# INNOVATIVE DEVELOPMENT OF REGIONS

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## *INNOVATIVE AND TECHNOLOGICAL DEVELOPMENT OF RUSSIAN REGIONS: AN ANALYSIS OF KEY SUCCESS FACTORS**

*SUMMARY. The paper analyzes conditions for innovation and technological development of Russian regions. In 2009-2011, innovative development was carried out due to extensive growth, i.e. growth was stimulated by costs, but it was not accompanied by increases in revenues from business activities. Therefore, the efficiency of innovation was low and decreased with increasing innovation costs. According to the data covering the dynamics of Russian regions development (83 regions) for the period from 2009 to 2012, we statistically confirm the assumption that growth of household consumption and increase in costs on supporting research and development (R&D) did not stimulate innovation and technological activity of Russian enterprises. The analysis comprises implementation of policies to promote innovation and technological upgrading over the past five years. Multifaceted models reflecting dependence of high-technology export earnings from economic and technological conditions have been constructed. It is shown that activities of the government aimed at direct stimulation of economic development (increase in domestic demand, lending money to enterprises, and direct support for the growth of innovation costs) and at competitiveness of Russian technologies do not have a stimulating effect. Innovation and technological development of regions of the Russian Federation, if the current trends are preserved, does not generate a potential for breakthrough growth, as the model of innovative and technological development of Russian regions proves to be a costly one. Cluster analysis helped to identify 14 regional groups, which in turn are grouped into 4 clusters according to the type of economic structure.*

*KEY WORDS. Management, economics, region, parameters, indicators, factor, cluster, regression analysis, a model, innovation and technological development.*

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**Technological challenges of our time.** Emergence of new technologies, which drastically reduce production costs (labor, energy, transportation, communication), increases significance of development of new products and services and emphasizes orientation of the product towards the end customer. These tendencies have already become signs of the post-industrial world when, as a result of growing complexities of modern products, design companies acquire production facilities located in close proximity (e.g. Silicon Valley, India and Korea). Competition between countries in the sphere of production increases; the favorable investment climate only and cheap labor force are already not able to ensure stable economic growth. There are several reasons for this. Firstly, economic growth is accompanied by growing salaries (China, Indonesia and other fast developing economies have already encountered this). Secondly, renewal of product lines occurs too fast but the end customer, due to growing "individualization" of the production process, directly participates in the final design and transformation of the product. The enumerated factors contribute to the fact that developed countries begin returning production from developing countries.

Today, according to a number of well-known economists, some production branches are not associated precisely with developed or developing countries [1]. Therefore, the industrial composition of economy itself cannot be a criterion of underdevelopment or modernization. Agricultural or extractive industries, not to a lesser extent than processing, can be associated with vehicles of economic growth.

At the beginning of the 2000s, the government paid attention to importance of entrance into the innovation sector and, for the first time during the whole post-Soviet period, there appeared a significant and rather logical complex of ideological, conceptual and policy documentation aimed at the stimulation of innovative development of Russia's economy [2]. In 2008, the government of RF approved The Concept of long-term socio-economic development of the Russian Federation until 2020, which became famous later [3]. It was supposed that by the designated time – 2020 – this model of development will allow to reach the target values, in particular: increase in the share of Russia in the global markets of high-tech services up to 5-10%, increase in the share of high-tech sector in GDP up to 17-18%, 5-6-fold increase in the share of innovative products in the total amount of shipped products, and increase in the share of innovatively-active enterprises up to 40-50% [4].

The document stated that the innovational economic sector will not simply function but also really define public well-being. However, by now the thesis that in reality "the Russian innovation model is collapsing" [5] has grown quite strong. Russia's inclusion in global trade in the sphere of high technologies remains more of an idea, a desire, rather than reality of the present moment.

Russian business is not ready to realize innovative projects. It is engaged in only 9% of innovative projects, as a comparison, this figure equals 62% in the USA and 95% in Japan. The number of innovatively-active enterprises is considerably different in different Russian regions; moreover, gaps continue to grow [6]. Let us consider what conditions are necessary for the innovative technological development and influence on the competitiveness of Russian technologies.

