Methodological support for increasing the technological potential in industry according to technological potential level and cyclical development

A A Sokolov¹, K V Samonova¹, M-Kh. R Umarkhadzhiev²

¹Southern Federal University, 10a, Zastavnaya, Gelendzhik, 353461, Russian Federation
²Chechen State University named after A. H. Kadyrov, 17а, Dudaev Boulevard, Groznyy, 364015, Russian Federation

E-mail: anso@sfedu.ru

Abstract. The article discusses the issues of increasing the level of technological potential on the example of the Russian economy in the form of targeted state intervention during the implementation of import substitution. In the paper, the increase in technological capabilities is investigated taking into account the life cycle of the industry. The practical application of methods for assessing the level and vector of technological potential, as well as a dynamic model of organizational decision-making, is displayed.

1. Introduction

The study of the process of development of the technological potential of the industrial sector made it possible to establish its cyclical nature, due to the emergence of tendencies to decline (decrease in the level of technological potential) and to growth (its increase). In this context, the increment is carried out in leaps and bounds due to the need to increase competitiveness and reduce the technological lag of industry, which falls on the time interval between the economic crisis and the revival of the economy, which is taken in work as a “bifurcation point”. The bifurcation point is the moment in time at which a managerial decision is made to neutralize the intra-system crisis and determines further development, in particular through the introduction of comprehensive protectionist measures and import substitution.

The main conditions determining the emergence of the bifurcation point, as well as the factors necessary for the increment of the technological potential of industries (Figure 1) were analyzed and systematized.

2. Materials and methods

One of the factors in overcoming the negative dynamics in the development of technological potential on the example of the branches of the industrial sector of the Russian economy under the influence of foreign economic and foreign policy processes was the state industrial policy in terms of targeted impact by introducing sectoral import substitution plans in 2014.

The results of the analysis of time series reflect the change in the parameters of the development of capital-forming industries in the process of impulse impact on the technological potential of the industrial sector and make it possible to detect the relationship between the volume of imports, the
volume of production and the level of utilization of production capacities, and the beginning of the implementation of the state impulse impact (for example, sectoral import substitution plans).

Analysis of the main economic indicators of the high-tech industry [3] allows us to conclude that the main factor in the controlled withdrawal of the industry to the growth phase through increasing the technological potential is a purposeful state industrial policy. At the same time, the basis for technological re-equipment is methodological support for assessing the level of technological potential, the vector of its development, and the model of dynamic analysis for the formation of basic organizational and economic decisions.

The formation of technological potential consists in the identification, structuring, and connection of resources to ensure the output of industrial products. In the process of capacity-building, the quantity and quality of resources are accounted for, technological limitations are determined, a problem field is built, and the possibility of increasing the technological potential of the industrial sector of the economy is evaluated.

Technological capacity-building of industries is achieved by impulse effects on an acceptable amount of technological capacity increment on an extensive or intensive basis. An extensive increase in technological potential consists in attracting additional resources without changing their qualitative properties, while intensive build-up implies updating the main production assets with advanced and productive technologies, the use of more qualified labor. The practical implementation of intensive technological capacity building is carried out through the activation of dynamic abilities.

Dynamic abilities are the ability to reconfigure resources, which ensures the continuous updating of technologies, by activating either absorbing abilities (in the implementation of borrowing and transfer strategies) or the ability to produce technological innovations (in the implementation of strategies for building up and innovation-distribution differentiation), through integration, cooperation and network interaction of economic entities.

Table 1. Strategies for the continuous development of the technological potential of the industrial sector while enhancing dynamic capabilities [1], [2].

| Development strategies | Concepts of continuous updating | Basis for building technological capabilities | A basis for building technological capabilities | A base for harnessing technological capabilities |
|------------------------|---------------------------------|----------------------------------------------|----------------------------------------------|-----------------------------------------------|
| Migration strategy     | Absorbency                      | Borrowed                                     | Borrowed/own                                 | Private                                       |
| Simulation strategy    |                                 | Own/borrowed                                 | Borrowed                                    | Private                                       |
| Growth strategy        | Ability to own production       | Private                                      | Private                                      | Own/borrowed                                  |
| Innovation-distribution differentiation strategy | | Own/borrowed | Private | Own/borrowed |

3. The power consumption analysis
One of the main conditions for the implementation of the first strategy is the availability of a sufficient level of technological, scientific, and technical potentials [4–14]. At the same time, the decline in the quality, consumer, and functional characteristics of industrial goods complicate the continuous updating of technologies due to the growth strategy and form the need to focus on the strategy of innovation-distribution differentiation based on the stratification of industries in the industrial sector, taking into account the level of technological potential and the level of capacity utilization [15], which
act as objective indicators for assessing production capabilities, branches of the industrial sector of the economy.

