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MANAGEMENT OF PRODUCTION POTENTIAL CONSIDERING FACTORS OF FIXED ASSETS RENEWAL ON THE BASIS OF MODELING

ABSTRACT

The article considers the approaches to the analysis and management of dynamics of the production potential, in particular fixed assets (FA) dynamics, on the basis of modeling this process. The need for such research arises due to the fact that in economic theory, in general, there are not enough works that would analytically link the rates of production growth, as a result, with the factors that determine it: service life and profitability of FA, depreciation rate, share of capitalized profit. According to the adopted approach, the study is performed in two stages. First of all, the scheme of FA renewal, taking into account constant of their growth rates and the service life is being constructed. In the second stage, an appropriate economic-mathematical dependence is developed and solved. In general, the article uses indicators that are generally accepted in the economic analysis of enterprises. However, both in theory and in practice, this is not related to the results achieved in relation to such a criterion as the growth rate of production. The study allowed to obtain the appropriate analytical apparatus to solve this problem. The use of a developed equation allowed to build an important quantitative dependence between resource parameters and the growth rate of fixed assets. The results are also presented in tabular form and allow to compare the options for the production potential renewal and take them into account when making appropriate managerial decisions. For the first time, a number of economic conclusions are obtained in the article with the help of modeling, which are important and cannot be detected by other methods of analysis. Also, for the first time by approximating the nonlinear rather complex dependence a simple dependence is obtained to calculate FA' renewal and disposal coefficients. That consequently allows determining the components of investment structure, which are used for FA' renewal.

Keywords: production potential, fixed assets, service life, profitability, modeling

JEL Classification: C1, L2

INTRODUCTION

The production potential of enterprises, as well as their components, are undergoing changes at the present stage of economic development. From the point of view of methods of analysis of production development processes, in addition to qualitative assessments of the impact of economic factors on production growth, it is important to have appropriate quantitative assessments of this impact on the dynamics of production potential.

Therefore, the need to introduce new additional indicators, that are related, for example, to the renewal of fixed assets (FA), should be considered an urgent scientific problem. It is also necessary to expand the assessment of the impact of generally accepted indicators, in particular, the time factor, in the transition to innovative economic development. Thus, the concept of assessing the useful service life of fixed assets may change somewhat, for example concerning their reduction. The renovation process is significantly influenced by the time factor, in particular, the features of investment support for the replacement of existing equipment with new ones. Reducing the service life of fixed assets has several limitations. Although the reduction in service life increases the amount of depreciation, it reduces the effect of depreciation turnover. This also

increases the depreciation component of the cost of production and, accordingly, reduces the level of profit, which together with depreciation form an investment resource for the expanded reproduction of fixed assets. The variability of investment flows requires the development of appropriate solutions and managerial decisions of a compromising nature. This compromise can be resolved if we focus on the rate of production potential growth and therefore there is a need to find the appropriate quantitative dependencies. The problem of efficient distribution of profit has also become much more complicated in modern conditions, in particular in the part of it that is directed to capitalization, because in market conditions there is greater variability in the distribution of profits. To optimize this process, it is necessary to have appropriate quantitative methods that could be implemented with the involvement of computer data processing.

It should also be noted that reducing the service life of the equipment and increasing the frequency of its replacement requires additional organizational efforts, increasing changeover of production, periods of mastering new equipment, etc. The assessment of these partial processes should also be attributed to certain economic problems. In general, economic-mathematical modeling should reflect the real economic patterns of the process the FA' renewal, meet the logical considerations and be easy to implement.

LITERATURE REVIEW

The economic literature contains a number of provisions relating to the dynamics of production potential and renewal of fixed assets, as well as aspects of investing in these processes. In the practice of management, methods of depreciation deductions are introduced, the norms of which are closely related to the terms of use of FA facilities. Also, statistical processing of information on the renewal of fixed assets is carried out continuously and the analysis of the relevant parameters of this process is carried out. In a number of scientific publications on the conditions of innovative development, the problem of reducing the service life of FA is relevant. But ideas and proposals require a quantitative analytical justification, which is associated with the development of appropriate models and methods. The developed method of Net Present Value deserves attention, according to which the investment flows, that are necessary for the realization of the investment project, and also a number of parameters of its efficiency are calculated. In essence, the method is based on the use of equations for the dynamics of production and allows its solution in relation to various important parameters, in particular, in terms of reproduction of the use of primary capital expenditures (investments) [1, pp. 504–505]. The method allows comparing different investment projects. But, in our opinion, it does not take into account the innovativeness of these projects, which should be offset by additional restrictions. This method also specifies the volume of production.

