SECTION 3. ENTERPRISE ECONOMICS AND PRODUCTION MANAGEMENT

DOI: 10.46299/ISG.2023.MONO.ECON.4.3.1

3.1 Optimizing aspects of enterprise's production potential renewal

In the conditions of the transition to a market economy, the requirements for accelerating the technical development of production increase. The renewal of products, improvement of their quality and competitiveness, reduction of manufacturing costs, increase in the cost of labor raise the problem of continuous renewal of the production potential of enterprises. This is a certain dynamic process, the regulation of which must take place taking into account the laws of intensive development of production. Previously, certain cause-and-effect relationships were considered, which related to the growth rates of the fixed assets [72]. Having the appropriate dependencies between these rates and the factors that determine them, one can ask questions about the optimal choice of controlled parameters, such as, for example, the relative size of the accumulation, the service life of fixed assets, and others. Modeling the technical development of a specific enterprise requires, first of all, taking into account its initial economic state, resource possibilities for changing this state. Then there is the problem of choosing the trajectory of the transition to another state of economic development of the enterprise. We will consider the content of optimizing the dynamics of technical development on the following simple example.

We assume that the production system consists of a set of equipment of the same type, which can be replaced by new equipment of higher productivity. At the initial moment of time, the cost of fixed assets, the number of employees, and production volumes are known. The system forms an accumulation fund at the expense of profit, which is used to purchase new equipment. To simplify considerations, we believe that during the renewal process, the number of employees remains constant during the interval of complete renewal of the equipment. Having investment funds at the initial moment of time, we will purchase a certain amount of new equipment. In conditions of a stable number of employees, the amount of equipment that is supposed to be

changed is clearly determined. By way of balance calculations, there is also an increase in fixed means of production and production volumes.

So, in the adjacent time period, a new economic state of the production system is known, which is characterized by similar initial indicators - the new cost of fixed assets, the number of employees and the new production potential in terms of production volumes. With a given rate of accumulation, the process is modeled and analyzed over the entire interval of replacement of existing equipment with new ones. The considered process should be classified as multivariate. There are several controllable parameters here. They include, first of all, the rate of accumulation. By increasing or decreasing the accumulation, a different intensity of renewal is achieved, that is, the period of complete replacement increases or decreases. Accordingly, the dynamics of increasing production volumes and reaching their maximum value, which is determined by the capacity of new equipment, taking into account the given number of employees, changes. The regulation of the update can take place within the limits that are related to the demand for products or other possibilities of their production. If the dynamics of production is specified, then with a constant number of employees, the amount of investment is determined unambiguously. The additional investments here can only be used to substitute workers.

Along with investments, labor resources are the second regulatory parameter, which depends on the dynamics of the technical development of the production system. The increase in the release of workers, other things being equal, is associated with a more intensive renewal of fixed assets.

The possibility of using different new equipment for replacement, which, in particular, differs in cost and productivity, determines the significant variability of the technical development of production. This affects the resource provision of development, the formation of investments, the substitution of workers, the rate of growth of fixed assets and production volumes.

The considered approach to modeling the technical development of production is illustrated by the calculations given in Table 1. According to the source data, at the beginning of the renewal, the production system included 10 units of the same type of

equipment, each of which had a cost of 4 ($F_d = 4$) and a performance of 5 ($P_d = 5$) . A unit of new equipment is characterized by a cost of 8.5 (Fn=8.5) and a productivity of 7 (Pn=7). The investment funds are formed at the expense of 10 percent of the volume of production (α=0.1) and depreciation deductions of 10 percent (αf=0.1) of the cost of the equipment.

Table 1

Technical development of production potential

($F_d = 4$; $P_d = 5$; $F_n = 8{,}5$; $P_n = 7$; $\alpha = 0{,}1$; $a_f = 0{,}1$)

Indicators	Years of equipment replacement				
	1	2	3	…	10
Products	50,00	52,12	54,40	…	72,24
Fixed assets	40,00	44,76	49,89	…	90,04
Investment funds	09,00	09,69	10,43	…	00,00
New equipment	01,06	01,14	01,23	…	00,00
Production growth	02,12	02,28	02,45	…	00,00
Fixed assets growth	04,76	05,13	05,52	…	00,00

Source: own calculations.

The analysis of tabular data shows that in the process of development of the production potential at the beginning of the renowation, the growth rate of production is 4.24 percent, fixed assets - 11.9 percent, investment funds - 7.7 percent. The rate of growth of fixed assets is ahead of the rate of growth of production, and the rate of growth of investment funds is between these two rates.

Let's also consider an example of the development of the production potential, when in the process of renewing the equipment, workers are substituted (Table 2). At the same time, certain growth rates of production volumes are set. In these calculations, these growth rates were assumed at the level of 4 percent.

