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RE-BALANCING OF INTENSIVE AND EXTENSIVE FACTORS IN THE CENTER–PERIPHERAL SYSTEM UNDER THE INFLUENCE OF TECHNOLOGICAL DEVELOPMENT

Yuri V. Preobrazhenskiy[1]*, *Anna A. Firsova*[2]

[1]Saratov State University, Faculty of Geography, Saratov, Russia; e-mail: topofag@yandex.ru
[2]Saratov State University, Faculty of Economy, Saratov, Russia; e-mail: a.firsova@rambler.ru

Abstract: Regional development prospects depend on a set of factors, among which the most essential are the population density, distance between actors, and the level of development. Those aspects are revealed, on one hand, while analyzing the type of regional development (intensive or extensive), and on the other hand, from the standpoint of the center–peripheral model. An assessment of the sectoral structure of employed people in the economy of the region and the population density are also used to identify the development type. The combination of these approaches makes it possible to identify the regional capacity for innovations diffusion and knowledge spillover. The aim of the research is to assess regional differences in the economy sectoral structure for identifying the innovative and extensive types of Russian regions. There are other methods used in the research as well: cartographic analysis, structural-sectoral analysis, and typology. The types of regions characterized by disproportions of intensive and extensive development have been identified. Measures are proposed to realize the regional economic potential. The issues of the territorial transformation of the settlement system and economic space are discussed. Further research is associated with an extended analysis of intensive development factors and cross-county comparison of the factors of innovations diffusion intensity and knowledge spillover.

Keywords: regional development; technological structure; intensive development; extensive development; Russian regions

Introduction

Over the past decades, due to the acceleration of the natural and anthropogenic components in the geosystems of various hierarchical levels, the issues of spatial contours of balanced development have become increasingly important. Taking into account the complexity and multifactorial nature of spatial development problems in the current context, it is necessary to develop new methods and approaches to identifying natural, social, economic, demographic, institutional, and political factors. It is also important to study the role and mechanisms of their influence on the increasing ability of territorial systems to maintain their sustainability. The most important aspects here are measuring the regional dynamics stability, center–peripheral relations,

*Corresponding author, e-mail: topofag@yandex.ru

structural differences in the stability of regional systems, indicators and models for assessing stability, institutions and mechanisms for managing regional systems, regional politics, and measures for increasing general and sectoral sustainability capacity.

In the modern conditions of global innovative development, it seems important to assess the relationship between extensive/intensive factors in the development of the center–peripheral system, as well as the place of Russian regions in this scheme. Finding the optimal combination between extensive and intensive development is one of the most important tasks. Only by solving this, it is possible to work out a correct spatial development policy. Many countries face a similar choice between extensive and intensive development. Some of them (e.g., Australia and Norway) show that balanced development is possible. For others, replacing extensive development with intensive one becomes a necessary condition for maintaining economic independence. In fact, we are talking about the country's choice of a long-term strategy—remain a raw material periphery or become a technology center (Kusurgasheva, Lubyagina, Stefanek, & Lapinskas, 2019).

To understand the modern determinants of regional development, it is equally important to take into account both spatial and structural and sectoral development factors. Only on their basis is it possible to compile a typology of regions and subsequent regionalization for the purposes of spatial planning. In modern studies, as a rule, the structural-sectoral approach is used, by economists, and the spatial one, by geographers. The results obtained in the course of such studies are incomplete and must complement each other. This comprehensive approach to the analysis of intensive and extensive factors of the development of territories is the novelty of this work. This article examines the problems affecting the spatial concentration, efficiency of the innovation transfers and economic activity in the region.

The aim of the research is to assess regional differences in the economy sectoral structure for identifying the innovative and extensive types of Russian regions. The current specifics of the interaction of natural and anthropogenic components require the use of a methodology based on the symbiosis of complementary basic theories of the territorial systems development in three vectors: structural-sectoral, spatial, and temporal. So, those theories are considered in literature review section. The evolution of the regional structure of economic activity in the world center–periphery model is set out in section "Spatial features of intensive and extensive development when changing technological structures." The most significant factors of intense development: density, distance, and development are detailed in "The influence of 'Three Ds' factors on Russian center–peripheral system" section. Research methods as well as the empirical analysis are shown in the corresponding section. In the Result and discussion section, we return to the problem of innovation diffusion and knowledge spillover in the developing regions. Finally, in the conclusion section, we try to demonstrate how the conclusions of this research can be applied.

