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THE METHOD OF QUANTITATIVE ANALYSIS OF THE FIXED ASSETS DYNAMICS AND ALTERNATIVE CHOICE OF INVESTMENT’S DECISIONS

The article deals with the methodological approach to determine the growth rate of fixed assets based on a number of technical and economic parameters. The influence of the economic dynamics of such factors as return on capital, its structure (the main and working), the share capitalization of profit rate loans,the term fixed assets use. The methodological basis of research supports the proposed scheme of expanded reproduction of fixed assets in the steady pace of economic growth. To determine the rate depending on the selected settings the appropriate algebraic equations were received, the solution of which is carried out by means of numerical iterative procedures. As one of the directions of results use - during evaluating investment decisions using discounted cash flows reproduction of capital.

У статті подається методологічний підхід до визначення темпів зростання основних засобів в залежності від ряду технічних та економічних параметрів. Аналізується вплив на економічну динаміку таких факторів як рентабельність капіталу, його структура (основний оборотний), частка капіталізації прибутку, ставка кредитування, термін використання основних засобів. Методологічною базою дослідження виступає запропонована схема розширеного відтворення основних засобів в умовах усталеної динаміки економічного зростання. Для визначення темпів в залежності від вибраних параметрів отримані відповідні алгебраїчні рівняння, розв'язок яких здійснюється за допомогою чисельних ітераційних процедур. Як один із напрямків використання результатів – застосування при оцінці інвестиційних рішень за допомогою дисконтування грошових потоків відтворення капіталу.

Introduction. Development of production is a dynamic process that is characterized by certain objectives, characteristics and laws. An important part of this should be considered the detection of variants of this process, in particular, on the basis of studies of causation, and the development of methods of economic evaluation of options and their comparison.The study of fixed assets dynamics requires such scheme of their rennovation, which would use the number of indicators, such as its lifetime, retirement and commissioning funds, the change in the resources allocated to upgrade and increase the assets.

Analysis and presentation of research. In the economic literature, towards its development problem's study the substantial role play the production function, which describe the dynamics of growth of production according to production factors changes [7]. An example of such a relation is called Cobb-Douglas production function, where main resources are the labor and capital assets. In quantitative terms, the capital growth dominates in development processes and calls for appropriate special studies. Various aspects of fixed assets expanded reproduction in several papers related to asset's valuation [2] of fixed assets accounting [3], the economic impact of financing investment costs [4], evaluation of investment projects [5], crediting projects [6], investment support of innovation [8]. At the same time the study offixed assets dynamics should not be considered complete, especially for common multifactorial quantitative laws regarding rates of reproduction of capital, which is the subject of this article.

Main research. In order to take into consideration all features listed above concerning the processes of its development, we propose the following version of fixed assets renovation interpretation, when their lifetime is equal to *T* years [1]:

1-st year	2-nd year	3-rd year	4-th year	...
F_0 →	F_T	F_T	F_T	...
F_1	F_1 →	F_{T+1}	F_{T+1}	...
F_2	F_2	F_2 →	F_{T+2}	...
...	...	...	F_0	...
F_{T-1}	F_{T-1}	F_{T-1}	F_{T-1}	...

On the scheme given above, the arrow shows updates for fixed assets (*FA*). For example, in the first retiring year the function value of *FA* is F_0 while new *FA* - F_T are being introduced instead.

We assume, that the acquisition of these *FA*, were done at the expense of financial resources – profit and depreciation. Generally, for accumulation purposes profit is only partially used, which is equal to (α) and amortization, calculated on the relevant standards (a_F). Taking into account the cost of *FA* in the first year and using the rentability (r), we determine the cost of new assets by carrying equality:

$$F_T= (\alpha r+a_F)(F_0+ F_1 +...+ F_{T-1}). \quad (1)$$

In the future we will be mainly analyzing the dynamics of *FA* with constant growth rate (η). For such a process, the following quantitative relation will be taking place between the value of *FA*:

$$Fi +1 = \eta Fi . \quad (2)$$

Taking into consideration this feature concerning quantitative interrelation between individual assets, equation (1) is equivalent to the following:

$$\eta^T = (\alpha r + a_F) (1 + \eta + ... + \eta T\text{-}1). \quad (3)$$

Assuming that the rates are the unknown parameter, they are determined from the algebraic equation of T-th degree, which can be solved by any method, including iterative.

