Article

Innovative Development of Russian Regions: Assessment and Dynamics in the Context of Sustainable Development

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Abstract: Innovative development of regions is a key factor that determines the level of competitiveness of the economies of all countries in the world. This article uses statistical tools to assess the level of innovative development of the regions of the Russian Federation. The purpose of the work is to assess the innovative development of the subjects of Russia for the period 2010–2020. Objectives of the study: (1) to study the main parameters of innovative development of the subjects of the Russian Federation; (2) to conduct a typology of Russian regions by the level of innovative development on the basis of cluster analysis. The selected time interval (2010–2020) was a period of increasing turbulent flows of development of socio-economic processes at the global, national and regional levels. Cluster analysis was used to identify spatial and functional features of innovative development of Russian regions. The obtained analytical calculations confirm a high degree of differentiation between the Russian regions by all key indicators of innovative development. The results of grouping regions on the basis of cluster analysis showed that there are four clusters based on the sum of normalized indicators, reflecting different levels of innovative development in Russian regions. The analysis revealed that most of the regions belong to the groups with moderate and low levels of innovative development. The regions of the Central and Volga Federal Districts have the highest level of innovative development, while the regions located in the north of the European part of Russia, the North Caucasus, the south of eastern Siberia and the Far East, as well as “new” regions, have a low level. The results of the study can be implemented by regional authorities for systematic monitoring of the level of innovative development of regions, making managerial decisions and developing mechanisms to ensure innovation activity in the regions.

Keywords: innovation; regional development; economic growth; cluster approach; Russia; sustainability
1. Introduction

In today’s context, significant attention is being paid worldwide to the challenges of sustainable development, including the financing of investment and innovation, as well as the creation of systems that promote the use of scientific and technological advances for the benefit of current and future generations at global, national, regional and local levels. Significant milestones in the development of the concept of sustainable development cover notable events supported by the United Nations and UNESCO, including the first international conference on the environment in Stockholm (1972) and subsequent meetings in Rio de Janeiro (1982, 1992) and Johannesburg (2002).

The term “sustainable development” has been in common use since 1987, when the report of the United Nations World Commission on Environment and Development “Our Common Future” was published. This document defines sustainable development as “development in which present generations meet their needs without hindering the ability of future generations to meet their needs” [1].

One of the key aspects of achieving the Sustainable Development Goals is the transition of the economy to an innovative model of socially oriented development. Innovation is becoming a factor contributing to economic and social development. Investment in the innovation sector is a driving force for long-term development and sustainable growth of the country’s economy.

According to the Global Innovation Index 2018, Russia ranked 46th out of 126 countries with a high level of educational and scientific potential, but this potential is not used effectively enough [2].

In 2023, Russia showed a decrease in scores for both the resource base for innovation (down 12 positions to 58th place) and results (down 3 positions to 53rd place), although, in the period from 2020 to 2022, the second subindex showed growth, ranking 51st among 132 countries.

Russia’s best results are still demonstrated in the development of human capital and science—26th place.

In modern conditions, in the current geopolitical situation, the innovative way of development becomes the only way to grow.

Innovation is becoming strategically important for increasing competitiveness and sustainable growth of the national economy.

Development of innovations, development of the scientific sphere and application of advanced technologies in modern society are among the most important factors of socio-economic development of any state and ultimately contribute to the growth of living standards of its citizens. The traditional view of regional development and innovation is based on the innovator–learner dichotomy: a small number of regions produce innovations, while others develop by adopting the experience of these innovative regions. However, researchers in the 1980s identified a blurred line between innovation and learning, which led to a large body of geographic literature on innovation and regional development. After four decades, researchers generally agree that (1) innovation is a major driver of regional development in advanced economies [3–5]; (2) innovation is often the product of a system of regional actors rather than a single inventor or firm [6–8]; (3) some regions have cultures that foster communication and cooperation, and such cultures stimulate and facilitate innovation [9,10]; (4) innovation is often a recombination of existing knowledge in the region [11,12]; (5) outside knowledge should be regularly replenished to maintain an abundance of opportunities for recombination; (6) radical innovation can occur outside the traditional core regions [13–15]; (7) innovation-driven regional development is mainly a phenomenon of advanced economies, although a limited number of regions outside the core have also succeeded in innovative development [16–18].
2. Background and Literature Review

2.1. Background

According to the Strategy for Socio-Economic Development of Russia until 2020, within the next five years, the Russian Federation should become a leader in the world markets of knowledge-intensive products, as well as take a strong global position in the production of innovative and high-tech products and provision of intellectual services. At the same time, as rightly noted by the developers of the Strategy, a serious threat to Russia’s competitiveness is that it is lagging behind in the development of new technologies of the latest generation [19]. The innovation component is the most important aspect of regional policy. Of all post-Soviet countries, Russia has a huge scientific and technical potential, a fairly high level of science development, scientific schools known abroad and a significant share of specialists with higher education. The problems of innovative development of regions are constantly at the center of the attention of representatives of the science and business community. This is due to the fact that in the process of achieving maximum competitive stability of the state, entering domestic products into international markets and increasing the turnover of exports and technology imports, the innovation system of the regions is given a paramount role.

2.2. Literature Review

Innovation, flexibility and the ability to adapt to change are now key elements in ensuring competitiveness. Innovation is the process of introducing a new product, service or method that results in improved productivity or quality. This concept was introduced by Austrian economist Joseph Schumpeter. He believed that innovation is the engine of economic development and contributes to the productivity and competitiveness of companies. Schumpeter also distinguished four main types of innovation: product improvements, new products, new production methods and new organizational forms. These innovations can be the result of research and development, technological improvements or changes in business models. They can be applied in both manufacturing and service industries and their aim is to increase efficiency and improve the quality of work [20].

The development of innovation in regions is directly related to their socio-economic condition and their ability to meet the challenges of regional growth. The definition of the strategy of innovative development of the region is aimed at solving problems related to life support within the socio-economic system and at creating an effective management approach that promotes informed decision making to improve the sustainability of this system.

Methodological and conceptual foundations of the innovation development trajectory in Russia, as an important component of the state economic policy, still continue to develop, while globalization and integration processes require qualitative systematization and improvement. In general, the trajectory of innovative development implies the directions of the region’s development that allow it to move from one stage of development to another, in particular, to the stage of advanced innovative growth.

However, there is a problem of assessing such development, since innovation processes require both quantitative and qualitative assessment, with the need to take into account systemic gaps arising both in a certain period of time and due to imbalances in the socio-economic development of different regions of the state.

This is primarily due to the incompatibility of the development of techniques and technologies, the system of using management methods, the potential of the region, different standards of quality of life, mentality, etc.

The ability to generate and implement knowledge and innovation is perceived as the most important driving factor for regional development.