Literature review

The evolution of macroeconomic is a technologically heterogeneous process and nonlinear in time. The concept of the sectoral model of Clark's economy and the typology of economic sectors were formulated in the works by Fisher (1939), Clark (1940), and Fourastié (1949). They attribute the changes in the sectoral structure of the economy, production, and employment to statistically identified changes in the structure of consumer demand: as per capita income grows, demand for agricultural products decreases, while for industrial goods it increases, but when it reaches the market saturation level it decreases, and demand for services is constantly growing. In accordance

with the changes in the structure of consumer demand, historically, the primary sector of the economy first receives preferential development, then the secondary, and finally the tertiary one.

Based on this theory, in modern conditions, it is justified to single out the following evolutionarily subsequent four sectors of the economy. The primary sector of the economy includes processes related to obtaining primary resources associated with the production factor "land" (agriculture, forestry, fisheries, and mining). The secondary sector of the economy includes manufacturing industries (engineering, metallurgy, petrochemicals, etc.). The tertiary sector of the economy covers the service sector, which Fisher (1939) attributed to the "intangible" benefits. This sector was identified as a residual, which is also characteristic of Clark's approach. The tertiary sector (services) is a highly heterogeneous, even artificial, conglomerate of economic activities, united only by the nonphysical nature of goods produced and services offered.

The tertiary sector is more focused on producing and disseminating knowledge, as well as serving people than on serving the branches of material production. Large branches of the service sector are those that have traditionally focused primarily on servicing people. These are trade, catering industry, and public administration, including defense. The next stage in the development of this theory is singling out the fourth sector, which is justifiable and grounded, taking into account the tremendous increase in the third sector, and the growth of employment in the financial, legal, information and service sectors and companies related to services for business, science, and public administration. According to the concept developed by Fourastié (1949), countries move through the development of primary, secondary, and tertiary sectors, becoming the developed ones, while the labor distribution between sectors occurs in the following ratio of primary, secondary, and tertiary sectors:

- pre-industrial society—the ratio is 70:20:10;
- industrial society—the ratio is 40:40:20; and
- post-industrial society—the ratio is 10:20:70.

However, in a globalized world, the sectoral model is largely determined by the country's position in the global labor division. The latter one is related to the concept of "center–periphery" proposed by Wallerstein (2004) as a model for the interaction of central and peripheral regions in the process of their development. The global economy has a three-tier structure: the core is highly developed countries, the periphery of the world economy are countries-suppliers of raw materials, and semi-peripheral countries with an intermediate position.

The law of regional economic development, described on the basis of the geographical center–periphery model, is that there are always the most and the least developed territories in the area. The center creates innovations, but for doing this it pulls together natural, human, and financial resources from the periphery. Only the concentration of resources allows the center to produce innovations which are, being created in the center, and then they spill over to the periphery according to the theory of "diffusion of innovations" (Hägerstrand, 1967; Rogers, 1962). The innovations move in two directions: (1) to the territories closest to the centers, i.e., to the semi-periphery (close diffusion), and (2) then according to the hierarchical system of cities, from large to smaller ones (distant diffusion). Any innovation, created in the largest center, begins to spread to smaller ones (semi-periphery) and then to the periphery. The temporal heterogeneity of technological development is described by the theory of long waves by Kondratieff and Stopler (1935), who revealed the existence of long waves (cycles) in the development of capitalism. The specifics of innovative development and its basic mechanisms and drivers are reflected in the theory of innovation.

The modern economic cycles theory develops the provisions of the cycles theory and theories of innovation and business cycles by Schumpeter (1911) concerning innovation as the prime cause of technological revolution. In particular, this approach was developed by Perez (2010). The concept of technical and economic paradigms and cycles of the economic revolution that she proposed connects the technological revolution with the emergence of dynamically developing new industries clusters and singles out five technological revolutions in the period 1770–2000s. The cluster contains a set of interrelated innovative technologies that lead to a boosting productivity in almost all the areas of economic activity, the production restructuring, and changes in public administration and society. Each of the cycles represents an expansion of new products, industries and infrastructures, gradually forming a new technical and economic paradigm.