For constant production volumes, but the variability of capital investment and current costs of production the reduced costs method is used for the comparison of different investment projects [2]. The essence of the method is that it determines the option with a minimum weighted amount of these costs. In this case, the capital ratio is multiplied by the conversion coefficient and it is taken as equal to the rate of return on fixed assets. But this method is used for the variant of new production and is not adapted to the variant of FA' renewal.

With regard to products, the literature is dominated by static dependencies, which allow determining the volume of production through the value of the involved production resources. These can be, for example, linear dependences or power Cobb-Douglas functions. This power may reflect certain characteristics of technical progress [3].

In statistical functions, there is no time factor and so they need to be modified to the analysis of dynamics of economic processes, including FA renewal.

Directly to the modeling of renewal are referred formulas of the American economist Domar to determine the calculation of the coefficients of renewal, taking into account the growth rate of fixed assets and their service life [4].

In addition to general modeling methods, the economic literature considers many aspects of an applied nature in relation to the development and dynamics of production potential and its functioning. A significant contribution to the development of these issues was made by H. Gersbach et al. [5], I. Kreidych et al. [6], O. Koleshchuk et al. [7], S. Lim et al. [8], I. Pryvarnikova [9], A. Sakhno et al. [10], F. Schulze Spüntrup et al. [11], G. Tarasyuk, N. Valinkevich [12], etc. [13]. Much attention is paid, in particular, to the aspects of reproduction and renewal of fixed assets at the enterprises of the agro-industrial complex, assessment of agricultural FA, increasing the level of technical and technological equipment for agricultural production. In this context, it is advantageous to note works of O. Zakharchuk, M. Mogilova, Y. Lupenko [14; 15; 16], O. Lemishko [17], V. Onegina, Y. Vitkovskiy [18], etc. [19].

We will also consider a number of studies by foreign scientists from the United States, China, Germany, Spain, Greece and other countries, the topics of which to some extent relate to the direction of our research. Thus, the issues of influence on the development of production potential of depreciation and service life of FA are studied in the context of current trends

in production [20; 21; 22]. In particular, it is worth noting the method of assessing the quality of materials for the production of agricultural machinery, which is important in predicting the service life of agricultural machinery [20]. Estimation of depreciation of fixed assets using the depreciation mechanism is also considered [21]. The relationship of the depreciation period with the indicators that characterize the profitability of the firm is studied in the context of the impact of the market environment on the value of fixed assets. The methodological approach is based, in particular, on the Tobin ratio as the ratio of the market value of the company to the replacement value of its assets [22].

New problems of investment support of production potential development are covered by a number of authors. In particular, in the conditions of economic crisis, the need for the renewal of fixed assets in order to provide long-term loans to enterprises with financial problems is developed [23]. The developments presented in the article [24] can be interpreted as an assessment of the relationship between industries in need of investment and the industry that produces the relevant FA. A number of econometric methods are used: VAR model, Granger causality test, etc. Some researchers in the context of forecasting investment flows emphasize the need to take into account the different rates of depreciation for research and development of the US economy and innovation industries, which provide different rates of technological change. At the same time, econometric methods of finding elasticity indicators are used [25].

For Bavarian agricultural production, when estimating the value of land, it is proposed to use a coefficient that characterizes its profitability. The importance of this assessment is that it ensures the optimal distribution of total funds to support farms for their effective development [26].

Researchers are also paying attention to the problems of evaluating the effectiveness of new technologies, such as irrigation systems in Greece. Based on the application of econometric models, the efficiency of these technologies is evaluated and their positive impact on productivity growth is revealed in comparison to the technologies that were used before [27]. Similar studies on the ecological-economic efficiency of irrigation projects have been carried out by Ukrainian scientists [28].

The developments considered in scientific publications to some extent were used by us at the decision of still insufficiently investigated problem – modeling of the interrelation of FA' growth rates with the aggregate influence of indicators set of enterprises' economic activity. The need for such research arises due to the fact that in economic theory, in general, there are not enough works that would analytically link the rates of production growth, as a result, with the factors that determine it: service life and profitability of FA, depreciation rate, the share of capitalized profit.

