingly, if its value is reduced from 1 to 0, this probability will be proportionally reduced.

To find out how much innovations will change the degree of competitiveness of the market and market power of a particular enterprise, we will apply a coefficient that determines the ratio of the monopoly price difference (PM) and marginal costs (MC) of products and monopoly price [9]. This coefficient, known in economic literature as the Lerner coefficient, is as follows:

$$L = \frac{P_m - MC}{P_m}. \quad (6)$$

The Lerner coefficient acquires a value from 0 (in the market of perfect competition) to 1 (net monopoly). The value of the coefficient is directly proportional to the market authorities and inversely proportional to competition. Having adapted the value of this coefficient to determine the effectiveness of economic activity, it can be argued that the monopoly price is the price of change, or rather, an increase in this price in accordance with the basic level of the price of ordinary products. The marginal costs will reflect the costs of developing and implementing changes, or rather their increase compared to the basic level of costs. Thus, the Lerner coefficient (formula 6) when determining the monopoly power of the enterprise will look like:

$$L' = \frac{\Delta P - \Delta B}{\Delta P}, \quad (7)$$

where  $L'$  – modified Lerner coefficient;  $\Delta P$  – increase of the price on products with changes compared to the usual (%);  $\Delta B$  – increase in the cost of changes in activities compared to the usual (%).

If the Lerner coefficient increases from 0 to 1, the company's power will also increase in proportion to the full monopoly position in the market and, as a result, increase the possibility of obtaining super profits [9]. The obtained data (formulas 2; 3; 5; 7) are synthesized into a single indicator of economic efficiency  $I_{ef}$ :

$$I_{ef} = I_r * I_{ech} * K_{mark} * L', \quad (8)$$

where  $I_{ef} \rightarrow 1$ .

From the investor's point of view, the criteria for assessing the effectiveness of the economic activity of the enterprise are due to the economic nature of the essence of economic activity, namely, profit from the implementation of the production process and optimization of the term of return on investment. That is, the basis of quantitative substantiation of the process of making a management decision of an investment nature is the anticipation of monetary [5].

Thus, using the method of multiple regression under conditions of interest in the investment attractiveness of enterprises, it makes sense to supplement the existing formula of the integral performance indicator with a parameter that takes into account the degree of profitability of investments made in the enterprise, taking into account the position of determining the mass of additional profit from investing in innovation activities in comparison with alternative activities; assessment of the level of losses associated with a lack of profit due to risk; ensuring timely return of invested capital.

Weighted Average Cost of Capital responds necessary set of requirements (Weighted Average Cost of Capital = WACC).

The investment process is carried out continuously, and in order to ensure the minimum cost of resources and the optimal capital structure, the enterprise must finance both share and leveraged capital. That is why when making financial plans and assessing future investments, managers of the enterprise use mainly weighted average capital value in calculations, but not the cost of individual sources of financing.

Under the unchanged capital structure, for some time the company can raise funds at the average price, which is determined by the available weighted average cost of capital. At the same time, each new currency of the attracted funds will have the same structure as the entire capital of the enterprise. However, attracting new sources of financing in large volumes can lead to increasing in the financial risk of the enterprise, and therefore to increasing of the weighted average cost of capital. The average cost of capital also increases as a result of rising market interest rates and a corresponding increase in the value of equity and borrowing capital [1].

The use of formula offered by the CFA Institute determines this indicator for "Motor Sich" JSC. The purpose of this study will be to consider the requirement to invest funds in support of products and activities of the enterprise. The source of funds can find itself in form of shareholders as initial

public offers, or taking loan from banks or financial institutions. Of course, capital has its own value, due to the large number of sources of loans, it's valuable to determine the weighted average cost of capital (Weighted Average Cost of Capital = WACC).

The calculation formula used according to the CFA Institute version [1]:

$$\text{WACC Formula} = (E/V * K_e) + (D/V) * K_d * (1 - \text{Tax rate}), \quad (9)$$

where  $E$  – market value of equity;  $V$  – market value of equity and debt;  $K_e$  – tax percentage;  $D$  – market value of debt amount of equity;  $K_d$  – cost of debt.

Formula of calculations takes into account the tax and interest rates with the attraction of the market value of equity. The algorithm of calculating the weighted average cost of capital (WACC) of “Motor Sich” JSC is presented on Table. 1.