The theory of technological structures by Glazyev (1993) considers scientific and technological progress as a dynamic uneven process of structural changes in the socio-economic system, characterized by a high degree of uncertainty, and in our opinion, most fully and holistically describes the essence and nature of this development. The change in technological structures and the ongoing industrial revolutions lead to a change in the structure of economic sectors, an increase in labor productivity, and intensification of innovative activity. Technological innovations generate significant spillover effects, influence structural proportions, lead to the transformation of the labor market, change the structure of supply and demand in the labor market, and contributes to regional economic growth (Ogurtsova, Tugusheva, & Firsova, 2019; Zaigrajkina & Ostapenko, 2017).

The reasons for the long waves and technical and economic development being uneven can also explain the mechanism and replacement of technological structures, the interaction of technological changes, and socio-economic institutions. The combination of these complementary approaches can give a more holistic comprehension of the co-development of society and nature over the past two centuries and reveal in more detail the spatial-temporal heterogeneity of technical and economic development and provide the necessary basis for assessing the state of the economy and predicting its future state.

Technological structure implies the technological interaction of industries related to the technological chain of manufacturing the final product. A change in technological structures involves greater intensification of production, deeper processing of raw materials, the inclusion of all new components of geosystems (for example, rare metals, wind energy, geothermal waters, etc.), and the creation of new types of transport and infrastructure. Here we can talk about the nature of anthropogenic impact: intensive (i.e., based on qualitative transformations, improving the quality and ways of resources utilization as well as improving the organization, production factors, and technologies) and the extensive growth of production factors (in this case, expanding spatially while keeping the old methods of nature management).

As for the spatial component of the shift in the evolution of technological structures and paradigms of economic development, it should be noted that the previous mechanisms of economic growth, extensive—associated with an increase in the number of workers or an increase in the area of cultivated land—over the past two centuries are growingly replaced by the mechanisms of intensive, no longer growth, but development. Intensive development based on innovation involves an increasingly effective utilization of available natural resources, improvement, and creation of new material and technical resources, strengthening the role of scientific resources. Intensive development transforms not only the structure of the national and global economy as a whole, but also transforms and reorganizes the newly developed natural landscapes. The technologies mastered and implemented in regional economics in each new

long wave allow intensifying the development and making it quite profitable, but only in individual regions. The efficiency of management in each new technological structure allows recovering the investments per unit area or per employee.

At the same time, such technologies are too expensive for semi-peripheral and peripheral regions; therefore, extensive, i.e., less expensive type of development prevails in these regions. Subsequently, due to the saturation of the central region market with any process or product innovation, it diffuses into semi-peripheral regions, triggering, in turn, an intensive development there (Preobrazhenskiy, 2016). However, this process does not occur throughout the territory of semi-peripheral regions, but only in individual zones where a sufficient density of economic activity has been created.

Discussion about sources of economic growth has been going on for a long time. Irmen (2005) argues that periods of extensive and intensive growth replace each other as capital accumulation leads to the introduction of labor-saving technologies. There are some mechanisms for the transition from extensive to intensive development that is widely discussed, especially in the BRICS countries (Brazil, Russia, India, China, and South Africa) (D'Costa, 2009; Jackson, Hewings, Rey, & Gracia, 2019; Lema, Quadros, & Schmitz, 2015). One of the main ideas is the organization of communication between innovation and economic centers to ensure the transfer of technology and knowledge. With a high population density, there are fewer restrictions for it. Therefore, the role of the state's spatial policy in achieving it is high (Romashina, Chistyakov, & Dmitriev, 2018).