The aim of the article is to develop approaches to the analysis of the dynamics of production potential, in particular the renewal of fixed assets (FA), on the basis of modeling this process. Therefore, it is necessary to develop the analytical dependence of the growth rate of fixed assets from a number of production factors – service life, their profitability, depreciation rates and the share of capitalized profits, as well as their quantitative interpretation. In management practice, the relevant issues are resolved sporadically, mainly on an intuitive level without a scientific generalization of empirical experience and its broad information coverage.

MATERIALS AND METHODS

In the process of studying the renewal of fixed asset patterns, a number of economic methods of analysis were used, including balance and statistical methods, as well as the method of economic and mathematical modeling. They allow, first of all, to establish the existing causal dependencies between the factors of production. In the future, this enables to use the obtained patterns in order to develop management decisions to improve the efficiency of production. The balance sheet methods are used in the analysis for time and material resources. Together with the time factor, they are used to analyze the movement of the main factors of production – fixed assets and the number of employees. This may be the ratio between the annual growth of fixed assets, newly introduced and withdrawn FA. By dividing them by the base value of resources, the transition to the growth rate of resource factors is obtained. Balance sheet ratios can also take the form of mathematical inequalities. Thus, when calculating the potential, it is necessary to take into account the possibility of their underutilization in some production units. The same applies to the use of other types of resources. It is possible to set the task of incomplete use of funds of the production development fund or its excess, attracting credit opportunities for this purpose. The funds for new fixed assets acquisition are mainly formed by a share of the profit and depreciation, which are directed to the accumulation fund. Thus, with the help of balance sheet methods, a ratio is obtained that determines the coefficient of FA' renewal with the help of parameters that characterize the resource provision of the expanded reproduction of fixed assets. Also, balance sheet methods can be used to determine the growth rate of production depending on the growth rate of the main factors of production. In this case, the desired indicators are different methods: iterative, analytical, as well as using spreadsheets. Therefore, balance sheet methods can be widely used in the

analysis of patterns of renewal of production potential. However, such an application is not always obvious and often requires non-standard approaches. A significant role in the study of real processes is played by statistical methods that allow the use of production data to investigate in quantitative terms the existing causal dependencies. Probability dependencies differ from determined ones so that they allow the assessment of the impact of a number of factors that are not taken into account or cannot be taken into account. These are dependencies that match the expected average value of output to a certain value of resource factors. The deviation from the average value will be greater, the greater the effect of factors that are not taken into account when finding dependencies. It should be noted that balance sheet and statistical methods can be used in combination.

Thus, the study first built a general balance sheet model and then carried out its interpretation using statistical methods based on production data. Calculations in the study of the processes of renewal of production potential were performed using Microsoft Excel, which made it possible to analyze a large amount of economic data.

In general, the article uses indicators that are generally accepted in the economic analysis of enterprises. However, both in theory and in practice, this is not related to the results achieved in relation to such a criterion as the grows rate of production. The study allowed to obtain the appropriate analytical apparatus to solve this problem. The use of a developed equation allowed to build an important quantitative dependence between resource parameters and the growth rate of fixed assets. The results are also presented in tabular form and allow to compare the options for the production potential renewal and take them into account when making appropriate managerial decisions.

RESULTS AND DISCUSSION

The dynamics of production potential are closely related to the processes of FA's reproduction. In the version of simple reproduction, it is considered that the production volumes remain at the same level, and in the extended version – the production volumes change. From the point of view of modeling, it is expedient to investigate the second version of reproduction and to consider the first as a separate case. In the process of reproduction, an important role is played by the renewal and, accordingly, the duration of use of fixed assets, as well as the volume of their introduction and disposal. The process of FA' renewal can be represented in the form of the following (proposed by us) scheme. For the simplest interpretation of the renewal process, we present this scheme for the service life of FA, which is 3 years (and for any value of the growth rate of fixed assets (η)).

t	0	1	2	3	...
	1 →	η^3	η^3	η^3	...
	η	$\eta \rightarrow$	η^4	η^4	...
	η^2	η^2	$\eta^2 \rightarrow$	η^5	...

