Use of Economic and Mathematical Modeling Tools in Planning Investments in Fixed Assets

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Abstract: In order to maximize the effectiveness of fixed assets use it is necessary to assess the impact of organizational factors on capital productivity of fixed assets, and also to assess the feasibility of capital investment in fixed assets. The purposes of the study are to design an economic-mathematical model that makes it possible to predict a value of capital productivity knowing the values of different factors, as well as to calculate the effectiveness of capital investment in fixed assets on the example of the regional branch of Tatarstan Energy Company. During the correlation and regression analysis of the Tatarstan energy company branch, the authors found that the cost of the active part of fixed assets has the greatest impact on the capital productivity of fixed assets, so the company is recommended to increase the active part of fixed assets. The proposed approach to scenario forecasting of capital investments in fixed assets allows to assess the prospects for changes in the company's financial performance as a result indicator of the company's performance.

Keywords: Fixed assets, capital productivity, correlation and regressive analysis, capital investments in fixed assets, net present value (NPV).

INTRODUCTION

In a modern market economy, fixed assets are essential components of the organization functioning since usefulness and efficiency of an organization's work depend on their availability and use. Fixed assets have a significant impact on the financial result of an organization's work due to their use on enterprise more than one operation cycle (Kulikova *et al*. 2016; Kulikova *et al*. 2017; Shaferi *et al*. 2020; Singh and Mohan 2020).

Fixed assets efficiency calculation is done by the ratio of results received from the use of fixed assets and resource costs. There are several indicators that are used for the analysis of fixed assets efficient use: capital productivity, capital intensiveness, capital-labor ratio, relative and absolute savings of basic production assets, return on fixed assets (Kayumova *et al*. 2019; Aydın *et al*. 2020b).

Fixed assets capital productivity can be defined as the division of sold production revenue position into fixed assets average annual cost.

Capital productivity is a summarizing indicator of the effectiveness of fixed assets use. It describes how many goods and services in value terms were produced in the reporting period for 1 ruble of the cost of fixed assets. The higher the use of fixed assets efficiency gets, the higher the rate of capital productivity is.

In the literature, there are some studies about the quality issues of projects and discussion on different analysis techniques for assessing efficiency of investments in fixed assets (Arab Momeni *et al*. 2019; Aydın *et al*. 2020a; Borsboom and Zeisberger 2020; Di Corato and Maoz 2019; Kousky *et al*. 2019a, 2019b; Kozlova and Collan. 2020; Li and McNeil 2019; Oliveira *et al*. 2020).

Some papers are dedicated to the issue of innovative performance measurement. They focus on techniques that can be employed for evaluation of single innovation project such as net present value (NPV) approach analysis (Dhavale and Sarkis 2018; Marchioni and Magni 2018; Žižlavský 2014; Buana *et al*. 2020). Used with care, these techniques can guide the management of the innovation project by providing indications of its potential financial value.

METHODS

An analysis of the fixed assets effectiveness that use in the Tatarstan energy company regional branch could be considered. The purpose of this analysis is to identify the form and degree of the relationship between output and performance indicators. The fixed assets capital productivity in the Tatarstan energy company regional branch as an output factor have

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used. It is an important indicator which describes fixed assets use efficiency.

Due to the high level of fixed assets wear and tear in the Tatarstan energy company regional branch, the dependence of capital productivity on a number of technical and economic factors and also design an economic-mathematical model that makes it possible to maximize the effectiveness of the fixed assets use will be considered.

RESULTS AND DISCUSSION

In this analysis capital-labor ratio (x_1), repairing costs (x_2), cost of active part of fixed assets (x_3) and degree of equipment wear (x_4) are independent variables.

Pair correlation matrix according to the data of the Tatarstan energy company regional branch for 2009-2019 years is presented in Table **1**.

According to Table **1** the capital productivity in Tatarstan energy company regional branch has a close link with the capital-labor ratio of fixed assets (ryx_1 =0,84), with fixed assets repairing cost (ryx_2 =0,83) and with the cost of an active part of fixed assets (ryx_3 =0,91). The degree of wear (ryx_4 =0,27) has a limited impact on the test parameter.

The link between the capital-labor ratio and the cost of active part of fixed assets in the Tatarstan energy company regional branch is close (r_{x1x3} =0,94). It means that there is multicollinearity that is why between two factors it is more appropriate to remain one that has the closest link with the capital productivity. Since the cost of the active part of fixed assets has a big impact on the capital productivity, a two-factor model for our analysis will be used.

Using tool "Regression" in MS Excel, regression analysis of the cost of the active part of fixed assets and the repairing costs' impact on fixed assets capital productivity in the Tatarstan energy company regional branch will be made [3, p. 42].

We have taken the logarithms of dependent variables. Linear regression equation with two variables can be found using the formula 1:

$$Y= -8,34487+0,033x\ln x_1+0,6x\ln x_2+e \quad (1)$$

The economic interpretation of the coefficients can be presented as follows: if the cost of fixed assets active part increases by 1%, the capital productivity will increase on average by 0,6%. If the repairing costs increase by 1%, the capital productivity will increase on average by 0,03%.

If the coefficient of determination is 0,8771 it means that 87,71% of capital productivity is formed by combination of these two factors, and 13,19% of dispersion is formed by impact of not previously considered others factors.

According to Student's T-test, the regression coefficient is significant with probability 99%, and between x_1 (cost of active part of fixed assets) and Y(fixed assets capital productivity) variables there is significant linear relationship.