Theoretical part

Spatial features of intensive and extensive development when changing technological structures

The correlation of the intensive and extensive path of development can be considered through the concept of center–periphery systems. Such a concept implies the formation of the economic activity cores in places where resources are concentrated, against the background of significantly different types of resources (primarily scientific, technical, and material) peripheries. During the change in the type of development and technological structures, fundamentally new industries are formed in the cores, while the key industries of the former technological structures are shifted to the provincial regions (semi-periphery), transforming landscapes accordingly. In the economy of the country or the macroregion the peripheral areas minimally affected by innovation are extractive industry and subsistence agriculture (otherwise, the primary sector of the economy).

In a pre-industrial (traditional) society, the main economic resources were natural, primarily agricultural land around which all the economic relations were built. In an industrial society, capital has become the main resource, both in physical term (means of production) and in the monetary one. Economic relations here are built largely on the basis of ownership and the use of this capital. In a post-industrial society, knowledge and labor become the main resources. Economic relations are largely determined by the ability to develop and use new knowledge and the effectiveness of knowledge spillover. The technological development of the last two centuries is characterized by spatial heterogeneity and determines the extensive or intensive nature of anthropogenic impact (Table 1).

Table 1
Spatial features of intensive and extensive development when changing technological structures

Periods of technological structure dominance		The evolution of the regional structure of economic activity		
		Center	Semi-periphery	Periphery
Pre-industrial	1 structure 1780–1830	Intensive development in individual European cities	Extensive development mostly agricultural	
	2 structure 1830–1880	Intensive development in individual cities of Western Europe and North America, based on the use of steam engines, coal industry, and ferrous metallurgy	Extensive development with centers of extractive industries and the development of transport infrastructure (railways)	Extensive development mostly agricultural
Industrial	3 structure 1880–1930	Intensive development in individual cities of Western Europe and North America, based on the introduction of electricity, the development of the steel industry	The centers of intensive development of previous technical structures in the areas of textile, coal, and cast iron production	Extensive development, primarily agricultural; centers of extractive industry
	4 structure 1930–1970	Intensive development in the countries of Western and Central Europe, the USA, some cities of the USSR	The spread of the intensive development zone; agricultural intensification	Extensive development, primarily agricultural; centers of extractive industry
Post-industrial	5 structure 1970–2010	Intensive development of the electrotechnical industry in the USA, Japan, and Western Europe while maintaining the importance of engineering, information technology, and microelectronics	The growth of the semi-periphery zone at the expense of the periphery zone (China); intensive development on the basis of industries determined by labor, energy, and material intensity factors	In general, the limits of further extensive development have been reached. Intensification of agriculture, centers of extractive industries
	6 structure 2010–2050	Intensive development based on NBIC technologies, artificial intelligence systems, nanotechnology, hydrogen energy, new transport systems, additive technologies, quantum computing	Intensive unstable development, the emergence of new centers while maintaining the role of the old ones	Remaining "technologically backward" areas

The growth of technological development is determined by economic factors, which, in turn, depend on population density and the availability of infrastructure. Therefore, it can potentially embrace only a certain territory of developing countries with a high population density. Underpopulated territories (mainly arid) will apparently remain peripherals. In the regions of the "old" center, technological development will transform the sectoral structure of the economy, increasing its concentration.

In the latter technological structures, the advantages in the dissemination of knowledge and innovations are gained by countries that are less bound by the need to renew fixed assets in "old" industries. Less

material economy becomes more sensitive to knowledge spillover than raw materials and as a result, landscapes and spatial laws of economic agents' location change. Today, in the geographical literature, the analysis of knowledge flow factors takes the position of analyzing the flows of raw materials and energy, and the practical tasks of locating productive forces in the context of innovative development have largely transformed into tasks to simplify the circulation of ideas (Capello, 2009; Nilsson & Grillitsch, 2015).

The influence of "Three Ds" factors on Russian center–peripheral system

According to the World Bank (2009) experts, the actions of the countries that have recently achieved the greatest success in economic development can be described in terms of "Three Ds":

- increase in density and growth of cities (Density);
- migration of the population toward the points of economic concentration (Distance); and
- reduction in disconnection, elimination of internal and external borders, which impede taking advantage of the benefits of scale and specialization (Development).