Figure 1. Scheme of fixed assets renewal

The scheme uses relative values, which do not affect the described process. According to the scheme, fixed assets of unit value serve the last year, after which they are decommissioned and replaced by new ones η^3 . Fixed assets are worth η serve the penultimate year, and then are replaced by fixed assets η^4 . FA value η^2 are new and will be in use still 3 years. It should be noted, that on the *Scheme*, the replacement of FA in the corresponding year is indicated by an arrow.

Below is a specification of the scheme for a ten percent increase in the cost of FA ($\eta = 1,10, T = 3$).

t	0	1	2	3	...
	100.0	133.1	133.1	133.1	...
	110.0	110.0	146.4	146.4	...
	121.0	121.0	121.0	161.1	...
$\sum F$	331.0	364.1	400.5	440.6	

Figure 2. A numerical scheme for fixed assets renewal

According to the Table on the time interval [0;1] FA valued 100 (USD) is substituted by new FA valued 133.1 (USD). The basic value of fixed assets is 331 (USD).

Because of this, the coefficient of fixed assets renewal (K_{ren}) according to the data in the diagram will be equal to:

$$K_{ren} = \frac{133,1}{331} = 0,4021 \quad (1)$$

It should be noted, that for every two adjacent intervals, this value is constant. The value of this coefficient can serve as a guide to determine the need for investment to a renewal of fixed assets of the production system.

The given scheme of FA' renewal reflects essential characteristics of this process in various directions. From the point of view of the time factor, the age structure of FA is reflected. Also, under this scheme, it is possible to investigate proportions between separate age groups of fixed assets. Yes, new FA are worth more than disposal provided under condition $\eta > 1$. Also in terms of the dynamics of the total cost of FA, it is easy to check that over time the total cost of FA changes at a constant pace. The given scheme is generalized for any service life (T) and growth rates of FA (η).

The developed scheme allows determining the number of important indicators that characterize the process of fixed assets renewal. These include, first and foremost, renewal and disposal coefficients.

The coefficient of renewal (K_{ren}) is determined by the following ratio at any FA service life:

$$K_{ren} = \frac{\eta^T}{1 + \eta + \eta^2 + \dots + \eta^{T-1}} \quad (2)$$

This formula coincides with a similar one developed by the American economist Domar [4]. In analytical form we obtain:

$$K_{ren} = \frac{\eta^T}{\eta^T - 1} (\eta - 1) \quad (3)$$

In tabular form, the calculations are presented in *Table 1*.

Table 1. Values of the coefficient of renewal (K_{ren}) depending on service life of FA (T) and their growth rate (η)					
T, η	1.02	1.04	1.06	1.08	1.10
5	0.2121	0.2246	0.2374	0.2505	0.2638
10	0.1113	0.1233	0.1359	0.1490	0.1626
15	0.0778	0.0899	0.1030	0.1168	0.1316
20	0.0612	0.0736	0.0872	0.1019	0.1177

For a constant rate of FA' growth, larger T corresponds to smaller K_{ren} . It can also be concluded that for constants greater η corresponds to larger K_{ren} . For example, the production system includes the active and passive part of the FA, so K_{ren} will be different, although the growth rates of FA will be the same. Note that the interpretation of the effect of η on the K_{ren} is quite complex. But our research on the interpretation of these effects has been simplified by obtaining the following

approximate calculation of the values of the renewal coefficient (K_{ren}):

$$K_{ren} = \frac{1}{T} + 0,63\Delta\eta \tag{4}$$

The numerical data are given in the Table 2.

Table 2. Values of the coefficient of renewal (K_{ren}) depending on service life of FA (T) and their growth rate (η) (according to an approximate formula)

T, η	1.02	1.04	1.06	1.08	1.10
5	0.2126	0.2252	0.2378	0.2504	0.2630
10	0.1126	0.1252	0.1378	0.1504	0.1630
15	0.0796	0.0922	0.1048	0.1174	0.1297
20	0.0626	0.0752	0.0878	0.1004	0.1130

For this dependence the two factors influence is additive – separately T and separately η . Therefore, it is possible to determine the change separately K_{ren} when changing T for 1 year, FA's rate of increase ($\Delta\eta$, where $\Delta\eta = \eta - 1$) on one percent. Moreover, these effects with different changes T and $\Delta\eta$ are added to each other because they have same sign.