Table 2

Technical development of production potential with the substitution of employees

$(F_d = 4\ ; P_d = 5; F_n = 8{,}5\ ; P_n = 7; \alpha = 0{,}1; a_f = 0{,}1)$

Indicators	Years of equipment replacement				
	1	2	…	8	9
Products	50,00	52,00	…	65,80	68,43
Fixed assets	40,00	44,67	…	79,38	86,44
Number of employees	10,00	09,98	…	09,47	09,31
Investment funds	09,00	09,67	…	14,52	00,00
New equipment	01,06	01,14	…	1,71	00,00
Production growth	02,00	02,08	…	02,63	00,00
Fixed assets growth	04,67	04,96	…	07,06	00,00
Number of employees growth	- 0,02	- 0,04	…	- 0,16	00,00

Source: own calculations.

As the analysis of tabular data shows, the investment funds ensure not only the specified growth of production volumes, but also the substitution of workers. In the considered time interval, the number of employees decreased by 6.8 percent.

However, it should be noted that there was a significant increase in the main fixed assets. They increased by 2.16 times while the production increased by 1.36 times.

This is explained by the relatively high cost of replacing one worker with fixed assets. We determine the cost of replacement as follows. In the second year of operation of the production system, production volumes increased by 4 percent. With the old technical base, to ensure such growth, it would be necessary to increase fixed assets and the number of employees accordingly. The cost of fixed assets, increased by 4 percent, should have a value equal to 41.6, and the number of employees - 10.4. In fact, in the considered year, the cost of fixed assets is slightly higher, equal to 44.67, and the number of employees is slightly lower - 9.98. To calculate the replacement cost under the condition of stability of production volumes, it is necessary to divide the change in the cost of fixed assets by the change in the number of employees:

$\frac{\Delta F}{\Delta N} = \frac{44,67-41,60}{10,40-9,98} = 7,31,$

where $\Delta F -$ change in the cost of fixed assets;

$\Delta N -$ change in the number of employees.

The obtained value of the replacement cost is quite significant, since it is almost two times greater than the initial capitalization of labor, which is a value equal to 4.

In this version of the technical development of the production potential, in comparison with the version in which the number of employees remains stable, along with lower rates of growth of production volumes, there is a slight decrease in the rates of growth of fixed assets and investment funds. At the beginning of the renewal, the growth rates of fixed assets are 11.67 percent, and investment funds are 7.4 percent. That is, the growth rates of fixed assets and investment funds decreased slightly.

Let's consider the option of development of the production potential with a larger share of accumulation, that is, when α=0.2; αf=0.1. The corresponding calculations are presented in Table 3.

Table 3

Technical development of production potential with the replacement of employees

$F_d = 4$; $P_d = 5$; $F_n = 8,5$; $P_n = 7$; $\alpha = 0,2$; $a_f = 0,1$

Indicators	Years of equipment replacement				
	1	2	…	5	6
Products	50,00	52,00	…	58,49	60,83
Fixed assets	40,00	46,38	…	68,10	76,29
Number of employees,	10,00	09,74	…	08,76	08,36
Investment funds	14,00	15,04	…	18,51	00,00
New equipment	01,65	01,77	…	02,18	00,00
Production growth	02,00	02,08	…	02,34	00,00
Fixed assets growth	06,38	06,79	…	08,19	00,00
Number of employees growth	- 0,26	- 0,29	…	- 0,40	00,00

Source: own calculations.

The calculations carried out for two variants of the share of accumulation show that increasing the value of α by two times leads to a decrease in the renewal period from nine to six years (Table 3). With a smaller share of accumulation (at α = 0.1), 6.8 percent of the workforce that was at the beginning of the replacement will be substituted by the end of the replacement. In the second version of accumulation, 16.5 percent of the initial workforce will be replaced by the end of the update. The relationship between accumulation and release is shown in tables (4–7). A characteristic feature of this dependence is that the relacement increases to a certain limit. A further increase in the fraction of accumulation does not lead to a noticeable increase in replacement. Thus, from the data in Table 4, it can be seen that an increase in the share of accumulation from 0.3 to 0.4 has almost no effect on the absolute value of the replacement of employees. A similar conclusion follows from the analysis of other tabular data. As can be seen from Table 6, it is irrational to increase the share of accumulation above 0.37 when manual labor is replaced by machine labor. The effective accumulation limit is significantly reduced for production links where more productive equipment is used for renewal. It should also be noted that the calculations were carried out assuming a constant annual growth rate of production, which is equal to 4 percent. The analysis of tabular data shows that for production links in which the update is carried out under the condition of equality or superiority of performance indexes compared to equipment cost indexes, the level of absolute replacement is much higher (tables 6, 7). This is explained by the fact that replacing the labor of one worker here does not require additional fixed assets.

Table 4

Indicators of renewal of fixed assets in dependence from the savings share with $P_n = 7$

Savings share (α)	Renewal period (years)	Release of employees during renewal
0,1	9	0,68
0,2	6	1,65
0,3	5	2,30
0,4	4	2,40

Source: own calculations.