**Analysis of the conditions for innovative and technological development**

For analytical purposes and taking into account the scope of innovative activities reflected in the Russian statistics, the following 11 indices are attributed to the indices (Xi), which characterize conditions for the innovation-driven technological development of the region: the actual household final consumption expenditure in current prices per capita (RUB/person) – $X_1$; the share of bank loans in the total investment volume in fixed assets (%) – $X_2$; number of innovatively active enterprises as percentage of the total number of enterprises (%) – $X_3$; technological innovations costs share in the total turnover of enterprises (%) (X4-1). Technological innovations costs share of enterprises (X4-2); the tempo of technological innovations costs growth of enterprises (%) – $X_5$; income derived from entrepreneurial activities in the population total money income (%) – $X_7$; number of R&D researchers (per million people) – $X_8$; share of trained employees in the total number of enterprise workers (%) – $X_9$; number of enterprises having a website on the Internet (per 100 units) – $X_{10}$; index of export openness (%) – $X_{11}$.

The analysis includes available data for Russian regions in 2008-2012 [7]. Since the parameter "technological innovations costs share in the total expenditures of enterprises (%)" for all Russian regions is not provided by the Statistical Books, it has been replaced by indices X4-1 and X4-2. The task of measuring competitiveness of innovation-driven technological development is complicated by the problem of endogenous dependence of the parameters, which can be resolved by identification of the most closely related groups of factors. Therefore, the first step was to set the pair correlation coefficient between all the indices of the conditions (Xi) of regional innovative-technological competitiveness. A network model of conditions for the regional innovation-driven technological development has been designed (Figure 1).

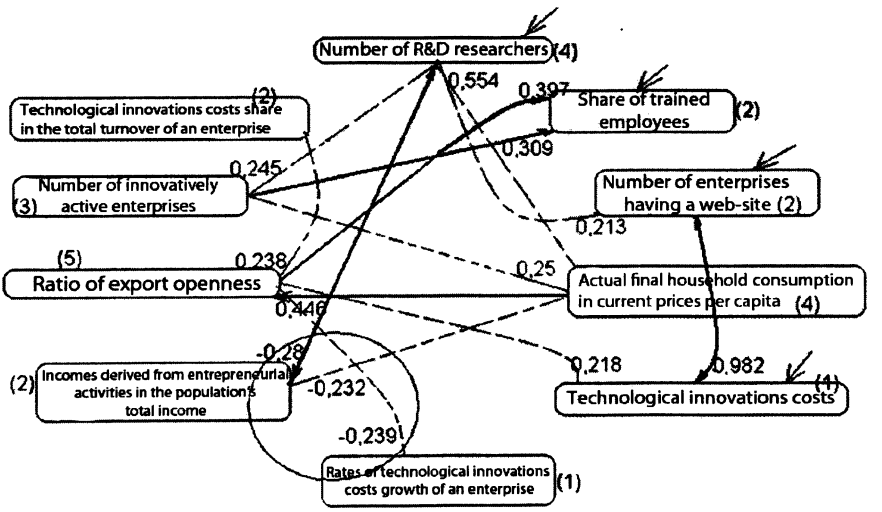


*Figure 1.* Network model of conditions for regional innovation-driven technological development

*Note*: The Pearson correlation coefficients are measured; significance level is at least 0.99

The network model of the conditions for regional innovation-driven technological development captures variables which have statistically significant correlation and the strength of association measured by the Pearson correlation coefficient. The parameter value in the network is indicated in brackets. Herewith, the maximum significant correlations are displayed with solid lines (statistical error is less than 0.001); statistically significant ones are shown with dashed lines (statistical error is less than 0.01).

The right side of the model reflects the factors which directly and positively affect conditions for the regional innovation-driven technological development in RF. The number of enterprises having a website and technological innovations expenditures are most closely related (0.982), which appears to be a statistical indicator. Statistically stable connection of an intermediate level (0.446) is observed between the actual household final consumption expenditure per capita in RF regions and the index of export openness. In the lower left-hand fragment of the model (encircled) there are two indices which are persistently negatively associated with the conditions for the regional innovation-driven technological development: income derived from entrepreneurial activities in the population total money income (%) and the tempos of technological innovations costs growth of enterprises.

