

Digitalization of the technological development management process of the Russian economy

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Abstract — To accelerate the pace of economic growth in Russia, technological modernization of production is necessary, but an appropriate mechanism must be developed for the digitization of its implementation management. The modern economic theory of endogenous economic growth does not allow one to proceed to the substantiation of the quantitative aims of technological development of production systems compatible at the macro, meso and micro levels of management, and without them any developed strategy of such development is ineffective. Accordingly, in practice, many unrelated target indicators are used to assess the use of technological innovations. To solve the above problem, it is proposed to use the terms of the developed new direction of economic analysis of the production systems (investment and innovation): investment and innovation leverage, a matrix of directions for the development of production systems depending on the efficiency of the resources used, the life cycle of the technological development of production systems and indicators of the stages of technological development: coefficient of the level of technological production, material return and capital productivity of production, calculated in the same way for all levels of management of the economy of the country and the regions of the Federation. As a result, an algorithm for real achievement of target values of interrelated indicators set by the production system in the process of finding out a retrospective investment and innovation analysis and the subsequent process of technological and economic forecasting and planning has been developed on a theoretical and methodological basis, which makes it possible to digitize the management of technological modernization.

Keywords — *economic growth, technological modernization, production system, indicators of technological development, investment and innovative analysis, coefficient of the level of manufacturability of production.*

I. INTRODUCTION

The formation of the digital economy in Russia is a leading factor in ensuring the further socio-economic development of the country [1]. At the same time, the informatization of the process of managing the development of production systems becomes an essential aspect of digitalization.

To enter the top five most developed countries in the world in terms of GDP and a significant increase in the level of well-being of the country's population, high rates of economic growth and a significant increase in labor productivity are necessary. The existing export-raw material model of the functioning of the Russian economy does not allow for this, therefore restructuring of the economy is necessary, the main element of which should be technological modernization of production development.

In the "Strategy of the scientific and technological breakthrough of Russia", the authors note that "the scientific and technological factor remains" not only the most important, but also the only engine of economic growth [2, p. 28], however, "the logic of the scientific and technological breakthrough is not spontaneous, but manageable and is not the" invisible hand of the market "... Here, the directing hand of the state is needed, a long-term state strategy based on scientific forecasts and strategies for using objective development patterns" [2, p. 15]. Accordingly, for the effective implementation of any strategy, it is necessary first of all to set realistic targets, that is, goals that quantify the relevant targets.

Unfortunately, the modern economic theory of a market economy does not allow to answer the question about the possibility of a formalized display of goals in the form of any indicators in the implementation of scientific and technological progress at the macro, meso and micro levels of economic systems. Since the mid 80s of the last century, foreign scientists have been actively developing the theory of endogenous economic growth, which replaced the neoclassical theory of exogenous economic growth, since the most important factor of economic growth in modern conditions — technical progress — in neoclassical models is an externally given parameter [3]. At the same time, endogenous economic growth depends on human economic activity [4]. In its development, the theory of endogenous economic growth went through several stages (periods). At the first stage, the developed models [5] used human capital and the external effect of training as an internal source of economic growth, but the models of the second stage focused on explaining the impact on economic growth of technical progress and the implementation of innovation (Research & Development models) [6 7]. At the same time, the positive impact on the economic growth of the state economic policy, stimulating the introduction of innovations, as well as the influence on decision-making in the field of economic development of individual economic agents, including companies, is considered. This made it possible to bring the models closer to practical reality, since it became possible to check the theoretical background laid down in the models on real statistical materials. However, one of the most important problems in the theory of endogenous economic growth is still the problem of combining the solutions obtained at the micro, meso and macroeconomic levels of the economies of states [8].

II. RESEARCH METHODOLOGY

A significant contribution to the methodology for assessing the impact of scientific and technological progress (NTP) on the development prospects of individual branches of the USSR economy and the country's economy as a whole in the 80s of the last century was made by the studies of famous scientists Acad. A.I. Anchishkina [9], acad. S.Yu.Glazyev [10] and Acad. V.A. Trapeznikova [11]. So, Acad. V.A. Trapeznikovym to evaluate the influence of NTP on the development of complex systems proposed to use the indicator "level of knowledge and skills" [12, p.77], which, firstly, characterizes the level of knowledge accumulated in the relevant economic system (industries) and secondly, the qualification level of managers at all levels of the management hierarchy. Unfortunately, in practice this indicator did not become widespread due to the lack of a methodological and statistical basis for its calculation at the level of enterprises and industries.

