Target Orientation of Technological Modernization of the Arctic Industrial Companies

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Abstract. The territory of the Arctic zone of the Russian Federation is the most important source of raw materials for the country's economy but for further efficient industrial exploitation of the Arctic resources for the enterprises operating there a significant increase of labor productivity is required due to the use of the latest equipment and production technology. This is hindered by the lack of a system of technological modernization targeting of enterprises. Modern economic theory of endogenous economic growth does not allow proceeding to the substantiation of the quantitative goals of the technological development of enterprises. Accordingly in practice many unrelated target indicators are used to assess the use of technological innovations. It is shown that an indicator reflecting the impact of scientific and technological progress on the economic efficiency of resources used by the enterprises - material, labor and physical capital in the form of fixed assets can be the "coefficient of production manufacturability level". Its values are calculated at the macro, meso, and micro levels according to statistical reporting and achieved values at the best enterprises of the industry can be used as target values when introducing technological innovations at the enterprises. It is determined that the growth of the coefficient of production manufacturability level is directly related to the renewal of the active part of fixed assets and the growth of the efficiency of capital of enterprises leading to an increase of labor productivity. The direction of technological development of the enterprises which simultaneously increases material efficiency, efficiency of capital and labor productivity is shown.

1. Introduction

For the country's economy the territory of the North and the Arctic regions has historically been the main base for the extraction of mineral raw materials, fuel and energy resources [1, 2]. In almost all the Arctic regions of the Federation the predominant share of the gross regional product is the extraction and primary processing of minerals. Resources concentrated in onshore fields are gradually depleted (mainly oil and gas fields). Geological exploration which is currently being actively carried out on the shelf of the northern seas shows the presence of new large oil and gas fields. At the same time the main industrial infrastructure for the exploitation of the fields has already been created since the exploitation of mineral resources located in the Arctic zone of the Russian Federation (AZRF) was carried out by the development of Federation subjects located in this zone with the attraction of labor resources from other regions of the country. Accordingly science and education were actively develop-

ing in the Arctic regions. A network of regional scientific centers of RAS has been created. Most of the Federation subjects have universities on their territory that train highly qualified personnel including in the specialties that will be required for the further exploitation of the Arctic. State policy is also aimed at the development of the Arctic regions since the Arctic has an important geopolitical location to ensure the country's defense.

However, the mentioned above favorable opportunities for further exploitation of the Arctic are limited by the following circumstances. First, exploitation of the northern sea shelf requires further socio-economic development of the Russian Federation subjects located in the AZRF what means further development of industry in these areas and on an innovation basis [3, 4]. For example it will allow solving the long-standing problem of complex use of mineral raw materials.

Second, the state despite the Federal Law "On Industrial Policy in the Russian Federation" adopted in December 2014 has not yet developed effective measures to stimulate innovation industrial development, for example, in the framework of long-term investment contracts with enterprises that are considered in this law. In opinion of the authors, for innovatively active industrial enterprises located in the regions of the Russian Arctic it would be possible to allow the use of the system of "quasi self-financing" [5] under terms of a private-state partnership. However, it is hindered by the lack of clear guidelines of the state and enterprises for innovation technological development that is goals that must be achieved. Accordingly, the aim of the work is a theoretical and methodological understanding of the possibility of setting such goals on the example of using the resources of the Arctic regions.

2. Research methodology

Modern economic theory of a market economy does not allow answering the question about the possibility of a formalized display of goals in the form of any indicators when implementing the achievements of scientific and technological progress at the macro, meso and micro levels of economic systems. Since the mid of 80-s 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 terms — technical progress — in neoclassical models is an externally given parameter [6]. At the same time endogenous economic growth depends on human economic activity [7]. In its own development the theory of endogenous economic growth have passed through several stages (periods). At the first stage, the developed models [8] used human capital and the external effect of learning as an internal source of economic growth but the models of the second stage focused on explaining the impact of technological progress and the implementation of innovations on economic growth (models «Research & Development») [9,10]. At the same time the positive impact on economic growth of the state economic policy stimulating the introduction of innovations as well as the influence on making decisions in the field of economic development of individual economic agents, including firms is considered. This made it possible to bring the models closer to practical reality since it became possible to check the theoretical premises established in the models on real statistical materials. However, until now one of the most important problems in the theory of endogenous economic growth is the problem of combining the solutions obtained at the micro, meso and macroeconomic levels of the economies of countries [11].