The recognition of the importance of knowledge in shaping economic development has roots in the theories of Schumpeter, who emphasized the importance of “new combinations of knowledge” as a driver of innovation and entrepreneurial activity. Innovation output is seen as the product of knowledge adoption within knowledge production [20].
In Romer’s long-run growth model, an increase in the stock of knowledge leads to a proportional increase in the productivity of the knowledge sector. The generation of new ideas within the knowledge production function for each region depends on the level of knowledge stock and human resources engaged in innovation activities. Since regions are not “isolated islands”, regional growth models need to take into account the spatial interaction effects that result from the spatial diffusion of technologies. Because knowledge is readily available and its resources are unevenly distributed in space, the location of knowledge production and the characteristics of knowledge flows become key factors in understanding economic growth. Knowledge production models are thought to be better suited to regional units of observation than to enterprises isolated from spatial context. Research has shown that the region provides a platform on which new economic knowledge can emerge and translate into innovation [21].

In modern Russian socio-economic science and practice, considerable attention is paid to the issues of innovative development of regions. The works of such authors as T.R. Akhmetov [22] consider the regularities and contradictions of the development of scientific and innovation activity in the regions of the Russian Federation during pandemic conditions.

Well-known researchers, including I.A. Azarov [23], A. Baluch, I.A. Pavlova [24], Guseinov, et al. [25] and A.L. Zelezinsky et al. [26], as well as many others [27–29], consider methodological approaches to the assessment and formation of prospects for innovative development of regions, the renewal of the innovation system of regions and the role of innovative development in the spatial development strategy of the Russian Federation.

Among researchers from abroad, it is worth noting the works devoted to regional innovation systems [30–32], as well as the impact of innovation on the socio-economic and sustainable development of regions [33,34].

The need for and importance of innovative development at the regional level is now receiving more and more attention.

Previously, scientists focused on innovation in individual enterprises, but today, the effectiveness of innovation is possible only in a specific territory.

The scale of modern scientific research and innovation requires the integration of new knowledge, commercialization of innovations and resource support for all participants of the innovation process, as well as the development of a comprehensive program of innovative development of the territory.

This requires the mobilization of all available resources within a specific specialization, the existence of proximity of “intellectual capital”, “technological resources” and business, as well as public management of innovation activities [35].

The category “innovation activity of the region” reflects the real results of the application of innovations in the production process. The analysis of different levels of innovation activity in the regions through the use of specific numerical indicators makes it possible to assess the level of innovation activity and the efficiency of the use of available resources.

To study the level of innovation activity, it is necessary to conduct a comprehensive analysis of several related indicators, which are combined into a single integral indicator. This approach allows us to accurately assess the level of innovation development in the region.

In a sense, shifting attention to the innovative development of a new object, namely the region (territory), does not represent novelty. Earlier, M. Porter noted that in the conditions of globalization, competitive advantages are often associated with a specific location. Organizations now choose their partners based on geographical, cognitive, organizational, institutional and social proximity, leading to joint R&D projects. The process of integration of regional and sectoral innovation systems is intensifying, resulting in a new spatial architecture of innovation.

The proximity of innovation activity participants naturally leads to their clustering, operative work and coordination of managerial decisions. Specialization of innovation activity participants contributes to the efficient distribution of innovation labor.
The development of innovations in the regions is characterized by several important aspects. Firstly, it is the creation of favorable conditions for the development of human resources, including access to educational and research resources.

Secondly, it is to support and stimulate the innovative activity of enterprises and organizations in the region. Thirdly, it is the expansion of innovation activity in the public sector at the regional level, which includes the provision and support of various innovation initiatives.

The main aim of the innovative development of the region is to form an innovation system that unites enterprises and organizations engaged in the creation of new knowledge and its practical application. This system contributes to the socio-economic development of the region by creating sustainable innovation processes and incentivizing innovation.

In general, the development of innovation in the regions is aimed at creating a favorable environment for the growth and development of the innovation system, which contributes to the progress and improvement of the quality of life in the region.

The innovation soundness of the region is determined by the total quality and quantity of innovations that ensure the level of innovation activity and meet the goals and objectives of the region’s development.

The innovative development of the region has unique characteristics that distinguish it from other development paths. These characteristics include a specific focus on goals and methods of achievement, as well as a unique innovative development mechanism.

Innovative development of the region is a balanced innovative state of the territory, which is manifested in the increase in innovative potential, increase in the intensity of the use of this potential and increase in the production of innovative products.

We consider the balanced innovation state of the region, or innovation statefulness, as a set of qualitative and quantitative characteristics that determine innovation activity in a given territory. This state provides the necessary resources and potential for economic development of the region on the basis of innovation activity, taking into account both the formation and optimal use of resources and potential in accordance with the goals and objectives of development [36,37].

The characteristics of the region’s innovative development that distinguish it from other possible development paths include the following features (Figure 1).

### Figure 1. Characteristics of regional innovation development (source author).
Yükçü, S. and Polat, E. state that “Sustainability has emerged as a critical issue in contemporary society, often evoking parallels with a newly discovered, unprophecied “religion”. However, upon closer examination of the world, it becomes apparent that adherence to this “religion of sustainability” is not as widespread as one might expect. The concept of sustainability centers on the concern for future generations and their ability to enjoy the same resources and quality of life as the present generation. This concern encompasses environmental, social, and economic aspects, including responsible consumption, transportation choices, and the consequences of natural disasters” [38].

In the opinion of a number of authors, “In the opinion of a number of authors, “sustainable development” can be seen as an adaptation to society, economy and in general the problems that humanity is facing today: climate change, water crisis, drought, desertification, resource depletion, waste problem, loss of biodiversity, population growth, poverty, migration, etc.

In order to prevent, counteract and address the consequences of the above challenges, as well as to ensure economic development, social progress and human development, specific actions that have measurable and concrete objectives are needed. This is precisely the subject of national sustainable development strategies” [39].

Russian and foreign scientists attach special importance to innovation in their research. Innovation is a new or improved product, process, technology, method or service that can improve the quality of life and increase the efficiency of production and the economy as a whole. Current research in the literature focuses on the creation of a new model that considers aspects of investment economics, management of innovation projects, international innovation implementation and the use of best practices [40,41].

Some of the scientists study the factors that influence the innovative development of regions and large cities. They study subsystems of regional innovation systems and also investigate the conditions that influence their functioning [42,43]. Undeniable attention in recent scientific publications has been paid to the development of conceptual approaches to the formation of innovation strategies of regions, as well as profiles of innovative development in the Russian Federation [44,45].

The literature review shows that cluster management at the level of regional socioeconomic systems is discussed in a limited number of scientific publications, while the study of clusters is quite active. Traditionally, in studies on cluster issues, foreign and domestic scientists use statistical data published by the state statistical service, ministries and agencies. Empirical works oriented on official statistics are diverse and are presented in large numbers.

Thus, for example, D.B. Audretsch, E.E. Lehmann and M. Menter conducted a study of the impact of state cluster policy on regional entrepreneurial activity, having accumulated statistics of labor markets in 150 regions of Germany [46].

In the paper by S. Bakhtiari and R. Breunig on the basis of econometric analysis of data from the Australian Department of Industry and Innovation on firms’ expenditures on R&D, an assessment of the spillover effects of innovation is given, taking into account the geographical proximity of firms and clustering processes in industry [47]. E. Feser, H. Renski and J. Koo proposed to supplement the regional industry cluster analysis with benchmarking [48], which, as E. Feser points out in his later study, constitutes an alternative methodology for identifying value chains on the basis of data from the North American Industry Classification System, indicating the functioning of clusters in the region.