It should be noted that, to date, the problem of evaluating the effectiveness of the use of technological innovations has been poorly studied, so this assessment is rarely used in managing innovations, including in the development of innovative strategies [13]. Under current circumstances, in foreign countries and in Russia, a diverse system of indicators [14,15] is used to display the level of innovation in the technological development of production systems, including the amount of expenditure on research and development, the number of patents received, the share of sales of innovative products in total sales the number of developed and implemented new technologies, etc. So, in the work of German scientists M. Dziallas and K. Blinda [14] based on the analysis of publications on indicators-indicators of innovative activity of foreign firms from 1980–2015 showed that 82 indicators are used as ones, including 26 in the early stages of the process of developing and implementing innovations. Accordingly, the authors of the article note that more specific indicators are needed to improve innovative solutions. However, many experts believe that such indicators should be indicators of the effectiveness of the use of innovations [16,17], but there are also a lot of them, therefore the effectiveness criteria are proposed to rank with the formation of a hierarchical structure [18].

Thus, the problem of choosing one or several interrelated indicators for managing the use of technological innovations is still not solved in the world in theory and in practice. As a result, even in the one adopted in accordance with the Decree of the President of Russia V. V. Putin №642 of 12/01/2016 "Strategies for the scientific and technological development of the Russian Federation" did not set specific quantitative goals, except for the need to increase research and development costs to 2% of GDP, which is not an indicator of efficiency, so this strategy, like many national and regional strategies remain a set of good wishes.

Accordingly, the state should ensure the implementation of a focused policy of technological renewal of production potential, using the capabilities of the sixth technological order [19], but without concrete targets and a political commitment to achieve them, the current economic policy of the Government of the Russian Federation in this direction will be ineffective.

The President of the Free Economic Society of Russia, prof. S.D. Bodrunov notes in his monograph "Noonomics", that in order to isolate qualitatively new technologies, "some tools are needed to assess the prospects for the development of specific technologies in terms of their compliance with the criteria requested by the NTP" [20, p. 152]. During the study [21] we showed for *the first time* that an indicator reflecting the influence of scientific and technical progress on the economic efficiency of resources used by enterprises — material, labor and physical capital in the form of fixed assets — can be the coefficient of the level of production manufacturability. It is defined as the ratio of the capital intensity of production to the material intensity of products manufactured by enterprises or as the ratio of material return to capital productivity. The quantitative value of this ratio for each enterprise may increase or decrease. Obviously, it is desirable to increase the value of this coefficient with a corresponding decrease in the level of material consumption of products, which increases the company's contribution to the growth of the gross regional product of the regions of the Federation of Russia and the gross domestic product of the country, as this increases the share of value added in the company's sales. and, therefore, the total gross value added of the regions and the country as a whole. At the same time, an increase in capital productivity is an intensive factor in the growth of labor productivity, in contrast to an increase in the level of capital-labor ratio, which is an extensive factor; therefore, it is more preferable from the point of view of increasing the efficiency of using limited resources in the economy.

The absolute value of the coefficient of the level of manufacturability of production depends on the level of the capital-labor ratio of the enterprise or industry. The increase in its value mainly depends on the degree of renewal of the active part of the fixed assets of an enterprise (machinery and equipment, vehicles), that is, in essence, on the level of knowledge invested in the production of new equipment and technology, but it is obvious that the effectiveness of the activity of the employees of the enterprise management system the same should influence, albeit to a lesser extent, the change. Thus, the indicator of the level of knowledge and skills proposed in the 1980s by Acad. V.A. Trapeznikov, by the economic sense, almost completely coincides with the coefficient of manufacturability of production proposed by us, that is, both these indicators determine the quantitative assessment of the impact of technical progress on the development of enterprises. However, our second indicator, in contrast to the first one, has a simple quantitative calculation both at the level of an individual enterprise and at the level of the industry or type of economic activity of the region and the country as a whole, since the indicators of material intensity and capital intensity required at all levels of management are reflected in relevant statistics. As a result, there is an opportunity for *goal-oriented* management of the technological development of enterprises, industries, the economy of the regions and the country as a whole, that is, at the micro, meso and macro level.

III. RESULTS OF THE RESEARCH

We developed the foundations for a new *investment and innovation direction of economic analysis* of production systems in the studies [22,23]. The direction introduced into science and showed *new* concepts of investment and innovation leverage, the technological efficiency level of production, the analytical relationship between indicators of capital intensity of production, material intensity of production and labor productivity. On this basis, a matrix of possible directions of technological development of production systems has been developed depending on the efficiency of use of production resources — labor, material and physical capital in the form of fixed assets, as well as a graphical model of the life cycle of technological development of such systems.

The results of a new theoretical and methodological approach to managing the technological development of production systems were tested on the example of analyzing statistical data on production development by the types of industrial activity of all regions of the North for the period 2005-2016, as well as on the basis of public accounting data of large industrial enterprises. "Alrosa" AK, "Kola Mining and Metallurgical Company" JSC, "Severalmaz" JSC, "Kovdorsky GOK" JSC, "Apatite" JSC for the period 2005-2017.

The matrix of possible directions for the development of production shows [22] that the best direction for technological development of production systems from four possible is an innovative and effective direction, when material consumption of products decreases simultaneously, the level of capital productivity of fixed assets of an enterprise increases, and mainly due to this, labor productivity increases.