Table 5

Indicators of renewal of fixed assets, depending on the savings share with $P_n = 7$

Savings share (α)	Renewal period (years)	Replacement of employees during renewal
0,17	8	1,06
0,27	6	2,00
0,37	5	2,57
0,47	4	2,60

Source: own calculations.

Table 6

Indicators of renewal of fixed assets, depending on the savings share with $P_n = 10{,}63$

Savings share (α)	Renewal period (years)	Replacement of employees during renewal
0,05	8	3,64
0,10	6	4,30
0,20	5	4,54

Source: own calculations.

Table 7

Indicators of renewal of fixed assets, depending on the savings share with $P_n = 15$

Savings share (α)	Renewal period (years)	Replacement of employees during renewal
0,05	6,5	6,01
0,10	5,0	6,35
0,20	3,5	6,45

Source: own calculations.

The considered examples of the technical development of production show, that even with the same new technical means, there may be different trajectories of the enterprise's transition to a new economic state. Different growth rates of production volumes, fixed assets, and the number of employees can be achieved. Of course, the amount of investment funds that the enterprise can allocate for the implementation of measures for the technical development of production is of significant importance. Although these funds, as a rule, are limited, there is a variant of their distribution both in the directions of technical development and in individual components of the production system.

We can offer the following methodological approach to optimizing the distribution of investment funds between separate production units, in each of which there can be talk concerning the renewal of the existing equipment with more progressive one. First of all, one should take into account the fact that there are certain proportions between the volumes of production by individual links, since the entire production system has a single material flow and the presence of appropriate technological connections is assumed. If at the beginning of the development of the production system, the production potential of individual links did not have bottlenecks, then in further development they should grow at the same pace. With the exception, of course, of situations where nomenclature shifts are made in manufactured products. In this case, the rates of growth of the production potential in individual sectors will differ among themselves.

For each of the production units, taking into account the given growth rates of production volumes, it is necessary to calculate several options for updating the equipment, which will differ in the size of the allocated investment funds and the replacement of employees during the very period. The size of investment funds is determined by their share in the total mass of investment funds. Thus, if one uses, for example, computer tools, the dependence of the replaced workers on the relative share of the accumulation can be obtained. Moreover, both the independent variable and the dependent variable can be defined with any discreteness interval. As a result of calculations, in accordance with the number of links, we will obtain a whole set of dependencies.

The resulting dependencies should be used to set optimization problems for the distribution of investment funds. The optimization criterion can be, for example, the maximization of the workers' replacement. If the development of production is to be carried out with a constant number of employees, it is advisable to take the minimization of investment funds as an optimization criterion. That is, we are talking about achieving, in the course of technical development, predetermined rates of growth of production volumes with the lowest costs of capital investments. The optimal solutions here will be related to the redistribution of workers between individual production units. If necessary, additional restrictions on the movement of workers within the enterprise can be introduced into the problem statement. The considered problem is solved by applying the methods of mathematical programming with use of different software.

It should be noted that the introduction of new equipment leads not only to a decrease in the labor intensity of products, but also to a decrease in other costs for its production. The specific consumption of materials and energy may decrease. An important point is also taking into account production areas for the operation of new equipment. Minimizing the growth of production areas can also be one of the criteria for optimizing the technical development of the production potential of the enterprise.

Here, it is also advisable to take into account the possibilities of expanding production areas in individual production divisions of the enterprise.

At the given rate of growth of production volumes, the criterion of optimization can be the achievement of the minimum production cost. This indicator accumulates the entire range of (sometimes multidirectional) components of the aggregate of production costs. The introduction of new equipment and technologies, as a rule, is aimed at reducing the cost of production, although at the same time its capital intensity may increase.

The size of the cost price significantly affects the amount of profit, which in turn is the main source of investment funds. The ratio of the amount of accumulation to the cost of fixed and working capital determines the rate of development of the production potential. At a constant share of accumulation, the profitability of fixed assets is of significant importance, which also affects the technical development of production.

The real scale of accumulation can be concluded by analyzing, for example, the activities of industrial enterprises of Ukraine for the period: 2016-2021 (table 8).

Table 8

Relative savings and efficiency of fixed assets enterprises of Ukraine in 2016-2021

Years	Relative savings	Profitability of fixed assets, %
2016	0,0344	0,363
2017	0,0464	2,182
2018	0,0490	3,000
2019	0,0548	5,471
2020	0,0377	0,643
2021	0,0525	8,664

Source: compiled from [73, 74, 75]

The analysis of the development of domestic enterprises shows that, in general, the relative savings, which is characterized by the ratio of funds for the purchase of new fixed assets to their basic value, as well as the efficiency of fixed assets, calculated by the indicator of their profitability, have a positive upward trend. It should be noted that for complex production systems of the concern type, which are technologically closely related to each other, it is important to create a common savings fund.

The rational distribution of this fund between individual enterprises would ensure the maximum overall effect.