Methodological foundations for the identification and analysis of territorial clusters through a comprehensive analysis of the regional economy in the context of branch statistics and its modifications are laid by M.E. Porter [49–51], E. M. Bergman, E. J. Feser [52], N. Harmancioglu and G. Tellis [53]. In turn, M.E. Porter points out the need to improve the system of information and analytical support for cluster research, because “the system of industrial classification standards (Standard Industrial Classification System) is poorly aligned with clusters and the real nature of competition”, while “clusters offer the government a different way of collecting and organizing information” [52].
This “other way” was developed by the research group of M.E. Porter. Porter created a classification that translates all sectors of the Standard Industrial Classification and Standard International Trade Classification into clusters for the purposes of their subsequent analysis [49]. This classification is the basis for the procedure of mapping regional clusters in the American open project Cluster Mapping.

In the practice of domestic regional cluster analysis, scientists rely on the All-Russian Classifier of Economic Activities (hereinafter—OKVED), according to which sectoral statistics are generalized in the Russian Federation; in particular, statistical measurements of various local effects are generalized in order to identify cluster groups and analyze clusters on the basis of the All-Russian classifier of types of economic activity.

To identify promising industries that form the basis of cluster spatial development of regions, state statistics data on the number of firms, their revenues, productivity and employment should be grouped by types of economic activity in accordance with the specialization of clusters.

The most comprehensive analysis was conducted by a team of scientists from the Institute of Applied Economic Research of the National Research University Higher School of Economics and other researchers. They note that to date there is a lack of statistical information on various types of economic activities to identify promising industries with high potential for cluster development [54].

Their research required both the development of a special algorithm for assessing the conditions for the formation of clusters from the sectoral and regional perspective, based on the principles of the European Cluster Observatory methodology, and the use of specialized paid databases SPARK and RUSLANA. The innovative development of Russian regions is one of the key factors in increasing their competitiveness both domestically and globally. Modern economy requires constant updating and creation of new technologies, products and services, which stimulates the development of innovation activities.

The importance of innovation development for Russia’s regions is as follows:

1. Improving competitiveness. Innovations allow enterprises and regions to produce higher quality and high-tech goods and services, which improves their competitiveness in the domestic and global markets.
2. Creating new jobs and raising living standards. Innovative projects contribute to creating new jobs, attracting investment and improving living standards.
3. Development of scientific and technological potential. Innovative projects require highly qualified specialists and modern infrastructure, which contributes to the development of the scientific and technological potential of the region.
4. Improvement of the economic situation. Innovative development of the regions contributes to the increase in production volumes, increase in export opportunities and improvement of the economic situation in general.

Thus, innovative development is a prerequisite for the sustainable development of Russian regions in the modern economic environment. In the modern world, innovation is understood primarily as technical innovation. However, even a closer look at technical innovation shows that technical inventions lead to widespread innovation only when the social conditions for it already exist or when social innovations are added. It becomes obvious that innovation can only be understood in relation to the relevant regional or cultural context. What has long been commonplace in one region may be an innovation in another region. If innovation is something specific to a particular region, there can be no universal innovation strategies; at best, there are some basic rules. To develop regions means to find specific, adapted combinations of social and technical innovations.

3. Materials and Methods

The section discusses the data used for the study and describes its source, as well as the CODAS method used for the analysis. The developed method of classifying the studied regions in terms of their innovativeness is also presented.
3.1. Data

The analysis presented here uses data (indicators) contained in the annual compilations “Regions of Russia”. The set of 16 indicators characterizing Russian regions in terms of innovation potential, performance, provision and costs of innovative development was used for the study (Table 1).

**Table 1.** Characteristics of indicators (diagnostic variables) adopted for the study.

<table>
<thead>
<tr>
<th>Scientific staff (I₁)</th>
<th>Share of employees with higher and postgraduate education employed in the economy</th>
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<tbody>
<tr>
<td>Ratio of the number of students in professional educational institutions to the number employed in the economy</td>
<td></td>
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<tr>
<td>Share of personnel engaged in research and development employed in the economy</td>
<td></td>
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<tr>
<td>Share of researchers with academic degrees and postgraduate students employed in the economy</td>
<td>Share of scientific works in the total volume of GRP</td>
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<tr>
<td>Ensuring innovative development (I₂)</td>
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<tr>
<td>Degree of readiness for fixed assets</td>
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<tr>
<td>Fixed assets renewal coefficient</td>
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<tr>
<td>Share of innovation-active enterprises</td>
<td></td>
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<tr>
<td>Share of expenditures on technological innovations as a % of internal R&amp;D expenditures</td>
<td></td>
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<tr>
<td>Share of expenditures on applied research and development in the total volume of expenditures on scientific research and development</td>
<td></td>
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<tr>
<td>Efficiency of innovative development (I₃)</td>
<td></td>
</tr>
<tr>
<td>Ratio of the number of granted patents for intellectual property objects to the total number of patents in the Russian Federation</td>
<td></td>
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<tr>
<td>Share of the region in the number of advanced production technologies created</td>
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<tr>
<td>Share of the region in the use of advanced production technologies</td>
<td></td>
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<tr>
<td>Share of innovative products in the total volume of shipped goods and services</td>
<td></td>
</tr>
<tr>
<td>Innovative activity of organizations</td>
<td></td>
</tr>
<tr>
<td>Expenditures on innovation activities (I₄)</td>
<td>Share of expenditures on innovation activities in the total volume of shipped goods, performed works and services</td>
</tr>
</tbody>
</table>

The set of indicators was selected by the author as a result of the literature review and data availability. Thus, in order to analyze the differences between Russian regions in terms of the level of innovative development, a set of indicators related to human capital, financing of R&D activities, enterprises’ activities in the field of innovation, intellectual property protection, regional wealth and labor activity, as well as the economic efficiency of enterprises, was adopted. The selection of indicators was also aimed at providing an opportunity to assess the diversity of the regions’ level of innovation and to identify which of them have problems with the development of innovation and which of them achieve very good results in this process. The indicators adopted for analysis and covering data for the period from 2010 to 2020 are also diagnostic variables. The study uses a dynamic approach, which allows us to make comparisons between the values of variables for different periods not only in relation to other objects of study (i.e., regions of Russia) but also in relation to time. The set of 16 indicators presented in Table 1 formed the basis for further analysis, on the basis of which differences in innovative development of individual regions were assessed and their clustering was carried out.

3.2. Methods

In the course of preparation of the research materials, the following methods were used: analysis and synthesis—to identify modern forms of innovative structures and outline their main characteristics; statistical—to form indicators characterizing innovative development in the subjects of the Russian Federation; grouping—to analyze the innovative development of regions; and cartographic—to visually display the obtained groups of regions according to the innovative development index. This study is based on the paradigm of scientific knowledge aimed at studying spatial development and revealing its unevenness, which is
reflected through the prism of the center–periphery theory and shows that the concentration of resources is a key factor for the possibility of innovative changes in the centers and their subsequent translation to the periphery. The following indicators were used for evaluation, structured in four blocks: Block 1—“Scientific Personnel”, Block 2—“Provision of Innovative Development”, Block 3—“Efficiency of Innovative Development” and Block 4—“Expenditures on Innovative Activity”. Each of the internal calculation indicators is normalized and consists of several coefficients with values between 0 and 1. To obtain an estimate of the relative indicators, the values for each group of indicators are averaged using a geometric mean.