The index of export openness has the maximum value (5) in the network. This variable is associated with the number of the trained employees (Pearson coef.=0.397) with statistically maximum significance; the actual household final consumption expenditure per capita in RF regions (Pearson coef.=0.446). Besides, it has statistically significant association with the technological innovations costs share in the total turnover of an enterprise (0.238) and technological innovations costs (0.218). There is a negative correlation with the tempos of growth of the technological innovations costs of enterprises. The latter fact is explained by extremely slow growth of companies' expenditures on technological innovations.

The model of domestic demand stimulation used in Russia is reflected in the growth of the actual household final consumption expenditure per capita in RF regions (the network value is 4). The latter has a direct statistically significant dependence on the export openness index and inverse correlation with the income derived from entrepreneurial activities. Thus, the export openness of enterprises and numbers of R&D researchers are greater in the regions with high levels of household consumption. However, population income growth is ensured only by increasing wages. Moreover, when export openness increases, growth rates of technological innovations costs decline. In other words, domestic R&D projects are replaced by imported technologies as the population's solvent demand rises.

Competitiveness of Russian technologies: growth conditions and constraints. Innovation constraints in Russia (values, institutions, and finances), repeatedly confirmed by researchers, do not require verification. We have narrowed the focus down to revealing how in reality the Russian declaratory policy regarding stimulation of innovation development and technological modernization has been realized over the last 5 years.

Competitiveness of Russian technologies in the world market is reflected in the parameters provided by the Russian Federal State Statistics Service: "technology export earnings under contracts with foreign countries ($1,000 USD per year)", endogenous variable in the model ($Y_j$).

Taking into account the autocorrelation effects identified previously, we included the variables listed at the beginning of the article (except $X_1$, $X_8$, $X_{11}$) in the regression model. The model summary table (a fragment is given in Table 1) has allowed us to write the regression equation given below*.

*Table 1*

**Fragment of the model summary table**

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate |
|---|---|---|---|---|
| 1 | ,962(a) | 0,926 | 0,913 | 28037,46 |

In the suggested simple linear regression model, the coefficient of determination R characterizes the force of the general linear bond between the variables. In our case R=0.962 which is a good indicator: the higher the coefficient is, the more appropriate the independent variables are for the determination of the behavior of the dependent variable. This regression model gives a reliable forecast regarding the behavior of the mean in 93% of the cases.

Coefficient F=72.99, statistic accuracy of the model is high (the probability of a forecast error is less than 0.001).

$$Y = 66898{,}63 + 14{,}065 * X10 + 2886{,}565\ X3 - 3076{,}88 * X7 - 3384{,}96 * X9 - 24{,}842 * X5 - 336{,}089\ X2 - 0{,}167 * X4\text{-}2 - 1191{,}62 * X4\text{-}1$$

Only two out of all the indices (X10 and X3) make a positive contribution, while the rest are accompanied by a decline of the total Y value. In other words, the increasing number of the enterprises having a website and the growing share of the innovatively active enterprises in RF regions is accompanied by enhanced competitiveness of technologies in external market. Whereas, the measures taken by the government to directly stimulate economic development (to increase domestic demand, business loans, and direct support of the growth of the share of innovation costs) negatively affect competitiveness of Russian technologies.

In reality loans granted to businesses and incomes derived from entrepreneurial activities are forwarded to final consumption and payrolls, but not to the development of competitive technologies. Direct expenditures on innovations prove ineffective since they only lead to increasing wages and gross input and fail to affect competitiveness of technologies in the external market. Competitiveness of technologies in the domestic market is also low due to the fact that growth of the companies' incomes goes hand in hand with increasing costs of foreign technology

* A more detailed review of the statistical data on all the models considered in the article is not provided due to space limitations. It can be provided upon request at the editorial office.

acquisition, negatively influencing on companies' incomes derived from export of technologies. In-house R&D products are replaced by imported technologies with the solvent demand growth.

The findings based on the data provided by the correlation and regression models are quite disappointing for the innovation policy implemented in Russia.

**Typology of the Russian regions according to their economic organization.** In the first approximation of the factor model we used 36 indices (2009, 2010, 2011 and 2012 were viewed as individual indicators) which characterize GRP, production structure by sectors and branches, export and import, as well as household income and expenditures. Furthermore, we identified those which had the maximum values and statistically significant association with the parameters at a level not lower than 0.1 (Pearson's coefficient).

The basic indices, which characterize the dynamics and structure of economy of the Russian regions (2009-2012), have been grouped into 4 factors.