In the first approximation we can take an amount equal to η1 = 1 + αr. The left and right parts of the equation are calculated separately, then the difference in these quantities is obtained. In subsequent iterations the value of approaching tempo can increase with the time difference until both parts of the equation do not change the sign to the opposite. To simplify the numerical calculations of equations by means of using the sum of a geometric progression can be converted as follows:

$$\eta^T=(\alpha r+a_F)\,\frac{\eta T-1}{\eta-1}. \quad (4)$$

Let’s take as example the version of the dynamics with following output parameters:

T=10; a_F=0,1; α=0,5; r=0,10.

Accordingly, the equation for determining rates is as follows:

$$\eta^{10}=0{,}15\,\frac{\eta 10-1}{\eta-1}.$$

Following the calculations outcome for the rate under iterative procedure, determining the difference of the left and right sides of the equation we obtain:

1. η_1=1,05; Δ_1=1,6289 – 1,8867=-0,2578.
2. η_2=1,06; Δ_2=1,7908 – 1,9771= -0,1863.
3. η_3=1,07; Δ_3=1,9671- 2,0725= - 0,1054.
4. η_4=1,08; Δ_4=2,1589 – 2,1730 = -0,0141.
5. η_5=1,09; Δ_5=2,3674 – 2,2789 = 0,0885.

The iterative procedure ends, as the difference of the left and right sides of the equation has changed sign from minus to plus. With an absolute accuracy of 1 percent growth we can assume that the growth rate is equal to η = 1,08, therefore the *FA* growth will be up to 8% annually. The difference that is being analyzed here reaches the smallest absolute value.

The equation for the rate (3) makes it possible to justify the discounting procedure of resource flows used in evaluating the effectiveness of one-time investments (projects). For this purpose, the left and right side of the equation, shall be divided by η^T and then multiplied by the amount of investment K. Then we obtain the following relation:

$$K=\frac{R}{\eta}+\frac{R}{\eta^2}+\cdots+\frac{R}{\eta^T}\quad, \qquad (5)$$

where $R=\alpha rK+a_F K$.

In this interpretation, the annual cash flows are being discounted, generated from profits and depreciation according to the value of the investment project.

The economic literature in order to evaluate investment projects considers the difference between the discounted cash flows and investments (NPV). The project is considered acceptable if the NPV has positive value [2, 3].

In terms of pace it is appropriate to consider three assessment options:

1. NPV = 0 – investment project provides existing rates.
2. NPV> 0 – a project focused on the growth rate.
3. NPV <0 – project leads to a slowdown.

The important area of analysis of economic dynamics should be considered in addition to basic account also of industrial revolving funds. The last one has the ability that entered into the system once they are used almost indefinitely in time.

An analysis of resource flows, in this case the equation for the rate takes the following form:

$$\eta^T=(\alpha r+a_F\frac{1}{1+\lambda})\,(1+\eta+\ldots+\eta^{T-1})+\frac{\lambda}{1+\lambda}, \qquad (6)$$

where $\lambda=\frac{F_{wc}}{F_{fa}}$, F_{wc} – **working capital,** F_{fa} – fixed assets value.

For the particular investments ($K=F_{fa}+F_{wc}$) this equation can be transformed into following:

$$K=(\alpha bK+a_F F_{fa})(\frac{1}{\eta}+\frac{1}{\eta^2}+\cdots+\frac{1}{\eta^T})+\frac{F_{wc}}{\eta^T}. \qquad (7)$$

The availability of working capital with the same amount of investment leads to a decrease in depreciation, since the last ones are accrued only on containing fixed assets part. At the same time during the NPV calculations to current resources the discounted value of working capital is added. The economic meaning of this component is due to the fact that working capital is as a rule used longer then fixed assets.

Here is example, when taken into account previous calculation parameters additionally believed that working capital equal to the fixed assets, therefore $\lambda = 1$.

In this case, the equation for determining the rate takes the following form:

$$\eta^{10}=0,10\frac{\eta^{10-1}}{\eta-1}+0,5.$$

Below the appropriate iterative process is listed:

1. $\eta_1=1,05$; $\Delta_1=1,6289 - 1,7578=-0,1289$.
2. $\eta_2=1,06$; $\Delta_2=1,7908 - 1,8180 = -0,0272$.
3. $\eta_3=1,06$; $\Delta_3=1,9671 - 1,8816 = 0,0855$.