Let us elaborate on the algorithm for calculating the integral innovation index of the region.

1. The values of the corresponding indicators \( X_{ij} \) are calculated for each thematic block.
2. The obtained values are brought into a comparable form by switching from absolute values to normalized values according to the formula:
   \[
   X_{ij} = \frac{X_{ij} - X_{ij\text{min}}}{X_{ij\text{max}} - X_{ij\text{min}}},
   \]
   where
   - \( X_{ij} \)—the normalized value of the indicator;
   - \( X_{ij} \)—the actual value of the indicator;
   - \( X_{ij\text{min}} \)—the lowest value of the indicator for all regions of the Russian Federation;
   - \( X_{ij\text{max}} \)—the highest value of the indicator for all regions of the Russian Federation.
3. Subindex values for each of the thematic blocks are calculated using the arithmetic mean formula:
   \[
   I = \frac{1}{n} \sum_{i=1}^{n} X_{ij} - X_{ij\text{min}} X_{ij\text{max}} - X_{ij\text{min}},
   \]
   where
   - \( I \)—the index of the region under consideration for the corresponding thematic block;
   - \( n \)—number of indicators in the block.
4. Based on the values of subindices obtained for each of the thematic blocks, the integral system-built innovation index of the region is calculated according to the following formula:
   \[
   I_p = \frac{(I_1 + I_2 + I_3 + I_4)}{4},
   \]
   where
   - \( I_p \)—the integral innovation index of the region;
   - \( I_1 \)—Scientific staff;
   - \( I_2 \)—Ensuring innovative development;
   - \( I_3 \)—Efficiency of innovative development;
   - \( I_4 \)—Expenditures on innovation activities.
To ensure the equal contribution of the selected indicators to the final value of the index of innovative development of the region, the weight coefficients of subindices of thematic blocks according to Formula (3) are calculated as a quotient of the number of indicators used in the calculation of each subindex divided by the total number of indicators of the evaluation system.

In accordance with the proposed method, the maximum possible value of the index is equal to one, and, naturally, the higher the obtained value, the higher the level of innovative development characterized by the region under consideration.

The critical limit should be considered as such a value of the indicator, the exceeding of which indicates the emergence of a threat to the functioning of the economy and the vital activity of society due to the violation of the normal course of the processes reflected by this indicator.
Usually, a single number is defined as the critical limit value, the exceeding of which (when the indicator is rising) or decreasing (when the indicator is falling) indicates the entry of the system into the risk zone.

It would be correct to define two maximum critical values of the indicator, which mark the boundaries of the interval of values permissible for normal functioning and development of the system.

The article uses various criteria, which are used by the authors to monitor the innovative development of regions.

1. In many cases, its critical level is chosen as the threshold value of indicator a. This is the maximum permissible value of the indicator, the failure to achieve which may lead to a negative scenario of economic system development. Critical values are determined expertly, sometimes using international comparison data. As the experience of monitoring innovation systems of various levels has shown, positioning the values of a number of indicators below critical levels has not led to the destruction of regional innovation systems, although it has not brought them to a level comparable to that of the leading countries of the world.

2. A number of strategic planning documents contain target values of indicators that are desirable to achieve by a certain date. In this case, the target level is selected as a threshold value a, and along with monitoring of the research object, the management system is monitored. Dysfunctions of this system can be manifested in overestimated (underestimated) values of target indicators, as well as in inefficient provision of innovation activities at various levels of the management vertical.

3. If the purpose of monitoring is to compare regions among themselves and their positioning within the constituent entities of the Russian Federation, the average level of values of the corresponding indicator for the Russian regions, can be taken as a threshold value a. This methodology can be used when compiling the intra-Russian innovation rating of regions.

4. Another, dynamic criterion is used if the task is to study the dynamics of the region’s development in the corresponding direction. Taking the threshold value a, in this case, it is advisable to choose the basic value of the indicator in the same region for a certain period in the past.

The K-means method was adopted as a clustering method, which allows the division of a set of observations into groups depending on the distance from the cluster center. The Euclidean distance method was used to determine the proximity measure (similarity measure) between the objects. The results of grouping on the basis of cluster analysis of the studied regions are presented in the form of clusters built on the sum of normalized indicators characterizing high, medium, moderate and low levels. The choice of 2010 and 2020 is due to the fact that the production of innovative technologies, as well as innovative development in general, is a long-term process, so it is not reasonable to conduct cluster analysis for indicators with a difference of one year. It is assumed that the greater the difference in the years under study, the greater the variability of clusters.

The Sturgess formula was used to determine the number of groups:

\[ h + 3322 \times \lg N \]  

\( h \) is the number of population units;  
\( \lg N \) is the decimal logarithm of N.

Once the number of groups had been established (four groups were identified), the question of determining the grouping intervals was addressed.

Statistical information on the main indicators of development of the regions of the Russian Federation is provided by the Federal State Statistics Service. Since the content of the Federal State Statistics Service’s reporting on regions has been changing recently, both due to changes in the methodology of calculating indicators and the All-Russian classifier...
of types of economic activity, and there have been transformations in the political–territorial structure, the current period of 2010–2020 was chosen as the analyzed period.

The purpose of the work is to assess the innovative development of the subjects of Russia for the period 2010–2020. Objectives of the study: (1) to study the main parameters of innovative development of the subjects of the Russian Federation; (2) to conduct a typology of Russian regions by the level of innovative development on the basis of cluster analysis. The selected time interval (2010–2020) was a period of increasing turbulent flows of development of socio-economic processes at the global, national and regional levels.

4. Results

The results of the analysis indicate that there is a significant difference in the efficiency of mastering new knowledge and creating innovative products due to the historical peculiarities of regional development and financial capabilities.

All regions of the Russian Federation are characterized by raw material, scientific, industrial and other types of potential with different levels and focus on economic, social, environmental and other problems.

The Russian regions are also characterized by the territorial remoteness of the majority of scientific institutions and industrial enterprises from each other and extremely poor (by world standards) development of an information support system, as well as modern telecommunication systems.

Intensive innovation activity simultaneously acts as a stimulating factor and one of the criteria of investment performance, providing investment attractiveness to the region and its competitiveness (taking into account the deterrent effect manifested in high riskiness).

The main factors influencing the level of innovative development are presented in Table 2.

Table 2. Factors affecting the development of the innovation sphere in the constituent entities of the Russian Federation.