The first factor includes the ratio of the production output of the manufacturing sector per capita to the all-Russian average; production output of the manufacturing sector per capita (1,000 RUB/person); the share of the manufacturing industries in GRP (%); the GRP share in production output (%) (2010-2012). This factor is named "The industrial economic organization".

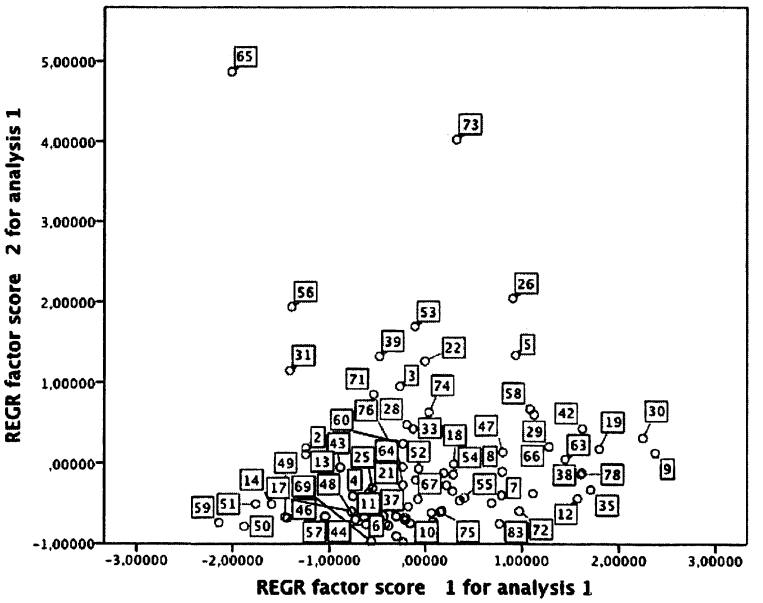


*Figure 2.* Factor scores of regions, factors 1 and 2

The second factor characterizes GRP per capita and the contribution of extractive industries to GRP. The factor is inversely related to the share of service sector in GRP and is called "Gross Regional Product".

The third and fourth factors characterize the degree of import orientation of the economy of Russian regions and amount of personal consumption expenditures. Figures 2-4 illustrate factor scores of the regions regarding the factors mentioned above. Numbers of the regions are indicated in Table 2.

