Features of Structural Investment and Innovative Industrial Policy in the Regions of the North and the Arctic and Assessment of Prospects for Technological Modernization of Industrial Production

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Abstract. To further increase the contribution of extractive industries to the gross regional product of the Northern and Arctic regions, it is necessary to increase their efficiency through technological modernization and automation of production processes. It is shown that the structural investment and innovative industrial policy in the North should be aimed at supporting the introduction of technological innovations by enterprises, primarily in the field of more complete and integrated use of natural resources. To assess the economic feasibility of technological modernization of industrial enterprises, it is proposed to use the methodology of investment and innovation analysis, which includes three stages of management decision-making. At the first stage, preliminary goals are set to achieve the necessary level of innovative and technological development of enterprises. At the second stage, a decision is made either to further improve the existing production technology or to switch to a new technology. At the third stage, various possible options for technological renewal of production are considered and the best option is determined with its subsequent implementation in the form of an investment project.

1. Introduction

Trends in the development of technological progress in the global economy and the concept of "industry 4.0" show that with the development of digitalization and intellectualization of production, the growth rate of the extractive industry in the future will be insignificant. This situation will also be typical for Russia, but in the regions of the Russian North and the Arctic, the extractive industry usually has the main share in the gross regional product (GRP) obtained not only in industrial activities, but also in the economy of such regions as a whole [1, 2]. Thus, in these conditions, on the one hand, to further increase the contribution of extractive industries to the GRP of regions, it is necessary to increase their efficiency through technological modernization and automation of production processes [3, 4]. On the other hand, in order to increase Russia's economic growth rates, it needs new industrialization with a corresponding annual increase in the manufacturing industry by 10-
15 \% [5,6], but the question arises whether it is needed in the North and in the Arctic, and if so, in what form.

The fact that, first, from the point of view of bigger GRP, growing mining industry is preferable, since in this type of economic activity share of value added in the production and sale of products is higher than in manufacturing [7,8,9]. Accordingly, with a decrease in the rate of mining, the growth rate of the manufacturing industry in the regions of the North and the Arctic should also be high. However, secondly, in this territory in extreme climate conditions, new machine-building enterprises are economically impractical due to the higher capital intensity, therefore it is necessary to develop a more in-depth processing of primary raw materials in the metallurgical, chemical, and forest industries [10,11]. At the same time, existing machine-building enterprises, mainly engaged in repair work, will obviously expand only if this becomes necessary due to the accelerated development of other sectors of the regional economy.

However, it is clear that more complete extraction of useful components and more marketable products in the processing of natural resources requires the introduction of technological innovations. Therefore, on the one hand, to assess the prospects for modernization of industrial production it is necessary to analyze the innovation activity of existing enterprises. On the other hand, it requires economic justification for the use of technological innovations prior to the implementation of any investment project, since, first, for each technology there is an economic limit to its improvement from the point of view of reducing the specific consumption of material and energy resources, the achievement of which means the need for introduction of a new technology. Secondly, the economic feasibility of expanding the range of products by enterprises requires a preliminary pre-project assessment.

2. Materials and methods

The methodology of investment and innovation economic analysis that we are developing allows us to answer theoretical questions [12-14]. It includes three main stages. At the first stage, preliminary goal setting of the necessary level of innovative and technological development of enterprises is carried out. For this, first, you need to calculate enterprise-specific annual values material productivity (MP), capital productivity (CP) and production effectiveness ratio (R_{pe}) for three to five years and over the retrospective period according to the public annual financial accounting reporting made under Russian accounting standards (RAS), using forms No. 1 and No. 2, as well as data on the composition and movement of fixed assets and the volume and structure of its expenses on producing goods and services that are contained in text explanation tables of the forms No. 1 and No. 2. Thus, investment and innovation analysis can also be external, that is, it can be used by any investor or lender interested in the development of the relevant enterprise. It should be noted that when conducting an internal analysis, it must be performed for each type of products produced and sold by the enterprise. To do this, we analyze the annual cost calculations of products, and, if necessary, quarterly and even monthly calculations. In this case, the calculation of the indicators of MP, CP and R_{pe} transforms in the following way. Instead of the MP indicator, you can use the consumption of material resources in value terms per unit of products sold by the enterprise of the corresponding type, and instead of the CP indicator, the amount of depreciation deductions in the cost of a unit of production. Then, the calculation of the index R_{pe} is performed as a relation between the specific depreciation deduction to the specific value of the expenditure of material resources in terms of value. Secondly, it is necessary to identify how the above-mentioned indicators change over the analyzed period to find the direction and variant of the direction of technological development from six possible combinations [15]. Accordingly, the trends of growing or declining indicators can be determined, or the trend of their abrupt change, that is, growth and decline in certain periods of time.