<table>
<thead>
<tr>
<th>Group Factors</th>
<th>Contributing to the Development of the Innovation Sphere</th>
<th>Constraining the Development of the Innovation Sphere</th>
</tr>
</thead>
<tbody>
<tr>
<td>Economic</td>
<td>- growth of demand for high-tech products;</td>
<td>- old structure of the economy of a number of regions of the Federation (predominant development of the resource and raw material base in the regions or the agrarian sector);</td>
</tr>
<tr>
<td></td>
<td>- growth of megacities/centers of attraction of intellectual labor;</td>
<td>- insufficient financing of R&amp;D;</td>
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<tr>
<td></td>
<td>- creation of territorial production clusters;</td>
<td>- inadequate pricing system in R&amp;D;</td>
</tr>
<tr>
<td></td>
<td>- creation of special economic zones;</td>
<td>- low labor remuneration of specialists;</td>
</tr>
<tr>
<td></td>
<td>- state order for R&amp;D.</td>
<td>- lack of investment in the economy;</td>
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<tr>
<td></td>
<td></td>
<td>- high risks of entrepreneurial activity;</td>
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<tr>
<td></td>
<td></td>
<td>- proliferation of shadow employment.</td>
</tr>
<tr>
<td>Social</td>
<td>- changing educational standards in higher education institutions;</td>
<td>- deficit of qualified specialists capable of research and development against the background of a surplus of graduates with higher education;</td>
</tr>
<tr>
<td></td>
<td>- development of a network of branches of leading universities in peripheral regions;</td>
<td>- rapid loss of qualifications of innovation workers in case of temporary unemployment (e.g., due to maternity leave or change in job);</td>
</tr>
<tr>
<td></td>
<td>- growth of investments in human capital.</td>
<td>- high level of hidden unemployment;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- “brain drain” from Russia abroad and from the periphery to the center.</td>
</tr>
<tr>
<td>Legal</td>
<td>- adoption of the Strategy 2020 focused on the innovative way of development;</td>
<td>- imperfection of legislation on intellectual property protection;</td>
</tr>
<tr>
<td>Infrastructural</td>
<td>- development of communications (cellular communication and Internet);</td>
<td>- substantial gap between the sphere of development and the sphere of application of innovations;</td>
</tr>
<tr>
<td></td>
<td>- development of social infrastructure facilities.</td>
<td>- poor material and technical base for conducting research;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- small number of research and innovation centers (science cities);</td>
</tr>
<tr>
<td></td>
<td></td>
<td>- low share of implementation of scientific and technical developments in practical activities.</td>
</tr>
</tbody>
</table>
In Russia, the largest number of functioning innovation infrastructure organizations belong to the production–technological and expert-consulting blocks. More than one-third of all infrastructure organizations of the regional innovation system are concentrated in the Central Federal District. The Central Federal District is characterized by high indicators of innovative development. The Volga Federal District also stands out. Together, these districts occupy about 10% of the territory area and contain 48% of the population. They produce 66% of innovative goods, works and services; in addition, the cost of technological innovation of organizations is quite high and amounts to about 61%. Advanced technologies are actively used and about half of all innovative production technologies have been created.

In the above-mentioned districts, the largest specialized innovation structures are concentrated, for example, the Skolkovo center, science cities and ZATO (closed territorial entities): Sarov, Obninsk, Dubna, Zhukovsky, Korolev, Pushchino, Reutov, etc. The range of investment and financial institutions, namely, venture capital industry enterprises, is also quite wide. The innovation development indicators of the Northwestern and Urals Federal Districts are at the average level. These districts have quite high scientific and technical potential, and many large enterprises of the military–industrial complex are based there, which use the most advanced technologies. The regions of the Southern and North Caucasian Federal Districts are characterized by a low level of innovative development. The share of innovative products in the total Russian volume is not even 3%. The low level of indicators is due to the insufficient level of socio-economic development of the regions of these districts, as well as the fact that the innovation infrastructure has not been formed.

Consequently, by the level of innovative development, Russian regions can be categorized into three conditional groups:
- Regions—generators of innovations. They have the following tendency: innovations are created much more than they are consumed.
- Regions—“acceptors”. Here, the situation is exactly the opposite: innovations are consumed much more than they are created.
- Promising regions. Their economy occupies an intermediate position between the first and the second groups [55].

In recent years, Russia has also formed a number of approaches to the comparative assessment of innovation activity and investment attractiveness of regions; their ratings are used to develop the most effective solutions in the implementation of economic policy both at the national and regional levels.

The results of innovative development of regions are statistically observable and measurable, and various methodologies are used to assess them, including various indicators in different groupings.

The presented methodology was used to assess the level of innovative development of Russian regions.

After categorizing all indicators into groups, the data for 85 subjects are ranked with respect to each indicator, where 1 is the worst value and 85 is the best value. Then, all obtained rank values are summed for each subject of the indicators. According to the central limit theorem, the sum of a sufficiently large number of weakly dependent random variables with approximately the same magnitude has a distribution close to normal. The indices for 2010 and 2020 were calculated using the formula (4). Figures 2 and 3 show the results of cluster analysis.

To obtain a normal distribution of data, the values of the following subjects of the Russian Federation were excluded: the Nenets Autonomous Okrug, St. Petersburg, the Primorsky Region, the Khabarovsk Region and the Jewish Autonomous Okrug, as their values were extreme points by regions.

For cluster analysis, we used the STATISTICA program. The analysis of the statistical characteristics of clusters allows us to conclude that it is reasonable to divide the regions into four clusters (Table 3).
Figure 2. Clusters by innovative development, 2010 (source author).

Cluster 1 includes the regions with higher values of innovative development, while cluster 4 includes the regions with the lowest indicators of innovative development. Considering the dynamics of changes in the composition of clusters, we note that in the period from 2010 to 2020, the number of subjects included in cluster 4 significantly decreased (5 units) and the number of subjects that fell into cluster 1 increased (4 units) (Figure 4).

Table 3. Clusters by innovative development (source author).

<table>
<thead>
<tr>
<th>2010</th>
<th>2020</th>
</tr>
</thead>
<tbody>
<tr>
<td>Moscow</td>
<td>Moscow</td>
</tr>
<tr>
<td>Moscow Region</td>
<td>Belgorod Region</td>
</tr>
<tr>
<td>Republic of Bashkortostan</td>
<td>Voronezh Region</td>
</tr>
<tr>
<td>Republic of Tatarstan</td>
<td>Lipetsk Region</td>
</tr>
<tr>
<td>Perm Region</td>
<td>Moscow Region</td>
</tr>
<tr>
<td>Nizhny Novgorod Region</td>
<td>Tula Region</td>
</tr>
<tr>
<td>Samara Region</td>
<td>Rostov Region</td>
</tr>
<tr>
<td>Sverdlovsk Region</td>
<td>Republic of Bashkortostan</td>
</tr>
<tr>
<td>Tyumen Region</td>
<td>Republic of Tatarstan</td>
</tr>
<tr>
<td>Chelyabinsk Region</td>
<td>Perm Region</td>
</tr>
<tr>
<td>Krasnoiarsk Region</td>
<td>Nizhny Novgorod Region</td>
</tr>
<tr>
<td></td>
<td>Samara Region</td>
</tr>
<tr>
<td></td>
<td>Sverdlovsk Region</td>
</tr>
<tr>
<td></td>
<td>Tyumen Region</td>
</tr>
<tr>
<td>1 cluster</td>
<td>Chelyabinsk Region</td>
</tr>
</tbody>
</table>
Table 3. Cont.