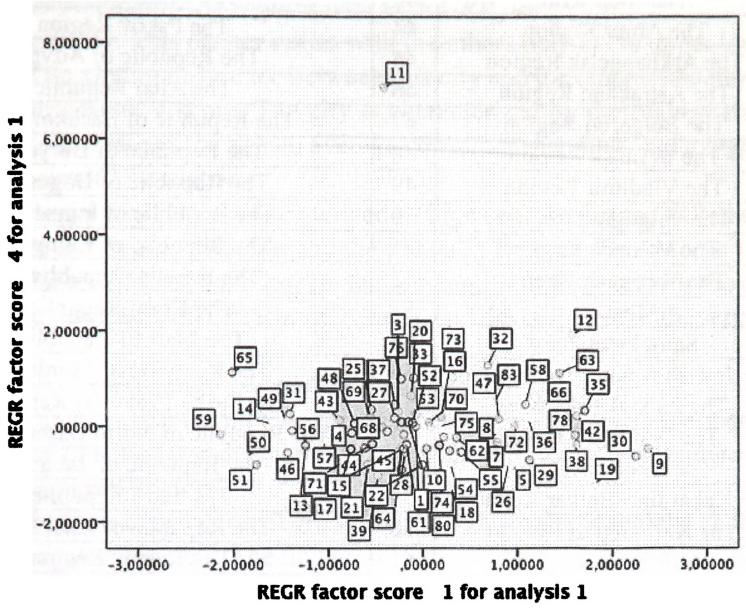


*Figure 3a*. Factor scores of the regions, factors 3 and 4

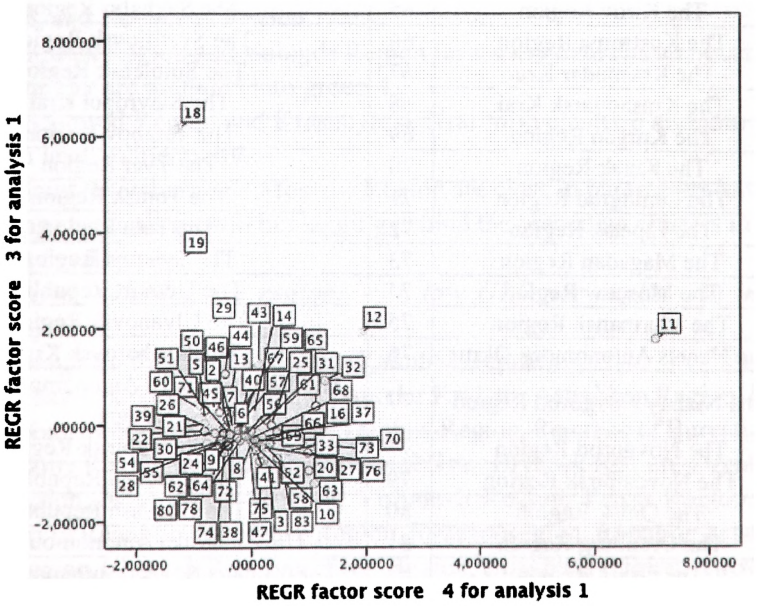


*Figure 3b*. Factor scores of regions, factors 3 and 4

*Table 2*

**List of regions under their respective numbers from Figs 2, 3a, and 3b**

| No. | Region | No. | Region |
|---|---|---|---|
| 1 | The Altai Krai | 43 | The Primorskii Krai |
| 2 | The Amur Region | 44 | The Pskov Region |
| 3 | The Arkhangelsk Region | 45 | The Republic of Adygea |
| 4 | The Astrakhan Region | 46 | The Altai Republic |
| 5 | The Belgorod Region | 47 | The Republic of Bashkortostan |
| 6 | The Bryansk Region | 48 | The Republic of Buryatia |
| 7 | The Vladimir Region | 49 | The Republic of Dagestan |
| 8 | The Volgograd Region | 50 | The Republic of Ingushetia |
| 9 | The Vologda Region | 51 | The Republic of Kalmykia |
| 10 | The Voronezh Region | 52 | The Karelia, Republic of |
| 11 | Moscow | 53 | The Komi Republic |
| 12 | Saint Petersburg | 54 | The Mari El Republic |
| 13 | The Jewish Autonomous Region | 55 | The Republic of Mordovia |
| 14 | The Zabaykalsky Krai | 56 | The Sakha (Yakutia) Republic |
| 15 | The Ivanovo Region | 57 | The Republic of North Ossetia-Alania |
| 16 | The Irkutsk Region | 58 | The Republic of Tatarstan |
| 17 | The Kabardino-Balkar Republic | 59 | The Tuva Republic |
| 18 | The Kaliningrad Region | 60 | The Republic of Khakassia |
| 19 | The Kaluga Region | 61 | The Rostov Region |
| 20 | The Kamchatka Krai | 62 | The Ryazan Region |
| 21 | The Karachay-Cherkess Republic | 63 | The Samara Region |
| 22 | The Kemerovo Region | 64 | The Saratov Region |
| 23 | The Kirov Region | 65 | The Sakhalin Region |
| 24 | The Kostroma Region | 66 | The Sverdlovsk Region |
| 25 | The Krasnodar Krai | 67 | The Smolensk Region |
| 26 | The Krasnoyarsk Krai | 68 | The Stavropol Krai |
| 27 | The Kurgan Region | 69 | The Tambov Region |
| 28 | The Kursk Region | 70 | The Tver Region |
| 29 | The Leningrad Region | 71 | The Tomsk Region |
| 30 | The Lipetsk Region | 72 | The Tula Region |
| 31 | The Magadan Region | 73 | The Tyumen Region |
| 32 | The Moscow Region | 74 | The Udmurt Republic |
| 33 | The Murmansk Region | 75 | The Ulyanovsk Region |
| 34 | The Nenets Autonomous Okrug | 76 | The Khabarovsk Krai |
| 35 | The Nizhny Novgorod Region | 77 | The Khanty-Mansi Autonomous Okrug – Yugra |
| 36 | The Novgorod Region | 78 | The Chelyabinsk Region |
| 37 | The Novosibirsk Region | 79 | The Chechen Republic |
| 38 | The Omsk Region | 80 | The Chuvash Republic |
| 39 | The Orenburg Region | 81 | The Chukotka Autonomous Okrug |
| 40 | The Oryol Region | 82 | The Yamalo-Nenets Autonomous Okrug |
| 41 | The Penza Region | 83 | The Yaroslavl Region |
| 42 | The Perm Krai | | |

Cluster analysis, which was performed further, permits us to classify the groups of the regions by the type of their socio-economic development (Figs. 2, 3a, 3b). Altogether we have identified 14 groups of the regions which can be divided into 4 clusters at the third level of the hierarchical cluster analysis.