In general, it is assumed that density, geographical proximity, and concentration contribute to the process of interaction between firms, between them and scientific institutions, to the process of knowledge spillover. Questions of a quantitative assessment of the relationship between population density and economic indicators in a certain area were raised in a number of works (Brülhart & Sbergami, 2009; Garces-Voisenat, 2012; Pilyasov, 2020; Zamyatina, Goncharov, Poturaeva, & Pelyasov, 2020). The research data as well as our own calculations based on the example of Russia show contradictory results that do not allow us to confirm the hypothesis about the high degree of influence of population density on intensive development. However, there is no doubt that there is a certain level of population density below which economic development is impossible due to the disproportionately high cost of creating the infrastructure for an extremely small number of its users.

The average population density of the Russian Federation is 8.5 people per 1 km^2. However, the population is unevenly distributed within each part of the country. In the European part and the Urals (occupying 25% of the total area of Russia), 79.7% of the population is concentrated. The population density here is 27.2 people per 1 km^2, which is much higher over the average in Russia. The rest of the country's population reside in Siberia and the Far East, while the average population density there is 2.3 people per 1 km^2 (Rosstat, 2020). These aspects influence the diffusion processes of innovations.

Population density is one of the factors limiting the potential for innovative development (Boschma, 2005). Each technological structure is characterized by its own level of development of transport infrastructure, which provides the necessary limit for the connectedness of society. Below this limit, the costs of moving people and goods are stranded. The Russian specificity of low population density and economic activity provokes a kind of delineation (autarchy) of the innovative activity. Population density is not the only factor functioning in isolation, but it intensifies and stimulates the formation and development of a favorable institutional environment for innovation, acts as a catalyst for the concentration of economic activities and leads to agglomeration effects (Firsova, Makarova, & Tugusheva, 2020).

In the present study, the population density indicator is used as one of the characteristics marking the type of development (extensive or intensive). However, it cannot be the only one and it is important to take other factors into account. The importance of the geographic factor in the economic and innovative development has been questioned many times since the last quarter of the twentieth century. Among economists (Boschma, 2005), the concept of proximity is actively developing, according to which the geographic type of proximity (i.e., the territorial (and the time

derived from it) interaction distance) can be compensated for by other types, including organizational (similarity of the organization of firms, inclusiveness, and supra-organizational networks), social (interpersonal relationships between workers and researchers inside the firm and outside it, with actors of potentially related organizations), cognitive (similarity of cognitive processes, homogenization of databases), and institutional (similarity of institutions).

However, it is obvious that such aspects of proximity can manifest themselves only in an integral and meaningful economic space. For example, Sekushina (2020) assesses the quality of the economic space on the basis of an integral indicator. Geographical proximity reduces the communication gap between the national innovations system's actors: universities, research centers, enterprises, facilitating the process of technological transfer, etc. (Firsova & Narhova, 2014).

The task of regional science and development and rational use of natural resources in modern conditions is to remove the contradiction between progressive technological development and the problems of resource depletion and environmental pollution. For this, it is necessary to understand as fully as possible the nature of the anthropogenic impact on nature, its spatial and temporal dynamics, and the degree of stability.

The determinants of technological development—the structure of the economy, the size and accessibility of markets, population density, as well as the costs of production factors and their mobility, the development of transport and communication infrastructure, concentration and agglomeration—are key factors that determine the spatial model of development and the spatial distribution of the economic activity. Both extensive and intensive development is equally important for Russia. Depletion of deposits (primarily oil and gas) is pushing for the development of new territories. This is an economic necessity, since raw materials account for more than half of the country's total exports and revenues from their sale are one of the main items of the federal budget. Enhanced technogenic development of the territory leads to negative externalities on ecosystems, and also negatively affects the traditional use of natural resources by the people of the Far North.

On the other hand, intensive development is necessary to overcome the de-industrialization trends that have been observed over the past three decades (Rodrik, 2015). In this regard, economic geographers are faced with the task of finding regions, nodes, and clusters, whose potential is sufficient for a neo-industrial breakthrough (Preobrazhenskiy, Firsova, & Muzhenskiy, 2020). The inner periphery is in an intermediate state: the developed territory, where the main structures remain three and four.