<table>
<thead>
<tr>
<th>2010</th>
<th>2020</th>
</tr>
</thead>
<tbody>
<tr>
<td>Belgorod Region</td>
<td>Vladimir Region</td>
</tr>
<tr>
<td>Vladimir Region</td>
<td>Kaluga Region</td>
</tr>
<tr>
<td>Voronezh Region</td>
<td>Kursk Region</td>
</tr>
<tr>
<td>Kaluga Region</td>
<td>Ryazan Region</td>
</tr>
<tr>
<td>Lipetsk Region</td>
<td>Yaroslavl Region</td>
</tr>
<tr>
<td>Ryazan Region</td>
<td>Volgograd Region</td>
</tr>
<tr>
<td>Tula Region</td>
<td>Voronezh Region</td>
</tr>
<tr>
<td>Yaroslavl Region</td>
<td>Leningrad Region</td>
</tr>
<tr>
<td>Leningrad Region</td>
<td>Stavropol Region</td>
</tr>
<tr>
<td>Rostov Region</td>
<td>Khanty-Mansiysk Autonomous Okrug-Yugra</td>
</tr>
<tr>
<td>Stavropol Region</td>
<td>Altai Region</td>
</tr>
<tr>
<td>Udmurt Republic</td>
<td>Irkutsk Region</td>
</tr>
<tr>
<td>Chuvash Republic</td>
<td>Novosibirsk Region</td>
</tr>
<tr>
<td>Orenburg Region</td>
<td>Omsk Region</td>
</tr>
<tr>
<td>Saratov Region</td>
<td>Tomsk Region</td>
</tr>
<tr>
<td>3 cluster</td>
<td></td>
</tr>
<tr>
<td>Bryansk Region</td>
<td>Bryansk Region</td>
</tr>
<tr>
<td>Ivanovo Region</td>
<td>Ivanovo Region</td>
</tr>
<tr>
<td>Kostroma Region</td>
<td>Kostroma Region</td>
</tr>
<tr>
<td>Kursk Region</td>
<td>Smolensk Region</td>
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<tr>
<td>Oryol Region</td>
<td>Tver Region</td>
</tr>
<tr>
<td>Tambov Region</td>
<td>Tver Region</td>
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<tr>
<td>Tver Region</td>
<td>Komi Republic</td>
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<tr>
<td>Komi Republic</td>
<td>Arkhangelsk Region</td>
</tr>
<tr>
<td>Vologda Region</td>
<td>Kinel Region</td>
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<tr>
<td>Murmansk Region</td>
<td>Murmansk Region</td>
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<tr>
<td>Novgorod Region</td>
<td>Krasnodar Region</td>
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<tr>
<td>Krasnodar Region</td>
<td>Astrakhan Region</td>
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<tr>
<td>Volgograd Region</td>
<td>Volgograd Region</td>
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<tr>
<td>Republic of Mari El</td>
<td>Republic of Dagestan</td>
</tr>
<tr>
<td>Republic of Mordovia</td>
<td>Republic of Mari El</td>
</tr>
<tr>
<td>Kirov Region</td>
<td>Orenburg Region</td>
</tr>
<tr>
<td>Penza Region</td>
<td>Kursk Region</td>
</tr>
<tr>
<td>Ulyanovsk Region</td>
<td>Khanty-Mansiysk Autonomous Okrug-Yugra</td>
</tr>
<tr>
<td>Kurgan Region</td>
<td>Yamalo-Nenets Autonomous Okrug</td>
</tr>
<tr>
<td>Yamalo-Nenets Autonomous Okrug</td>
<td>Republic of Sakha (Yakutia)</td>
</tr>
<tr>
<td>Kemerovo Region—Kuzbass</td>
<td>Amur Region</td>
</tr>
<tr>
<td></td>
<td>Sakhalin Region</td>
</tr>
<tr>
<td>4 cluster</td>
<td></td>
</tr>
<tr>
<td>Smolensk Region</td>
<td>Kostroma Region</td>
</tr>
<tr>
<td>Republic of Karelia</td>
<td>Pskov Region</td>
</tr>
<tr>
<td>Kaliningrad Region</td>
<td>Republic of Adygea</td>
</tr>
<tr>
<td>Republic of Adygea</td>
<td>Sevastopol</td>
</tr>
<tr>
<td>Pskov Region</td>
<td>Republic of Crimea</td>
</tr>
<tr>
<td>Republic of Kalmykia</td>
<td>Sevastopol</td>
</tr>
<tr>
<td>Republic of Crimea</td>
<td>Republic of Ingushetia</td>
</tr>
<tr>
<td>Sevastopol</td>
<td>Republic of Kabardino-Balkaria</td>
</tr>
<tr>
<td>Republic of Ingushetia</td>
<td>Karachay-Cherkess Republic</td>
</tr>
<tr>
<td>Republic of North Ossetia—Alania</td>
<td>Chukotka Autonomous Okrug</td>
</tr>
<tr>
<td>Chechen Republic</td>
<td>Republic of Altai</td>
</tr>
<tr>
<td>Republic of Altai</td>
<td>Republic of Tyva</td>
</tr>
<tr>
<td>Republic of Tyva</td>
<td>Republic of Khakassia</td>
</tr>
<tr>
<td>Republic of Buryatia</td>
<td>Republic of Sakha (Yakutia)</td>
</tr>
<tr>
<td>Republic of Sakha (Yakutia)</td>
<td>Transbaikal Region</td>
</tr>
<tr>
<td>Transbaikal Region</td>
<td>Kamchatka Region</td>
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<tr>
<td>Kamchatka Region</td>
<td>Amur Region</td>
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<tr>
<td>Amur Region</td>
<td>Magadan Region</td>
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<tr>
<td>Magadan Region</td>
<td>Sakhalin Region</td>
</tr>
<tr>
<td>Sakhalin Region</td>
<td>Chukotka Autonomous Okrug</td>
</tr>
</tbody>
</table>
This fact indicates that there is a gradual introduction of innovations in the economy of subjects and the production of innovative goods, works and services is increasing, as well as growth of the research and development and experimental design development spheres. However, it should be noted that the pace of these processes is rather slow. The number of subjects in cluster 2 and cluster 3 remained almost unchanged (Figures 2 and 3).

Innovative development is influenced by a number of factors, both endogenous and exogenous.

The first cluster, which includes 15 regions (2020) (Figure 3), represents the regions of the Russian Federation where most innovation infrastructure facilities are concentrated. It should be noted that their number (10) has increased compared to 2010.

Belgorod, Voronezh, Lipetsk, Tula and Rostov regions improved their positions. This cluster has a wide variety of investment and financial institutions, including both federal and regional venture capital funds.

In addition, there is a well-developed network of information network communications, which allows prompt reception and transmission of relevant information.

The above regions, located in Russia, are home to leading defense industry enterprises specializing in advanced technologies. They play a key role in the development and production of defense and space systems.

A few important enterprises to highlight include the Progress Rocket and Space Center, which develops and manufactures rocket and space technology.

Uralvagonzavod is one of the largest machine-building companies, specializing in the production of military and civilian equipment, including tanks and railway cars. The Ural Optical and Mechanical Plant manufactures optical instruments and systems for various applications, including military applications.

Other leading enterprises in the region include the Votkinsk Plant, which specializes in the production of small arms and ammunition, and the Izhevsk Machine Building Plant, which is one of the largest manufacturers of small arms and automatic weapons in Russia.