An important characteristic of the FA's replacement process is also the coefficient of FA disposal (K_{dis}), which is calculated by the formula:

$$K_{dis} = \frac{1}{1 + \eta + \eta^2 + \dots + \eta^T} \tag{5}$$

If we calculate the sum of the members of the geometric progression, this coefficient is determined as follows:

$$K_{dis} = \frac{\eta - 1}{\eta^T - 1} \tag{6}$$

Between the coefficients of disposal (K_{dis}) and renewal (K_{ren}) following relationships exists:

$$\frac{K_{ren}}{K_{dis}} = \eta^T \tag{7}$$

From there we obtain:

$$K_{dis} = \frac{K_{ren}}{\eta^T} \tag{8}$$

Below is Table of values K_{dis} , using a Table of values K_{ren}

Table 3. The value of the coefficient of disposal (K_{dis}) depending on service life of FA (T) and their growth rate η

T, η	1.02	1.04	1.06	1.08	1.10
5	0.1921	0.1846	0.1774	0.1705	0.1638
10	0.0913	0.0833	0.0759	0.0690	0.0627
15	0.0578	0.0499	0.0429	0.0368	0.0315
20	0.0412	0.0336	0.0272	0.0219	0.0175

Let's calculate the approximate values of the coefficients of disposal by the formula:

$$K_{dis} = \frac{1}{T} - 0,37\Delta\eta \tag{9}$$

Table 4. The value of the coefficient of disposal (K_{dis}) depending on service life of FA (T) and their growth rate η (approximate formula)

T, η	1.02	1.04	1.06	1.08	1.10
5	0.1926	0.1852	0.1778	0.1704	0.1630
10	0.0926	0.0852	0.0778	0.0704	0.0630
15	0.0596	0.0522	0.0448	0.0374	0.0297
20	0.0426	0.0352	0.0278	0.0204	0.0130

Here, there is also an additive influence of factors T and η on the disposal coefficient. But a qualitatively different impact has the growth rate of FA. For larger η at constant T the K_{dis} is smaller. The formula for the approximate definition is obtained by using the balance equation for the growth of fixed assets.

An important issue in the development of production potential is to determine the growth rate of fixed assets with the involvement of factors that determine it. Here, also, an analytical apparatus can be used and a scheme similar to the previously considered. The factors that determine the possibility of the FA' renewal on a self-financing basis include the amount of depreciation and the share of profits directed to the purpose of the FA' renewal. Then the desired dependence will look the following:

$$\eta^T = (\alpha r + a_F) \times (1 + \eta + \eta^2 + \dots + \eta^{T-1}), \quad (10)$$

where α – the share of profit used for capitalization; r – FA' profitability; a_F – depreciation norm.

This equation can be represented as follows:

$$\eta^T = (\alpha r + a_F) \frac{\eta^T - 1}{\eta - 1} \quad (11)$$

It should be noted that the value in the case of using the straight-line method of depreciation is inverse to the fixed assets' service life.

The given equation is not solved explicitly but can be solved by iterative methods. Here is the following example.

May $\alpha = 0.20$, $r = 0.16$, $T = 10$. Let find the expression

$$\alpha r + a_F = 0.032 + 0.1 = 0.132$$

For these data, the equation takes a specific form for any T:

$$\eta^T = 0.132 \times \frac{\eta^T - 1}{\eta - 1} \quad (12)$$

On the first step of the iterative process, we assume η equals 1.03.

Let's compare the left and right parts of the ratio (12):

- the left part is – $1.03^{10} = 1.3439$
- the right part is – $0.132 \times \frac{1.03^{10} - 1}{1.03 - 1} = 1.5132$

The difference of the left and right parts of ratio (Δ_1) will be the following:

$$\Delta_1 = 1.3439 - 1.5132 = -0.1693$$

On the second step of the iterative process, we consider $\eta = 1.04$, and calculate the left and right parts of the ratio and compare them:

- the left part is: $1.04^{10} = 1.4802$
- the right part is: $0.132 \times \frac{1.04^{10}-1}{1.04-1} = 1.5848$

The difference between the left and right part of ratio (Δ_2) will be the following:

$$\Delta_2 = 1.4802 - 1.5848 = -0.1046$$

Continuing the iterative process to calculate η , considering it equals to 1.055. With this value of η , the left and right parts of the equation are as following:

- left part: $1.055^{10} = 1.7081$
- right part: $0.132 \times \frac{1.055^{10}-1}{1.055-1} = 1.6995$

The difference of the left and right par of ratio equals:

$$\Delta_3 = 1.7081 - 1.6995 = 0.0086$$

As the calculation shows, the difference between the left and right parts of the ratio (Δ_3) changed the sign from minus to plus and is very small, so with sufficient accuracy, we can say that for the accepted conditions (share of capitalized profit is 20%, service life of fixed assets 10 years and profitability 16%) the expected growth rate of FA will be equal to 5.5% per year.