The increased technological potential ensures the production of competitive industrial products in the process of its use [16, 17]. To determine the parametric characteristics of the processes of development of technological potential, the method of econophysics (the method of analogy in the model of mechanical movement of the body) was applied, which makes it possible to consider the branch of the industrial sector as a certain object with a certain mass, speed, and position in the process of technological development. The state and dynamics of the physical body are completely characterized by a combination of kinetic and potential energies. Similarly, the dynamics of the industry can be fully characterized by kinetic and potential capacity, which are analogies of physical quantities and will fully characterize the processes of building and using the technological potential of industries [18-21]. At the same time, the volume of industrial output, in particular the volume of innovative products produced, can act as an analogy for the speed of the physical body. As an analogy to the position of the physical body, the level of the technological potential of the industrial sector can act [2, 22].

![Figure 1](image1.png)

**Figure 1.** Vector of technological development of industries on the example of Russian industry in the period 2005–2018 [2].

Thus, such a representation of the dynamics of industries will allow analyzing the processes of development of the technological potential of the industrial sector in a two-dimensional space. The indicator of the development of the technological potential of the industrial sector will be its vector $I$, 

$$I = \{I_1, I_2, \ldots, I_n\}$$
which is the sum of the vector of increasing the technological potential and the vector of its use, characterized by length and direction. The effectiveness of the development of the technological potential of the industrial sector implies the presence of a vector direction in which the processes of building and using this potential are balanced $I_0$.

Deviation of the vector of development of the technological potential of the industrial sector from $I_0$ will mean the intensification of either the process of increasing ($I_1$), or the process of using the technological potential of the industrial sector ($I_2$), and negative ($I_2$, $I_3$). The collinearity (co-directionality) of the vector of development of the technological potential and the vector $I_0$ will indicate the balance of the processes of increasing and its use ($I_5$, $I_6$).

Determining the vector of development of the technological potential of the branches of the industrial sector makes it possible to use it as a tool for managing the processes of building and using the technological potential of the industry.

At the same time, the formation of organizational solutions is carried out for stratified groups of industries in the industrial sector that have similar factors for the development of technological potential. This approach makes it possible to build promising trajectories for the development of technological potential, taking into account the identified trends. Industries with the greatest technological potential and available opportunities for reloading production capacities should be considered as locomotive industries or growth points, while industries with reduced technological potential should be focused on meeting the needs of the locomotive industries and subjected to restructuring if necessary. Figure 1 shows that the most energy-intensive equipment of the plant are electrolyzers, welding machines, and pumps. They account for about 47% of the total power consumption of the enterprise.

4. Conclusion

The analysis showed that not a single branch of the industrial sector of the economy fell into the I–III sectors characterized by uncompetitive development. Branches of the industrial sector of the economy located in these sectors require the most stringent direct and indirect measures of a state policy of a stimulating nature (restructuring and re-profiling of enterprises) that contribute to the transfer of industries from the crisis phase.

Sectors VI of the VI sector have a negative vector of development of technological potential and its value below the average, while building up technological potential is limited by high utilization of production capacities. In this case, organizational and economic instruments of industrial policy should stimulate the inflow of real investment, including by attracting foreign investment.

Despite the fact that the branches of the IV and V sectors have sufficient reserves for increasing the volume of industrial production, the increase in technological potential is carried out not on the basis of technological modernization, but at the expense of highly profitable investments. Relatively short payback periods of financial resources determine the investment attractiveness of these industries. In view of the stability of demand for products, there is no need for significant technological capacity-building. Organizational and economic instruments of industrial policy, in this case, can be concentrated mainly on the renewal of fixed production assets, since, as a rule, in this group of industries, there is a high level of qualification of personnel. Technological modernization of fixed production assets will ensure uniform dynamics of changes in technological potential, improving the quality of products and its competitiveness in the domestic and foreign markets.

Sector IX sectors have a more stable pace of building technological potential. Indicators of the use of fixed production assets indicate the presence of a process of technological modernization, respectively, industrial policy measures to build technological potential can be aimed at ensuring the consolidation of the achieved positions and maintaining the formed level of technological potential, by improving the quality of use labor resources and preservation of export indicators.

In the VIII sector, there are industries for the production of vehicles and equipment and chemical production. In relation to these groups of industries, organizational and economic instruments of industrial policy should be aimed at ensuring a 5% growth rate of the enlarged groups of indicators of
technological potential, which can be achieved by activating dynamic abilities (increasing the number of own developments, localizing design and engineering centers, increasing the share of innovation costs in the cost structure of production). Increasing the technological potential of industries located in the VIII and VII sectors can become a priority direction of the state industrial policy in the context of import substitution and the transition to a strategy of innovation and distribution differentiation.

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