Admiralty shipyards, located in St. Petersburg, are engaged in the construction of military and civilian vessels. The Motovilikhinskiye plants are engaged in the production of heavy equipment and military hardware. At the same time, several large science cities and closed cities specializing in nuclear technologies are located in this region.

They are centers of research and production work in the field of nuclear power and nuclear weapons. Lesnoy, Snezhinsk, Novouralsk and Ozersk are the main science cities in this region.
They are closed cities granting special status because of their specialization in nuclear technology.

In addition, there are other settlements and enterprises specializing in the defense industry and nuclear technologies. Tryokhgorny is another science city with a focus on nuclear research and development.

In general, these regions play an important role in the development of the defense industry and are key centers for advanced technologies in Russia. It is also worth noting the strong influence of Moscow and St. Petersburg, i.e., the so-called “capital effect”.

The second cluster includes 24 subjects (Figure 3). This group has slightly expanded due to the subjects that have increased their level of innovative development. Among them, we should note the Kursk, Vologda, Kirov, Ulyanovsk, Penza, Kemerovo and Krasnodar regions and the Republic of Mordovia.

At the same time, there are a number of subjects that moved from the second cluster to the third cluster. Despite all the efforts and potential, regional innovation activity in these subjects remains at a low level.

The transition of some regions from cluster 2 to cluster 3 indicates changes in the structure of innovation activity. Perhaps, these subjects redirected their efforts and resources to other development priorities.

In recent years, there has been a decline in all indicators of innovation activity in the regions of this type compared to previous periods. Expenditures on innovations have decreased almost six times, which indicates a significant reduction in innovation activity.

At the same time, it is worth noting that these regions are actively investing in the development of innovation infrastructure. This suggests that the regions recognize the importance of innovation and seek to create an environment that fosters the growth and development of innovative enterprises.

Business incubators provide assistance and support to startups in the early stages of development, helping them overcome challenges and succeed. Technoparks provide infrastructure and resources for innovative companies, as well as facilitate networking and interaction between participants in the innovation ecosystem.

Technology Transfer Centers serve as a bridge between the academic sector and business, helping to commercialize research results. All these efforts demonstrate the desire to create a favorable and supportive environment for innovation and entrepreneurship.

The volume of innovative goods and services in these regions exceeds seven times, which can speak about the growth of competition and demand for innovative products in the market.

In addition, these regions have significant scientific and technological potential, which may become the basis for the future development of the innovation sphere. However, at the moment, regional innovation activity remains low, and further work on its development is required.

Thus, despite the relatively low level of expenditures on innovation, these regions continue to actively develop innovation infrastructure and successfully produce innovative goods and services on the market, which means their potential for further development and investment attraction.

The third cluster unites 22 regions (Figure 3), whereas in 2010, their number amounted to 24 subjects. This cluster unites the northwest and north of Russia, certain regions of central Russia, as well as western and eastern Siberia, which have significantly lower innovation development indicators compared to the first type of regions.

The main indicators of innovative development here are already dozens of times lower than in the first type. However, most of these regions can be considered promising, as they have all the necessary prerequisites for active innovative development.

The strengthening of the regions’ prospects is due to several factors. Firstly, the favorable economic and geographical position is one of the main advantages of these regions.
Their geographical location provides convenient trade and transportation links with other regions and countries, which contributes to the development of international business and attraction of foreign investment.

Secondly, the significant availability of scientific and technological potential in these regions is a significant factor contributing to innovative development.

The availability of qualified scientific researchers and specialists in various fields of science and technology makes it possible to create and develop new technologies and innovative products.

In addition, the presence of large local innovation centers in these regions plays an important role in their development. These centers provide a platform for research and innovation projects and stimulate active interaction between scientific, technical and business communities.

They provide various opportunities to attract funding and share knowledge and experience with other innovation centers to further develop and expand innovation activities.

Moreover, the main indicators of innovation activity development in these regions exceed the average indicators of the first type of region. This indicates a higher level of innovation activity and the degree of involvement of regions in the processes of development and implementation of innovations.

High innovation performance is reflected in higher labor productivity and increased exports of innovative goods and services, as well as job creation and capital attraction.

Thus, favorable economic and geographical location, significant availability of scientific and technical potential and the presence of large local innovation centers are the key factors contributing to the strengthening of the regions’ prospects.

The improved indicators of innovation activities confirm the successful development of these regions in innovation and provide opportunities for further progress and prosperity.

The fourth cluster consists of 19 regions that have a low level of innovative development. They are located in the north of the European part of Russia, in the North Caucasus, in the south of eastern Siberia and in the Far East. New regions are also included in this cluster.

The Kostroma Region is particularly noteworthy, where the level of innovation activity of organizations has decreased approximately twice over the last 10 years. In this cluster, there is a large group of entities whose main activity is tourism.

Accordingly, regions mainly engaged in agricultural and tourism activities and labor spend less on innovation.

This cluster is an “innovation periphery” with minimal values of innovation development indicators. The costs of technological innovation in these regions are significantly lower, approximately eight times lower, compared to other types of regions.

In addition, the volume of innovative goods, works and services is at a very low level, about seven times lower. The number of advanced production technologies used in these regions is also noticeably lower, about three times lower, compared to the central regions.

However, it is worth noting that the number of created or developed advanced production technologies in the “innovation periphery” is much higher—by a factor of 5. This means that, although these regions lag behind in terms of innovation development, they are actively engaged in the development and implementation of new production technologies.

Thus, the “innovation periphery” represents regions that have not yet achieved high indicators in innovative development but are active in the development and implementation of new technologies.

This gives them the potential for growth and development, as innovation is a key driver of competitiveness and economic development.

Considering the trends of innovative development of Russian regions in 2020 and 2020, we note the following.

In 2010, the innovative development of Russia’s regions was much less active than in 2020. At that time, the regions lagged behind the world leaders in innovation and had rather limited opportunities for development.
Limited funding, insufficient government support and lack of necessary infrastructure have hindered more active development of innovations.

However, by 2020, the situation had changed significantly. Thanks to the active government policy of innovation development, Russia’s regions received additional investment and support. As a result, many regions have significantly improved their innovation performance.

There have been significant changes in the structure of innovation projects. While in 2010, the main focus was on information technology projects, in 2020, we saw an increase in interest in environmental and health-related projects. Moreover, innovative development took place not only in large cities but also in small regions.

The introduction of new technologies and the digitalization of processes has also been an important change. In 2010, the use of digital capabilities was not as widespread as in 2020.

Now, many regions have created digital platforms and developed applications and systems that simplify people’s lives and make it easier to conduct business.

Considering the dynamics of innovative development of Russian regions in 2020, we note the following trends:

Firstly, there has been an increase in the total number of innovation projects, especially in the central and developed regions of the country. This indicates a growing awareness of the importance of innovation for economic development and regional competitiveness.

Secondly, the share of R&D and innovation expenditures in total financial investments of the regions has increased. This indicates more active public and private financing of innovation projects, including the promotion of the creation and development of technoparks and innovation centers.

Thirdly, there is an increase in the number of patents and other intellectual property rights obtained by Russian enterprises. This may indicate an increase in innovation activity and awareness of the importance of intellectual property for regional development.