Thus, we can conclude that the rates are equal to the value of $\eta = 1,06$ (6% annual growth).

Having ceteris paribus working capital leads to slower growth, because it reduces the flow of depreciation as direct investment resources. For one hundred percentage growth rate of fixed assets amounted to 8%. The turnover depreciation is an important factor in the intensification of economic growth dynamics.

We have analyzed the dynamics of variations, where the acquisition of new assets carried at their own expense. At the same time it is important to the development of which involved investment resources, those the borrowed funds are used.

Let's consider the partial renewal option of investing funds through borrowings, which must be paid back in one year with interest (i).

Analysis of the relevant resource flows shows that in this embodiment, investment rates are determined from the following equation:

$$(1+\alpha i)\ \eta^{T-1}= (\alpha r+a_F)\ (1+\eta+...+ \eta^{T-1}). \qquad (8)$$

To specify this equation we consider to rise funds at 10% per annum. Then equation (8) takes the following form:

$$1,05\eta^{9}=0,15\frac{\eta^{10-1}}{\eta-1}.$$

Here are the final pieces of the iterative process for calculating the rate for this equation:

1. $\eta_1=1,08$; $\Delta_1=2,1589 - 2,2357=-0,0768$.
2. $\eta_2=1,09$; $\Delta_2=2,3674 - 2,3665= 0,0009$.

Thus borrowing compared with development from its own resources increases the absolute annual growth rate from 8% to 9%.

Analysis of equation (8) shows that for the assessment of rationality raising significant role played by the relationship between the rate of return of funds and size of loan interest. An important issue is the definition of allowable loan rate, at which the rate is not slowing development.

For example, considering the option where i = 0,16 (16%). Calculations are made for the equation obtained after some arithmetic operations:

$$\eta^{10}=0{,}1389\frac{\eta^{10}-1}{\eta-1}\eta.$$

The appropriate calculation for the increase rates, are listed below:

1. η_1=1,05; Δ_1=1,6289 – 1,8342=-0,2052.
2. η_2=1,06; Δ_2=1,7908 – 1,9407= -0,1499.
3. η_3=1,07; Δ_3=1,9671- 2,0533= - 0,0862.
4. η_4=1,08; Δ_4=2,1589 – 2,1684 = 0,0095.

The calculation shows that when taken interest rate borrowing rate does not change. In other words we shall consider the option of involving funds for the development will be appropriate only if the interest rate does not exceed 1,6 times return on assets. If the interest rate is higher, then borrowing will lead to slower growth.

Noteworthy option of interest-free loans (i = 0). In this case, equation (8) takes the following equivalent form:

$$\eta^{T}= (\alpha r+a_F)(1+ \eta+...+ \eta^{T-1})\eta \qquad (9)$$

Quantitative calculation shows that in this embodiment, the growth rate increased to 15%, therefore providing development intensification.

It should be noted that in order to determine the NPV for Option borrowed funds relation (5) is modified:

$$K=\left(\frac{R}{\eta}+\frac{R}{\eta^2}+\cdots+\frac{R}{\eta^T}\right)\frac{\eta}{1+\alpha i} \quad . \qquad (10)$$

The implication is that to determine the NPV using a more complex relation than the discounted cash flow. In equation (10) discounted cash is multiplied by a certain factor, which, in particular, depends on the pace and interest rates in respect of borrowed funds.

In general, we can conclude that the considered method of fixed assets quantitative dynamics, based on the constructed scheme for fixed assets renovation and development as well as the approach to obtain equations for determining the rate of their increase depending on a number of technical and economic parameters shall be considered quite promising. The proposed approach enables a deeper patterns identification of production systems and uses them for the resolution of practical problems, including the choice for financial support and development sources, investment decisions, forecasting and more.

Conclusions. The proposed scheme extended renovation taking into account the dynamics of retirement where fixed assets allows to obtain a quantitative laws regarding the pace of economic growth and assessing the impact of a number of technical and economic parameters of the economic dynamics, that can serve as a basis for forecasting and decision making towards the investment policy of various management levels. We believe, that direct scientific novelty and practical significance are the results on assessing the effect of turnover depreciation influence on the degree of profit's capitalization along with the pace of lending rates. We can also conclude that the practice of calculating the discounted cash flows of capital reproduction requires a sound methodological approach because the monetary funds are driven by more factors than is usually taken to consider when assessing the effectiveness of investment decisions.

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