*A. Clusters including the regions with high GRP per capita.*

1. Moscow city. This cluster unites with the others only at the upper level which indicates the maximum difference between this city and the other Russian regions. It has the highest factor 4 score. The city is characterized by the highest standard of living, the highest rate of the annual average consumer spending, and a high share of import from non-CIS countries.

The two regions which are characterized by high contribution to GRP of extractive industries are the Tyumen Region and the Sakhalin Region. These score maximum for factor 2, high for factor 4 and low for factors 1 and 3. In these regions the extractive industry is predominant, diversification is weak, and development of the service sector lags behind.

*B. Clusters with average level of GRP per capita.*

3. Three dynamically developing export-oriented regions which are characterized by a high level of innovation development: the Kaluga Region, the Leningrad Region, and the Kaliningrad Region.

4. The cluster is divided into 2 groups of the industrialized regions characterized by long-lasting development. The first group includes the Samara Region, Perm Krai, Sverdlovsk Region, Republic of Tatarstan, Nizhny Novgorod Region, Chelyabinsk Region, and Omsk Region. The second group comprises less industrialized regions: the Yaroslavl Region, Republic of Bashkortostan, Volgograd Region, Vladimir Region, Tula Region, and Novgorod Region.

5. The Lipetsk Region and Vologda Region form a separate cluster but at the third level of hierarchy are included into group 4.

6. The Belgorod Region and Krasnoyarsk Krai form cluster 6 and join cluster 4 at the fourth level of hierarchy.

7. The Saint Petersburg and Moscow Region are close in parameters having high rates of living standards growth but lagging behind the preceding clusters in the rates of industrial development.

*C. Clusters including the regions with low GRP per capita and industrial underdevelopment.*

8. The Magadan Region and Sakha (Yakutia) Republic.

9. Karachay-Cherkess Republic, Krasnodar Krai, the Astrakhan Region, Republic of Adygea, Kabardino-Balkar Republic, Tambov Region, Republic of Buryatia, Rostov Region, Saratov Region, Altai Krai, Stavropol Krai, Bryansk Region, Oryol Region, Ivanovo Region, Novosibirsk Region, Voronezh Region, Penza Region, Kurgan Region, Mari El Republic, Smolensk Region, Ryazan Region, Republic of Mordovia, Kostroma Region, Chuvash Republic, Tver' Region, Ulianovsk Region, Kirov Region, Republic of Karelia, Irkutsk Region.

10. Khabarovsk Krai and Kamchatka Krai, forming a separate cluster, join large cluster 9 at the 2nd level of hierarchy.

11. Republic of Khakassia, the Tomsk Region, Udmurt Republic, Kursk Region, and Murmansk Region, Arkhangelsk Region.

12. Komi Republic, Orenburg Region, and Kemerovo Region.

*D. Clusters of the lower level including the regions with low index scores, which characterize the quality of economy, life and/or pace of economic development.*

13. The Pskov Region and Primorskii Krai are distinguished by their export openness and higher development potential.

14. Tuva Republic, Republic of Kalmykia, Republic of Ingushetia, Altai Krai, Republic of Dagestan, Zabaykalsky Krai, the Jewish Autonomous Region, and Amur Region.

Thus, the conducted analysis has shown that it is possible to divide Russian regions into 4 unequal clusters by the type of their economy organization and line of development. Two out of four clusters (A and B) have potential for innovative technology development. These regions are characterized by sufficient domestic demand. However, investment climate is defined by fundamentally different mechanisms. Therefore, strategic management of the regional innovative technology development should take into account specific features, existing potential, and correspondence to the current economy organization. Therewith, it should be taken into consideration that, in fact, the existing direction of state support for the innovative technology development leads nowhere. Urgent measures should be taken in order to modify the formulated regulatory measures.

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