However, despite the positive dynamics, the innovative development of Russia’s regions in 2020 still had its limitations and problems. Some regions had too low innovation activity, which requires increased efforts and support from the government and the business community.

Another problem is the insufficient linkage between R&D and business. Collaboration and technology transfers between universities, research institutes and businesses need to be more actively promoted in order to increase the commercial success of innovation.

Also, the innovative development of the regions faces the lack of a quality human resource base and a shrinking number of researchers. This calls for increased investment in education and support for young professionals, as well as the attraction of experienced foreign personnel.

Thus, despite some achievements, the innovative development of Russia’s regions still needs further support and improvement.

This requires joint actions on the part of both the state, business and scientific–academic sphere to create a favorable innovation environment and ensure economic growth and development of the country’s regions.

5. Discussion

Innovation activity is the most important condition for the formation of regional strategy. Assessment of its state, control of changes and analysis of development peculiarities in condition when searching for new solutions for economic development are necessary for stable growth of production within the state.

The impact of the level of regional innovation development on the economic and social well-being of territories and structural diversification of production and services is studied by many scientists in Russia and abroad.
A comparative analysis of the results of the innovative development index assessment leads to an unambiguous and predictable conclusion that the leaders—Moscow, the Republic of Tatarstan and St. Petersburg—have a significantly higher level of the index. The system of indicators includes significant, already accomplished and accumulated innovative investments. In addition, the leaders of the rating are well-known centers of scientific research with a strong educational and scientific base.

This study proposes a new methodological approach to assessing the level of innovative development of Russian regions.

The presented results can be compared with other studies, for example, the work of Ketova K.V. and her colleagues [56], where five regional clusters were identified using the K-means method.

In the work of Mityakov S.N. and his colleagues [57], the “nearest-neighbor method” was used, in which the Euclidean distance between the values of relevant indicators was used to determine the level of innovative development of regions.

In addition, the level of innovative development of the regions was determined using the method of cluster analysis.

The found data of Polina E.A. and Solovieva I.A. [58] confirm the results of this study, namely, that Moscow, St. Petersburg, the Republic of Tatarstan and the Moscow Region effectively use their resources for innovative development, since all spheres of innovation activity in these regions have a high level.

The analyses conducted by Inevatova O.A. [59] and Mudarisova Z.R. and Yunusbaeva V.F. [60] show that the regions with an increased level of innovativeness have a higher competitive attractiveness in terms of economy and quality of life and develop more sustainably.

Thus, the conclusions from this study are that the innovative development of Russian regions plays a key role in their sustainable development [61–63].

Despite extensive research on this topic in the Russian Federation, there is still no single unified methodology for assessing the level of innovative development taking into account sustainability.

More in-depth work will be required to determine the relationship between the level of innovative development and the sustainability of regions.

The limitations of this study are as follows.

Currently, there are no global standards and unified methodologies for assessing and verifying the quality of ratings of the innovative development of regions.

Evaluating individual indicators that are not included in a unified framework leads to different conclusions and recommendations for policy decisions.

In future studies, factor analysis can be used to assess the variability and stability of innovation processes. The identification of “weaknesses” in the process of development of regional innovation systems will help to identify priority problems to be solved.

A set of key innovation development indicators should also be systematically measured to provide reliable information on the results of decisions and their utilization.

In future research, it is recommended to apply the maximum criticality method using simulation design and modeling of innovation processes based on statistical and empirical data analysis, probabilistic analysis and threat graphing.

This study did not take into account social factors such as demographic processes, the structure and quality of the labor force and the skill level and quality of human capital, as well as social mobility of the population, which affect the level of innovative development of regions.

Future research should take into account the demographic factor that determines the overall level of need due to changes in population size and structure, which in turn will determine the redistribution of the demographic burden on the working-age population.

In light of the above, a promising direction for further research is to improve the methodology for assessing the level of innovative development of regions, which reflects...
It can be argued that the regional economy, the state of which is characterized as economically safe, simultaneously has all the conditions and indicators for sustainable socio-economic development. Thus, the chain “innovation–competitiveness–sustainable development” becomes fundamental in ensuring the task of sustainable and progressive development of any social and economic system. With the active participation of the state in the management of innovation activities, it will be possible to smooth out the marked divergence in the performance of the regions. The increasing role of regions in the management of innovation development in Russia is dictated by the very essence of innovation policy, which creates the basis for sustainable development of territories and industrial complexes through the effective use of their labor, scientific, technical and production potential. In modern developed countries, there is a gradual strengthening of the role of regions in innovation development, achieved both by partial decentralization of innovation management and by increasing the internal efficiency of innovation.

The strategic aim of regional economic development implies sustainable and long-term economic growth. The study of the problems of regional specifics of innovative development of the Russian Federation regions shows that today, in an open and dynamic economic system, there are no geographical boundaries for the latest scientific and technological ideas and developments.

The following results were obtained from the study:
1. The content of the concept of “innovative development of the region” is considered—all interpretations of innovative development of the region assume that it is “a certain state of the region’s economy, capable of promoting innovations, adequately responding to the requirements of the competitive struggle”.
2. The uniformity or convergence of innovation space reflects the ability of territorial socio-economic systems of the regions of the Russian Federation to converge or equalize the indicators of innovation activity over time. In Russia, spatial unevenness has arisen mainly in the socio-economic sphere under the influence of objective and subjective factors. Objective factors include unique territorial differentiation and peculiarities of the population, which strongly depend on natural climatic conditions. Subjective factors are related to the socio-economic policy pursued by the state, which determines priority directions in the development of industries and regions, as well as the actions of regional authorities to implement federal priorities, including innovative development.
3. The main feature of innovation development in Russia is the significant unevenness of this process between different regions. However, in the long term, this unevenness will decrease due to the spread of innovations from the development centers to the peripheral regions. However, this requires active participation of the state in the management of innovation activities and an increase in the number of private investors in innovation projects.
4. There is a significant concentration of economic space exclusively around large cities, where clusters of innovative growth are currently being formed.
5. There is low receptivity to innovations, which is mainly due to resource deficit (financial, investment, personnel, information, etc.).
6. The methods of cluster analysis allow the grouping of the subjects of the Russian Federation by similar features and attributes, which is of great importance for creating targeted programs and improving regional policy aimed at supporting innovation activity by the federal government.
7. The results of grouping on the basis of cluster analysis of the studied regions are presented in the form of clusters built by the sum of normalized indicators characterizing high, medium, moderate and low levels.
8. It was found that the highest level of innovative development is characteristic of the regions of the Central and Volga Federal Districts. The cluster with a low level of development includes the regions located in the north of European Russia, the North Caucasus, the south of eastern Siberia and the Far East, as well as new regions.

Thus, the study was conducted to assess the level of innovative development of the regions of the Russian Federation based on the formation of a set of parameters and diagnostics of the level of innovative development of socio-economic systems. The assessment of innovative development of the Russian Federation regions makes it possible to diagnose the main problem areas of socio-economic development. The materials of this study are of practical value for regulatory and monitoring bodies of innovation activity of regions, subjects of regional innovation infrastructure and technology transfer for innovation-active enterprises, as the obtained results can be the basis for the development of optimization solutions for the formation of an innovation strategy of modernization for industries, regions and the macroeconomic system as a whole.


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