**Table 1. WACC (Weighted Average Cost of Capital) Calculation Algorithm**

Options	Engagement Price	Cost, \$	Calculation formula
Market value of equity		346285000 \$	
The total market value of own capital and debt		346650260 \$	
Market value of debt		383230\$	$= C[(1 - (1/((1 + K_d)^t)))/K_d] + [FV/((1 + K_d)^t)]$
Interest expense (C)		3951\$	
Total due (FV)		365260\$	
The cost of debt ( $K_d$ )	5,2%		$= \text{Interest rate} * (1 - \text{Tax rate})$
Corporate tax rate	18%		
Weighted Average Cost of Capital (WACC)	11,01%		$\text{WACC Formula} = (E/V * K_e) + (D/V) * K_d * (1 - \text{Tax rate})$

Source: developed by the author on the basis of the source of [1]

Thus, according to the results of calculations, it was found that the weighted average cost of capital of “Motor Sich” JSC is 11%, which is satisfactory level for the value of the indicator in question. This level of indicator provides for a satisfactory opportunity to be a source of funds, because the capital structure is protected from negative changes under the conditions of stability, otherwise other variable factors should be supported in the coming years.

For a more accurate and correct answer to the question of whether to invest in the company or not, potential investors should also check other coefficients for assessing the level of efficiency of the economic activity of the enterprise in order to make a final decision. So, in an outfit with a calculated indicator of the weighted average cost of capital and depending on the level of profitability of the company, it is possible to understand whether it is advisable to invest in an enterprise, according to the results of which an analysis of the effectiveness of the economic condition of the enterprise is carried out.

Therefore, conclusion is that the risk quantitatively reflects the degree of short-level of profit.

To determine the objective quantitative measurement of risk, rely on the statement that risk-forming factors in today's extremely unstable economic environment can be many factors of influence of external and internal financial, economic, political, social, environmental environment, so it is advisable to determine the risk dimension in proportion to the index of changes introduction (3). For clear gradation of the risk of the change index scale, the Stegers formula was used:

$$k = 1 + 3.322 * \lg(N), \quad (10)$$

where  $k$  – number of metric groups;  $N$  – input data.

For our case, the total amount of data is 11, having made the necessary calculations we have:

$$k = 1 + 3.322 * \lg(11) = 4.6 \sim 5 \text{ groups.} \quad (11)$$

The next step is to determine the step of the interval  $h$ , which is equal to:

$$h = \frac{\max(x) - \min(x)}{k}, \quad (12)$$

where  $x$  – variable value.

If the maximum value is 1 and the minimum 0 step definition of the interval  $h$  is:

$$h = \frac{1-0}{5} = 0.2. \quad (13)$$

On the basis of the obtained data, formation of a risk gradation from the minimum to the maximum will proportionally increase the value of the fundamental change index with an increase in the possibility of costs. If there is information about possible costs, the risk factor is determined:

$$k_r = (1 - p_i), \quad (14)$$

where  $p_i$  – opportunity of expenses.

To assess the justification of investment activity, it is advisable to enter an index of expectations, which should limit the riskiness of investments. This index should determine whether there will be sufficient profit, additional profit to cover increased risk. Its value ranges from 0, which does not justify investments, to 1, which makes investing a priority task.

$$I_h = 1 - \frac{WACC_{bas}}{WACC_{ch} * kr}, \quad (15)$$

where  $I_h$  – index of expectations in return on investment;  $WACC_{ch}$  – weighted average cost of capital in economic activity, subject to changes, taking into account the level of investment risk determined on the scale, UAH;  $WACC_{bas}$  – weighted average cost of capital in normal activities of the enterprise.

It should be noted that the effectiveness of investment activity is based on such a conceptual basis of investment activity as justification of costs and return of invested capital in the shortest possible time. Therefore, the feasibility of assessing economic efficiency from the investor's point of position in cost-effectiveness is obvious, since one of the target directions of economic activity is to optimize it.

Therefore, among the indicators of the effectiveness of investment activity, we will highlight an indicator of cost effectiveness. The advantage of this indicator in comparison with the payback period is taking into account the time factor, provided that all the positive aspects of the second are maintained.

In view of this, in order to assess the impact of performance from the point of view of payback of expenses, it is advisable to determine the cost optimization index:

$$I_{oe} = 1 - \frac{P_{B\ ch}}{P_{B\ bas}}, \quad (16)$$

where  $I_{oe}$  – expenses optimization index;  $P_{B\ ch}$  – modified cost-effectiveness;  $P_{B\ bas}$  – basic cost-effectiveness.

In order to evaluate the effectiveness of the economic activity of the enterprise from different positions of interest of the parties, it is advisable to summarize the indicators considered, useful to us, in the form of a single index of the effectiveness of investments in the enterprise:

$$I_{inv.ef.} = I_{oe} * I_h, \quad \text{де } I_{ef} \rightarrow 1, \quad (17)$$

where  $I_{inv.ef.}$  – index of investments in the enterprise.