Similarly, it is possible to calculate the growth rate of FA for other service life, as well as for a different share of capitalized profit or profitability.

In addition to the iterative method of solving the equation to determine the growth rate of FA, other approaches could be offered, in particular, using the coefficient of renewal. For this purpose, the equation is given in the following equivalent form:

$$K_{ren} = \frac{1}{T} + \alpha r \tag{13}$$

The quantitative table for K_{ren} is already calculated, there is a possibility to obtain values of αr . Appropriate calculations are given below in Table 5.

Table 5. The size αr depending on the service life of the FA (T) and their growth rates η

T, η	1.02	1.04	1.06	1.08	1.10
5	0.0121	0.0246	0.0374	0.0505	0.0638
10	0.0113	0.0233	0.0359	0.0490	0.0626
15	0.0111	0.0232	0.0363	0.0501	0.0649
20	0.0112	0.0236	0.0372	0.0519	0.0677

It should be noted that the αr as content is the result of a division of capitalized profit to the basic value of FA. The analysis of tabular data shows, that at constant service life, the greater αr corresponds to higher growth rate of FA. Therefore, we can assume that this product (αr) determines the volume of FA' growth. To some extent, the impact of service life (as follows from the tabular data) is quite insignificant. In fact, the table in analytical terms is used to solve the problem, the essence of which is to find the value of the growth rate of FA through a known product αr . From Tabular data for $T = 10$ we obtain rate of FA's increase in the amount of 6% for $\alpha r = 0.0363$.

In the direct method of solving the problem by iterative process at $T = 10$ the product αr was 0.032 and caused the FA's growth of 5.5%. In other words, for smaller value of αr corresponds to smaller value of FA' rates of increase. A fairly similar result, as we see, is obtained from the data in the table. If the appropriate smaller step for the table is taken, the results of accurate calculations and tabular data will coincide. Thus, it is possible to use a variant of its tabular solution instead of the equation for the growth rate of FA. This may be important for assessing options for fixed assets renewal in business practice and for making appropriate managerial decisions.

As mentioned earlier, the production potential is significantly determined by such a production resource as fixed assets. In other words, knowing the dynamics of changes in this production resource it is possible to determine the dynamics of production potential.

It should be noted that according to the adopted approach, fixed assets act as a productive resource. The relationship between production and the value of FA is determined by such indicator as the capital productivity. In other words, knowing the value of fixed assets, the production volumes can be calculated unambiguously. If over a certain period of time the capital productivity is unchanged, the growth rate of fixed assets and the growth rate of production will be the same.

We interpret the obtained analytical results on the example of agricultural production. The primary information was the statistical data for the period 2013–2019 on the dynamics of production, fixed assets and profit. Additionally, the annual growth rates of products, FA and current profitability of fixed assets were calculated (Table 6).

Table 6. Dynamics of fixed assets, profitability and agricultural products of Ukraine over 2013–2019

Year	The value of FA (mln UAH)	Rate of FA' growth	Amount of production (mln UAH)	Growth rate of products	Net profit (mln UAH)	FA' profitability (%)
2013	156013	-	196385	-	14984.4	9.6
2014	171392	1.099	286906	1.461	21481.3	12.5
2015	210169	1.226	416620	1.452	102849	48.9
2016	270467	1.287	474884	1.139	90613.2	33.5
2017	341622	1.263	524121	1.104	68858.5	20.2
2018	407146	1.192	616094	1.175	71002.6	17.4
2019	469383	1.153	636661	1.033	93255.4	19.9

Source: compiled on the basis of [29]

The analysis of tabular data showed that the growth rates of fixed assets are quite high, as is the high level of their profitability. According to the developed model (which connects the growth rate of FA with the factors that affect them), other things being equal, the significant influence of the profitability of FA on the rate of their growth is proved. The economic justification here is that the higher profitability of fixed assets provides greater opportunities for increasing capital resources, which are directed to the growth of FA.