Active research of the influence of scientific and technological progress on the development of the economy of the country and its individual industries was carried out in the 80s of the 20th century by various teams of scientists in the USSR [12, 13], including academician V.A. Trapeznikov and his colleagues. At the same time, in particular, V.A. Trapeznikov proposed an indicator defining the rate of scientific and technological progress (STP) in the country's economy which he called the indicator of "level of knowledge and skills" [14]. Its value is determined by the level of knowledge accumulated in the relevant industry and management skills to use them. In [14] on example of STP development in pipeline transport of the USSR it was shown that this indicator as a STP rate depends on the growth rate of labor productivity (LP) and the rate of decline of the capital-labor ratio (CLR), that is, actually depends on the growth rate of efficiency of capital (EC). Unfortunately the indicator under considera-

tion was obtained when transforming models of economic growth based on the apparatus of production functions and therefore it was not considered at the level of individual enterprises.

It should be noted that so far the problem of assessing the effectiveness of use of technological innovations has been poorly studied so this assessment is rarely used in the management of innovations, including in the development of innovation strategies [15]. Under current circumstances in foreign countries and in Russia a diverse system of indicators [16, 17] is used to show the level of innovation in technological development of production systems, including the amount of expenditures on research and development, the number of patents received, the share of sales of innovation products in total sales, the number of developed and introduced new technologies, etc. Thus, in the work of German scientists M. Dziallas and K. Blind [16] based on the analysis of publications on indicators of innovation activity of foreign firms for 1980-2015 it was shown that 82 indicators, including 26 in the early stages the process of developing and introducing innovations are used as indicators. Accordingly, the authors note that more specific indicators are needed to improve innovation solutions. At the same time, many experts believe that such indicators should be indicators of effectiveness of innovations use [18, 19] but there are also a lot of them, therefore the effectiveness criteria are proposed to be ranked with the formation of a hierarchical structure [20].

In [21] the authors for the first time showed that the indicator reflecting the influence of scientific and technological progress on the economic efficiency of resources used by enterprises - material, labor and physical capital in the form of fixed assets can be «coefficient of production manufacturability level» (k). It is defined as the ratio of capital-intensiveness of production (CI) to material intensity of products manufactured by enterprises (MI) or as ratio of material efficiency (ME) to efficiency of capital (EC). The quantitative value of this coefficient 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 intensity of products what increases the company's contribution to the growth of the gross regional product of the regions of the Russian Federation and to the gross domestic product of the country. It increases the share of value added in the company's sales and the total gross value added of the regions and the country as a whole. At the same time, an increase of efficiency of capital is an intensive factor of the labor productivity growth in contrast to an increase of the capital-labor ratio which is an extensive factor. Therefore increase of efficiency of capital is more preferable from the point of view of increasing the efficiency of using the limited amount of resources in the economy.

The absolute value of coefficient of production manufacturability level depends on the level of the capital-labor ratio of an enterprise or industry. The increase of its value mainly depends on the renewal degree of the active part of the fixed assets of an enterprise (machinery, equipment and vehicles), that is, on the level of knowledge invested in the production of new equipment and equipment but it is obvious that the effectiveness of the employees activity of the enterprise management system also should influence this change although to a lesser extent. Thus, the indicator of the level of knowledge and skills proposed in the 1980s by academician V. A. Trapeznikov, by economic sense almost completely coincides with authors' coefficient of production and manufacturability level, that is, both indicators determine the quantitative assessment of the impact of technological 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-intensiveness required for the calculations are reflected in the relevant statistical data at all management levels. As a result there is an opportunity for target 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.

3. Results and discussion

In [21] authors developed the fundamentals of a new direction of economic analysis of production systems - investment and innovation analysis in which new concepts of investment and innovation leverage and the coefficient of production manufacturability level were introduced and the analytical

relationship between indicators of capital-intensiveness of production, the material intensity of products and labor productivity was determined. On this basis a matrix of possible directions of technological development of production systems depending on the efficiency of use of production resources — labor, material and physical capital in the form of fixed assets was developed.