According to Fisher test the regression changes in appropriate way, with chosen variable (x_1 - cost of fixed assets active part, x_1 – repairing costs of fixed assets) it has an impact on Y (capital productivity).

As the result, the cost of fixed assets active part has the greatest impact on fixed assets capital productivity

Table 1: Correlation Matrix According to the Tatarstan Energy Company Regional Branch for 2009-2019 Years

Indicators	Capital productivity, in thousands of rubles	Capital-labor ratio, in thousands of rubles per person	Repairing costs, in thousands of rubles	Cost of active part of fixed assets, in thousands of rubles	Degree of wear, %
Capital productivity, in thousands of rubles.	1	x	x	x	x
Capital-labor ratio, in thousands of rubles per person	0,838969342	1	x	x	x
Repairing costs, in thousands of rubles	0,832580953	0,854378611	1	x	x
Cost of active part of fixed assets, in thousands of rubles	0,919561102	0,942181446	0,850615835	1	x
Degree of wear, %	0,270126737	0,287697434	0,407158511	0,42399398	1

and therefore the Tatarstan energy company regional branch is recommended to increase it.

In the modern economy, capital investment planning is one of the methods of predicative model in financial analysis. Capital investment is the advance of funds to both tangible and intangible assets. Planning capital investments in fixed assets is one of the most important strategic tasks in the effective organization management.

At the first stage of the study, it is considered to the branch of the Tatarstan energy company to construct a combined-cycle gas turbine with a capacity of 230 MW. This turbine is a relatively new type of generating stations that run on gas or liquid fuel. The advantages of the turbine are low cost per unit of installed capacity, ability to install it in 9-24 months, compactness and high production efficiency.

The reasons for implementation of the 230 MW combined cycle gas turbine by the Tatarstan power company branch are optimization of the ratio of electricity and heat produced, need for increase of electricity generation and for minimization of the possibility of accidents. As a result, this can lead to an increase in the company's competitiveness in the wholesale electricity and capacity market.

The next structural element of the study is the choice of the construction method. We offered to the Tatarstan energy company branch to build a combined-cycle gas turbine using borrowed funds (credit). The construction of a combined-cycle gas turbine is proposed to be carried out by a contract method with the involvement of a loan for a period of 24 months at an average loan rate of 15% per annum. Initial contribution amounts to 20% of the total cost of construction (2 327 756,8 thousand of rubles), and the total cost of construction works is 13 966 540,8 thousand of rubles including 20% VAT.

The next stage of the study is to determine the initial cost of the 230 MW combined-cycle gas turbine. According to accounting regulations 15/2008 "Accounting for borrowing costs", interest on loans received on the acquisition of an investment asset increases the initial cost, so the initial cost of the 230 MW CCGT will be 13 467 613,7 thousand of rubles. The useful life of the combined-cycle gas turbine is 15 years. According to the accounting policy of the Tatarstan energy company branch, fixed assets are subject to the linear depreciation method.

We will next consider the deliverable criteria of selection rationale and investment project efficiency. Deliverable criteria of investment project efficiency are net present value (NPV). The net present value is the present value of investment project's cash flows, which is estimated by considering discount, after deduction of investment cost. The project will be cost-effective if NPV is positive and the bigger its value gets, the more profitable this project is. NPV is found using the formula 2:

$$NPV = \sum_{1}^{n} \frac{NCF_t}{(1+r)^t} \quad (2)$$

Where NCF_t is the value of net cash flow in period t, thousands of rubles.;

r – Discount rate, %.

The value of the net cash flow means the difference between proceeds and cost, as well as between borrowing costs. Calculation of the net present value of the 230 MW combined-cycle gas turbine construction project for Tatarstan energy company branch is presented in Table **2**.

In implementing 230 MW combined-cycle gas turbine construction project, calculation of the change in the financial result is general indicator of effectiveness of capital investments in fixed assets for the Tatarstan energy company branch.

According to Table **3** in implementing of the 230 MW combined-cycle gas turbine the financial result of the Tatarstan energy company branch will increase by 993.5 million ofrubles due to an increase in commercial output of energy by 825 million of rubles and commercial output of power by 316 million of rubles with a constant output of heat in the amount of 2,838 million of rubles. Revenue growth in implementing of the 230 MW combined-cycle gas turbine is accompanied by an increase in fuel costs by 147.2 million of rubles, but this does not have a significant impact on the expected financial result.

DISCUSSION

Method of correlation and regression analysis is used to assess the effectiveness of fixed assets use. It requires a significant array of historical data and the selection of key indicators that do not have a high level of correlation. According to the authors, the use of correlation and regression analysis of the capital productivity of fixed assets has a significant potential

for predicative assessment of the effectiveness of fixed assets use. During the correlation and regression analysis of the Tatarstan energy company branch, the authors found that the cost of the active part of fixed assets has the greatest impact on the capital productivity of fixed assets, so the company is recommended to increase the active part of fixed assets.

The proposed approach to scenario forecasting of capital investments in fixed assets allows to assess the prospects for changes in the company's financial performance as a result indicator of the company's performance. Approbation of forecasting of capital investments in fixed assets is based on empirical data of the Tatarstan energy company branch. The implementation project of the 230 MW combined-cycle gas turbine is cost-effective for the company branch, since the net present value at the end of construction of the object is positive and will amount to 97,196 thousand rubles. The implementation of 230 MW CCGT will increase the financial result of the Tatarstan energy company branch by 993.5 million rubles due to the increase in electricity output by 1,141 million rubles. The minimum payback period is 8 years.

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