At the second stage, management decisions are made by the company's management either to improve the existing production technology or to introduce a new technology. Improving the technology allows you to reduce the specific consumption of material resources without significant investment costs, but only to a certain limit, which can be physical and economic. The physical limit is
determined by the capabilities of the technology itself to reduce production waste or by the properties of mineral raw materials that do not allow extracting useful components from it beyond the maximum possible level. The economic limit means that starting from a certain period of time, the improvement of technology begins to cause not a decrease, but an increase in the cost of production (all other things being equal). The question arises: how to determine this limit if it is less than physical in terms of extracting useful components?

At the third and final stage, if a decision is made to introduce a new production technology, its various options are considered, first, by achieving different levels of target values and, secondly, by the time period for achieving these values. This allows to take into account, on the one hand, the ability of enterprises to self-finance the required investments to ensure financial stability, and, on the other hand, the loss of profit in case of growth of unit cost of production until the technological innovation investment project is implemented.

3. Results and discussion

The growth trend is favorable for the company and means its sustainable technological development, which allows you to reduce the unit costs of production and sales and increase the profitability of products, return on sales and, other things being equal, return on assets and return on equity. The second trend, that is, the tendency to reduce the values of MP, CP and $R_{pe}$, is extremely unfavorable for the enterprise, since if it continues, it will approach possible bankruptcy as a result of an increase in the cost of production and a decrease in net profit. The third trend usually means that the company, on the one hand, pays little attention to technological development and, on the other hand, it is possible that the enterprise experiences a problem of insufficient qualifications or experience of staff, not only among senior management but also the middle one and even lower, leading to a periodically stopped production lines as a result of various breakdowns of machinery and equipment, including emergency and downtime caused by maintenance workers (late for work, absenteeism).

From the point of view of the methodology of investment and innovation analysis, there is a need to understand that a better technology is a means of supporting sustainable enterprise activity, i.e. such activity, in which its main economic and financial results (revenue and profitability) do not at least get worse. Therefore, the enterprise must provide technological support for its development in accordance with the stage of the technology life cycle, which simultaneously increases the values of MP, CP and $R_{pe}$. The Indicator that shows the completion of this stage and a move to the next one is the beginning of the decline of values $R_{pe}$ due to the lower growth rate of material productivity compared with the growth rate values of return on assets. Thus, if over a long period of time, a better production technology ensures the development of the enterprise at the most cost-effective stage, and then there is the inevitable decrease in the values of $R_{pe}$, it clearly shows the depletion of further reserves for higher production efficiency through improved technology and the introduction of new technologies. If in the analyzed retrospective period of time, the enterprise has already experienced a long-term decrease in the values of $R_{pe}$, accompanied by a decrease in the values of material yield, this clearly shows the need for the enterprise to switch to a new production technology.