This matrix allows to form the life cycle of technological development of production systems, each stage of which determines the improvement or deterioration of the use of certain types of economic resources through changing the values of material intensity, capital productivity and labor productivity [24]. Accordingly, in the direction of changing the values of indicators (material return, capital productivity and coefficient of the level of manufacturability of production), you can determine the stage of technological development, as well as the need and the possibility of transition to the best stage, when the values of material return, capital productivity and productivity increase simultaneously. The main indicator is the coefficient of the manufacturability level. As a result, it becomes possible to simultaneously control the process of technological and economic development of production systems and the *digitalization* of this process when carrying out the investment and innovation analysis proposed by us.

IV. DISCUSSION OF RESULTS

This analysis should be carried out on the basis of retrospective statistical data for the activities of enterprises and industrial sectors of the country's economy for three to five years. As a result, there is a tendency to increase or decrease the value of the coefficient of the manufacturability level of production or the absence of a pronounced tendency. From the point of view of theory, in any production system there should be an increase in the values of this coefficient, therefore the absence of growth means a low degree of controllability of the system development process. Accordingly, in this case, the

prospect should raise the coefficient, but the question arises, to what level and in what time period? The possible answer in any case is determined by the withdrawal of financial resources that the system can generate for its development, but this volume must first be determined. If the production system is not a leader in the implementation of technological innovations, then the target value of the coefficient of the level of manufacturability of production can be taken its value, which has a similar system, which is the leader in the field of technological renewal. However, it should be remembered that a high value of the coefficient of the production manufacturability level may be in the case of both low values of material return and capital productivity, which, by the way, is typical for Russian industry in relation to the industry of developed countries. Thus, the second target benchmark should be material return or material intensity of production, the value of which is the system-leader. Then, on this basis, the required value of capital productivity is calculated, and further, depending on future sales, the volume of fixed assets and the corresponding required volume of investment in fixed assets. As a result, possible real sources and volumes of investments are determined to be maintained by the system during the considered period of time with a normal level of financial stability. Accordingly, if it turns out that the required amount of investment is impossible to obtain, then the desired target values of the coefficient of the level of manufacturability of production and material return should be reduced and the procedure of calculations under consideration should be repeated. Such calculations can and should be performed for each year of the forecast or planned period of time.

Thus, the direct problem of assessing the economic efficiency of investments in technological innovations is solved, but there is also an inverse problem, which in practice, as a rule, is not solved. As a result, it turns out that many technological innovations introduced into production are not effective, that is, they do not increase the profits of the production system. The fact is that the methodology for evaluating the effectiveness of the implementation of investment projects used in Russia and abroad ensures the selection of the best project or project option for a positive value of net present value (NPV) and maximum internal rate of return (IRR) [25,26] but when calculating the sum of the net discounted effect, as a rule, the existing values of resource efficiency indicators of the system in which the investment project is supposed to be implemented, that is, material output, are not taken into account, capital productivity and labor productivity. As a result, it may turn out that the values of all these indicators for an investment project or individual ones may be lower than those already achieved by the system. To prevent this from happening, it is necessary to calculate the level of capital productivity, which the system intends to achieve in the case of the project in question in the respective year, a prospective period of time and on this basis make the final decision on the feasibility of the project. If an investment and innovation analysis is carried out in the system, it is easy to accomplish when solving the first (direct) task. Otherwise, the lower limit of the level of capital productivity will be its level already achieved by the system.

Thus, the management decision-making process for technological upgrading of production systems at any level of

the management hierarchy (enterprise, industry, region, country) can be algorithmized and implemented as a digital model.

V. CONCLUSIONS

1. In order to accelerate the growth rate of the Russian economy, technological modernization of production is necessary, and more efficient management of the introduction of technological innovations is possible through the digitization of this process.

2. Modern economic theory of endogenous economic growth does not allow to quantitatively and unambiguously determine the impact of technical progress on increasing the efficiency of production systems at the macro, meso and micro levels, so in practice a wide variety of indicators is used to assess the impact of technological innovation on their activities.

3. We have developed the basics of a new direction of economic analysis of the production systems: investment and innovation, in which the main indicator of technological development of production systems is the coefficient of the level of technological production, calculated uniformly according to the statistical reporting at the macro, meso and micro levels as the ratio of material return to capital productivity.

4. The shortcomings of the existing methodology for evaluating the effectiveness of investment projects in terms of their lack of reference to the indicators of the resource efficiency of production systems in which projects are to be implemented are noted.

5. As a part of an investment and innovation analysis, an algorithm has been developed to really achieve the level of target indicators set by the production system (coefficient of production manufacturability, material return and capital productivity, and labor productivity as a result) in the process of technological and economic forecasting and planning, what allows to perform the digitalization of this process.

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