In [22] the authors showed that three indicators (k, MI and EC) depending on the direction of change of their values (increase or decrease) are indicators of four possible directions for the development of industrial production and two variants of two directions. The best is the first version of the first direction (innovation-effective) when the values of all indicators simultaneously increase. On this basis in [23] the authors presented a graphical model of the production technology life cycle. It allows to determine the prospects of technological renewal of production and the need for future actions of the authorities of enterprises to introduce technological innovations since, first, all indicators are quickly and simply calculated in the dynamics according to the accounting (financial) statements of enterprises. It allows on the one hand to identify the trend of changes of values of the coefficient of production manufacturability level k and on the other hand to determine the direction number and the variant of the development of the enterprise and their sustainability during the analyzed period of time. Second, it is possible to compare the obtained results with other enterprises of the industry and identify the leading enterprise in the implementation of technological innovations. In this case the value of the k coefficient as well as the ME and EC values of this enterprise can be targeted for other enterprises of the industry but for the leading enterprise the values of these indicators achieved by similar enterprises in developed countries can be used as target values. Third, based on the need to achieve the target values of the k coefficient and the material intensity indicator as the inverse of the material efficiency, the determined target value of the efficiency of capital indicator can be, on the one hand, the basis for determining the target value of labor productivity indicators, and, on the other hand, it allows to calculate, depending on the achievement of the required volume of production and revenue from sales of products, the future volume of fixed assets of the enterprise and hence the amount of necessary investments in main capital. Further, based on the existing value of the financial leverage coefficient a possible additional amount of borrowed capital is determined in the form of bank loans and (or) the required amount of financial assistance from the state or from regions of the Russian Federation including in the form of “quasi self-financing” under terms of public-private partnership of relevant investment contracts.

The results of a new theoretical and methodological approach to the management of the technological development of production systems were tested on the example of analyzing statistical data of production development by type 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, JSC Kola MMC, JSC Severalmaz, JSC Kovdorskiy, JSC Apatit for the period 2005-2017.

Considered investment and innovation analysis should be carried out on the basis of retrospective statistical data of 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 of the values of the coefficient of production manufacturability level or the absence of a strong tendency. From the point of view of theory any production system there should have an increase of 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 for the prospect should be set to increase the coefficient but there is a question - to what level and in what time period? A possible answer is in any case is determined by the amount 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 production manufacturability level can be the value which has a similar system which is the leader in the field of technological renewal. However it should be borne in mind that a high coefficient of production manufacturability level can be in the case of both low values of material efficiency and efficiency of capital which is typical for Russian industry in relation to the industry of developed countries. Thus the second target should be material efficiency or material intensity of production which value has the leading system. Then on this basis the required

value of efficiency of capital and further, depending on future sales, the volume of fixed assets and the corresponding required volume of investments in fixed capital is calculated. As a result a 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 appears that the required amount of investment cannot be obtained then the desired target values of the coefficient of production manufacturability level and material efficiency should be reduced and the calculation of the considered procedure should be repeated. Such calculations can and should be performed for each year of the forecast or planned period of time.

Thus the direct task of assessing the economic efficiency of investments in technological innovations is solved but there is also an inverse task which in practice, as a rule, is not solved. As a result it appears that many technological innovations introduced into production are not effective that is they do not increase the profit 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 variant by a positive value of net present value (NPV) and maximum value of internal rate of return (IRR) [24, 25], 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 efficiency, efficiency of capital and labor productivity are not taken into account. In result it may appear that the values of all these indicators of an investment project or some of them may be lower than those ones already achieved by the system. To prevent this from happening it is necessary to calculate the level of efficiency of capital which the system is going to achieve in the case of the considered project in the respective year of a prospective period of time and on this basis make the final decision about of the project expediency. It is easy to accomplish this when solving the first (direct) task if an investment and innovation analysis is carried out in the system. Otherwise the lower limit of the level of efficiency of capital will be the level already achieved by the system.

4. Conclusions

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

Following foundations for a new direction of economic analysis of production systems have been developed: investment and innovation where the main indicator of technological development of production systems is the coefficient of production manufacturability level calculated uniformly according to statistical reporting at the macro, meso and micro levels as the ratio of material efficiency to efficiency of capital.

The target values of the coefficient of production manufacturability level and material intensity determine the target value of efficiency of capital of enterprises and hence the productivity. At the same time it becomes possible to calculate the attainability of the targets based on the financial possibilities of the enterprises including the use of "quasi self-financing".

Considered methodological approach must first be used to assess the possibility of activating innovation technological activities and a corresponding increase of the labor productivity of Arctic industrial enterprises operating in difficult climatic conditions.

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