The second conclusion is, that on average for the studied period the growth rate of fixed assets is almost the same as the growth rate of production (average annual growth rate of FA is 20.2%, production -21.6%). This indicates the potential for production is closely correlated with the size of such a production resource as FA in the studied period of agricultural development of Ukraine (we can trace the relationship between the value of FA and production volumes with a coefficient of determination $R^2 = 0.9685$).

Therefore, having the models of dynamics of FA' growth for this branch, it is possible to predict with great accuracy the dynamics of growth of volumes of agricultural production. As noted, the average growth rate of FA is about 20%, which should be considered quite significant. According to the analytical approach developed by us, such rates can be achieved only through high profitability of production and a large share of profits aimed at investing in the renewal of fixed assets. But it is also possible to attract additional funds from external sources to invest in production development.

CONCLUSIONS

The performed research allows to make a number of conclusions. In particular, the application of quantitative methods for the analysis of the FA' dynamics makes it possible to identify a complex impact on this process several factors, that determine the growth rate of fixed assets, namely their service life, profitability, depreciation rates and share of profits going to capitalization. Since this is a renewal process, it is also important to take into account the dynamic features of this process, in particular, the disposal of FA and, accordingly, its compensation by new fixed assets. In methodological and theoretical aspects, the developed model allows determining for any set of values of selected factors the corresponding growth rates of FA. This model allows developing management decisions, both strategic and local, for example, the evaluation of investment projects and more. The necessary values of the growth rate of FA, can be obtained in one of three ways: analytical, iterative, as well as through the use of spreadsheets. In general, the developed analytical methods allow solving other important problems. For example, in production practice, which is often characterized by exceeding the

regular life of fixed assets arises the need to assess the economic consequences of such managerial decisions. In the future, the analytical apparatus to some extent needs to be developed for the option of fixed assets renovation in terms of innovative production changes and innovative renewal of FA. At the same time, new factors and effects due to innovations will appear along with the ones that were developed.

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УПРАВЛІННЯ ВИРОБНИЧИМ ПОТЕНЦІАЛОМ З УРАХУВАННЯМ ФАКТОРІВ ОНОВЛЕННЯ ОСНОВНИХ ЗАСОБІВ НА ОСНОВІ МОДЕЛЮВАННЯ

У статті розглянуто підходи до аналізу та управління динамікою виробничого потенціалу, зокрема динамікою основних засобів (ОЗ), на основі моделювання цього процесу. Необхідність такого дослідження виникає у зв'язку з тим, що в економічній теорії загалом недостатньо робіт, у яких пов'язувалися б темпи зростання виробництва з факторами, що його визначають: терміном використання та рентабельністю ОЗ, нормою амортизації, часткою капіталізованого прибутку. Відповідно до прийнятого підходу, дослідження проведено у два етапи. Спочатку побудовано схему відновлення ОЗ із урахуванням постійних темпів їхнього зростання та терміну служби. На другому етапі розроблено й розв'язано відповідну економіко-математичну залежність. Загалом, у статті використані показники, які є загальноприйнятими в економічному аналізі підприємств. Однак і в теорії, і на практиці це не пов'язано з результатами, досягнутими за таким критерієм, як темпи зростання виробництва. Дослідження дозволило отримати відповідний аналітичний апарат для вирішення цієї проблеми. Використання розробленого рівняння дозволило побудувати важливу кількісну залежність між параметрами ресурсу та темпами зростання основних засобів. Результати також представлені у вигляді таблиці й дозволяють порівняти варіанти оновлення виробничого потенціалу та врахувати їх під час прийняття відповідних управлінських рішень. У статті за допомогою моделювання вперше отримано ряд економічних висновків, які є важливими та які неможливо виявити іншими методами аналізу. Також уперше шляхом апроксимації нелінійної, досить складної залежності отримано просту залежність для розрахунку коефіцієнтів відновлення та утилізації ОЗ. Це відповідно дозволяє визначити компоненти структури інвестицій, які використовують для відновлення ОЗ.

Ключові слова: виробничий потенціал, основні засоби, термін служби, рентабельність, моделювання

JEL Класифікація: C1, L2