From the point of view of the actual production process, it is obvious that technology improvement does not occur simultaneously. This is preceded by the stages of laboratory research and (or) pilot tests, where in addition to technological indicators, primarily the coefficient of extraction of useful components from raw materials, the values of economic indicators should be calculated at least approximately, including the specific consumption of material resources, that is, the consumption per unit of output of raw materials, materials, fuel and energy. Accordingly, when improving the process of ore enrichment and increasing the level of extraction of useful components from it, the cost of raw materials, that is, ore, in the cost price of one ton of concentrate begins to decrease, which means that the total specific consumption of material resources in value terms will first decrease. If the technological equipment does not change, then the specific amount of depreciation in the technological process remains constant. As a result, the value of $R_{pe}$ as the ratio of the specific amount of depreciation to the total cost of the specific consumption of material resources will increase.
However, at a certain stage of technology improvement, with a further increase in the level of extraction of useful components, the specific consumption of energy and (or) materials begins to increase. After this increase in value it is equal to the cost of reducing the cost of ore, the total cost of the specific consumption of material resources will begin to increase again, that is, the value of the $R_{pe}$ will decrease. Thus, the beginning of this decline will mean that the process of improving production technology has reached its economic limit.

The life cycle of their technological development shows that the most preferable period of time for the introduction of a new technology is the duration of the stage at which the value of the $R_{pe}$ begins to decrease with a decrease in the growth rate of material output compared to the growth rate of capital output. At the same time, the cost of a unit of output still continues to decrease, so the company operates in a stable mode.

However, if the value $R_{pe}$ continues to decline with long-term decrease in material productivity, it leads to an increase in the unit cost of production, that is, the decrease in profit per unit of output and the total mass of profit of enterprise, that if you continue this process for several years will lead the company to eventual bankruptcy. Thus, the faster the company starts implementing new technology in these conditions, the less it will lose profit. However, on the one hand, you need to understand that the implementation of the investment project, including preparation of a business plan will last for several years. During this period there will also be further decline in profits of the company, and therefore the funding will decrease. On the other hand, it is clear that not every Russian enterprise can immediately independently finance an investment project to update production technology, even in conditions of growing profits [16,17], so you have to use loans from commercial banks or other opportunities to find financial resources, which are not usually free. Accordingly, the definition of proper time management decision on a need for the introduction of new technologies and consideration of several options, depending on the magnitude of the proposed values of the three targets ($R_{pe}$, MP and CP) as well as the period of full implementation of the relevant investment project should be taken into account when performing economic calculations: not only the investment costs but also costs in the form of loss of the discounted stream of annual profits.

Unfortunately, the level of innovation activity in industrial enterprises operating in the regions of the North and the Arctic remains very low. We analyzed the development and implementation of innovative projects at 32 enterprises located in these regions for the period 2013-2020 based on their annual reports presented on official websites and information contained in articles of leading Russian journals [18-20]. During this period, only ten enterprises introduced technological innovations, but most of them were aimed not at increasing the completeness and degree of extraction of useful components from mineral raw materials, but at improving the processes of its transportation and ore preparation for further enrichment, which allows increasing the volume of ore extraction and reducing the cost of these processes.

New technologies aimed at increasing the level of extraction of useful components from traditional raw materials or using "poorer" or substandard raw materials were implemented only in a few enterprises.

Thus, the results of the analysis show that most industrial enterprises are not engaged in innovative and technological modernization of production with the introduction of new technologies for processing raw materials, so a significant increase in the efficiency of their activities in the regions of the North and the Arctic is not expected in the near future. Accordingly, the use of the methodology of investment and innovation analysis in the practical activities of enterprise management can provide significant assistance in finding reserves to increase the efficiency of using production resources in the implementation of technological modernization by enterprises.

4. Conclusions

1. Structural investment and innovative industrial policies in the regions of the North and the Arctic should be aimed at supporting the introduction of technological innovations by enterprises, primarily
in terms of more complete and integrated use of natural resources, which will increase the economic efficiency of their activities and increase the share of manufacturing in the GRP of the regions.

2. To assess the economic feasibility of technological modernization of industrial enterprises, it is proposed to use the methodology of investment and innovation analysis, which includes three stages of management decision-making. At the first stage, preliminary goal setting is carried out to achieve the necessary level of innovative and technological development of enterprises. At the second stage, a decision is made either to further improve the existing production technology or to switch to a new technology. At the third stage, various possible options for technological renewal of production are considered and the best option is determined with its subsequent implementation in the form of an investment project.

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