In order to unambiguously interpret the results, it is necessary to establish clear limits of the values of all integral indicators of this direction. We set the limits of integral indicators by the number of constituent indicators in the criteria. Thus, for our case, the evaluation of the effectiveness of investment activity by cost optimization indices and expected returns on investment is 0.25.

The final stage of evaluating the effectiveness of enterprises is the formation of conclusions on the effectiveness of its activities in each direction or criterion. In order to interpret the results of evaluating the effectiveness of the enterprise in the target areas and criteria (Table 2).

**Table 2. Interpretation of the results of evaluation of the effectiveness of the enterprise by criteria and subject of evaluation**

Subject of evaluation	Conclusion	
	Activity is effective	Activity is not effective
Enterprise	$I_{ec\ ef} \in (0,01;1)$	$I_{ec\ ef} \in (0;0,01)$
Investor	$I_{inv.\ ef.} \in (0,25;1)$	$I_{inv.\ ef.} \in (0;0,25)$
Evaluation criterion	Activity is effective	Activity is not effective
Cost-effectiveness	$I_{ec\ ef} \in (0,06;1)$	$I_{ec\ ef} \in (0;0,06)$
Investment efficiency	$I_{inv.\ ef.} \in (0,25;1)$	$I_{inv.\ ef.} \in (0;0,25)$

Source: developed by the author on the basis of the source of [8]

For practical implementation of the model for improving the efficiency of the economic mechanism, the “Motor Sich” JSC enterprise has been chosen. The company was the most successful enterprise of the sample, and its economic activity - the most effective. But, since 2018, shares of “Motor Sich” JSC sold to Chinese investors have been under arrest at the request of the SSU investigators in order to preserve material evidence in the criminal case initiated in 2017. [6].

This is the event that takes role of a change, the impact of which will be determined in terms of economic and investment efficiency. In accordance with the content of the economic activity of the enterprise and its fundamental features the criteria of economic and investment efficiency will be evaluated.

System for assessing the effectiveness of the economic mechanism consists of indicators representing the source data of the results of evaluation of the efficiency of “Motor Sich” JSC (Table 3).

**Table 3. Initial data for calculating the effectiveness of activities “Motor Sich” JSC**

Indicator	Meaning
Profitability of the enterprise in the basic 2017 year, %	20
Profitability after changes in 2018 year, %	10
The costs due to the change that took place, thous. UAH	5388396
Income (loss) due to the change that took place, thous. UAH	(1851981)
Implementing a change	0
Profit from the sale of products after the change (2018), thous. UAH	12239687
Profit from sales to change (2017), thous. UAH	15150429
Increase in prices for products with changes, %	109
Increase in costs on condition of change, %	74
Risk factor of short-term investment profit	0,7
Weighted average cost of capital in the base year (2017), %	11
Weighted average cost of capital in 2018, % *	6
Cost profitability in basic 2017, %	15
Cost profitability in 2018, %	8

Source: developed by the author on the basis of the source of [4]

The evaluation of the effectiveness system for the economic mechanism consists of indicators of the initial data, which is summarized in Table. 4.

**Table 4. Evaluation Results “Motor Sich” JSC**

Criterion	Indicator	Meaning
Economic effectiveness	Activity Profitability Index	0,79
	Market share ratio	-0,24
	Monopoly coefficient	0,32
	Index of Economic Efficiency of Activities	0,15
Investment effectiveness	Investment Profit Expectations Index	-0,83
	Cost Recoupability Index	0,46
	Investment Performance Index	-0,38

Source: developed by the author on the basis of the source of [7]

Basing on the data obtained, with taking into account the adopted change, which took place in 2018, it is noted that “Motor Sich” JSC has suffered a decrease in market share, a decrease in the expectation of investment returns and, as an investigation, a decrease in investment efficiency. However, the strong economic base of the enterprise allowed it to remain profitable with satisfactory indicators of economic efficiency and cost recoupability.

Regarding the model developed for assessing the effectiveness of the economic mechanism, it is important to note its usefulness in the effectiveness of the organization of economic activity and the ability to respond in a timely manner to changes in the internal and external environment.

**Discussion.** The proposed model for evaluating the effectiveness of the economic mechanism of the enterprise performs a number of useful functions, such as: it offers a flexible system of criteria and components in accordance with the requirements of the assessment subject in analytical data; it takes into account the interests of donors and beneficiaries in the activities of enterprises; it offers a structure of indicators which are capable to identify the problems and their potential solutions.

**Conclusions.** The article proposes a methodical approach to assessing the effectiveness of the activities of mechanical engineering enterprises on the basis of the integral indicator due to the weighted average cost of capital, which also considers changes in the internal environment of the enterprise. The use of this approach makes it possible to assess the level of efficiency for enterprise’s activity as well as to form proposals for improving the work of enterprise.

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