Methodology

Achieving the main objective of this study required the use of several methods: cartographic analysis, structural-sectoral analysis, and typology. At the first stage, a map (Figure 1) was built on the basis of the volume of innovation goods and services data (Rosstat, 2020). Taking into account the fact that the innovation activity is concentrated in cities, when constructing the map, we interpolated data for the region into cities, taking into account their population size. Unfortunately, Rosstat does not provide specific data on the volume of innovative products by city. This map made it possible to assess the intensity of the innovation in the country and the spatial configuration of its manifestation.

At the second stage we analyzed the structure of employment by economic sectors in Russian regions. The idea of the relationship between the extensive and intensive types of development in a region is provided by the pattern of employment by the economic sectors. Extensive development implies a high employment in the primary sector (extractive industry plus agriculture). Intensive development, on the contrary, consists of the secondary and quaternary sectors.

To study the current structure of the economy and the ratio of the four sectors in the Russian economy, we determined the types of economic activity in the structure of the gross regional product (GRP) in accordance with the Russian industry classifier of economic activities (Obŝerossijskij klassifikator vidov èkonomičeskoj dejatel'nosti [OKVED]) of the Russian Federation, harmonized on the international principles (Ministry of Economic Development of the Russian Federation, 2019). As methodological justification for the structuring of industries of OKVED in the study we used the three-sector model of economy and the typology of sectors by Fischer-Clark, based on which in modern conditions four sectors of the economy are distinguished.

Based on the foregoing, we calculated the share of employment and determined the sectoral structure of employment in GRP by economic sectors according to the following principle: sections A (agriculture, hunting, and forestry), B (fishing, fish farming), C (extraction of minerals) of the OKVED classifier were included in the primary sector; sections D (manufacturing), E (production and distribution of electricity, gas, and water), F (construction), I (transport and communications)—the secondary sector; sections G (wholesale and retail trade), H (hotels and restaurants), J (financial activity), M (education), N (health and social services), O (provision of other public, social, and personal services)—the tertiary sector, as well as the remaining sections K (real estate transactions, leasing, and provision of services) and L (public administration and military security, social insurance), after we deducted from them the number of employees in the sector "research and development", as well as in the sector "public administration of general and socio-economic nature" that were attributed to the quaternary sector.

At the third stage, Russian regions were systematized according to population density and the share of the secondary sector in the structure of employment. This made it possible to identify nine types of regions, including those whose type of development does not correspond to the population density. In general, the research methodology was aimed at showing the ratio of intensive and extensive types of development within the country.

Results and discussion

The centers of innovative development are surrounded by the periphery of the extensive one. Since agricultural development is not possible for a large territory of Russia due to climatic conditions, the main types of extensive development are forestry and mining.

The analysis was carried out according to the data for 2017 on 78 regions of Russia (seven regions: Moscow, St. Petersburg and some regions were not included due to extreme values that impede visualization or lack of data) (Rosstat, 2020). The calculation and analysis results are presented in Figures 1 and 2. The regions are arranged in order of increasing population density.

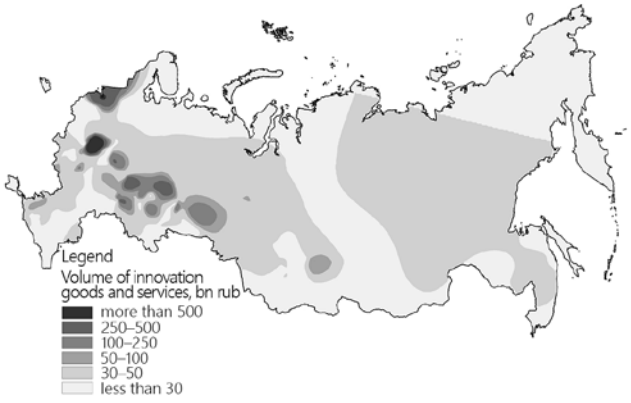

Figure 1. Volume of on innovation goods and services, bn rub. Data used for the presentation of results are obtained from *Regional statistic*, by Rosstat, 2020 (https://rosstat.gov.ru/regional_statistics). In the public domain.

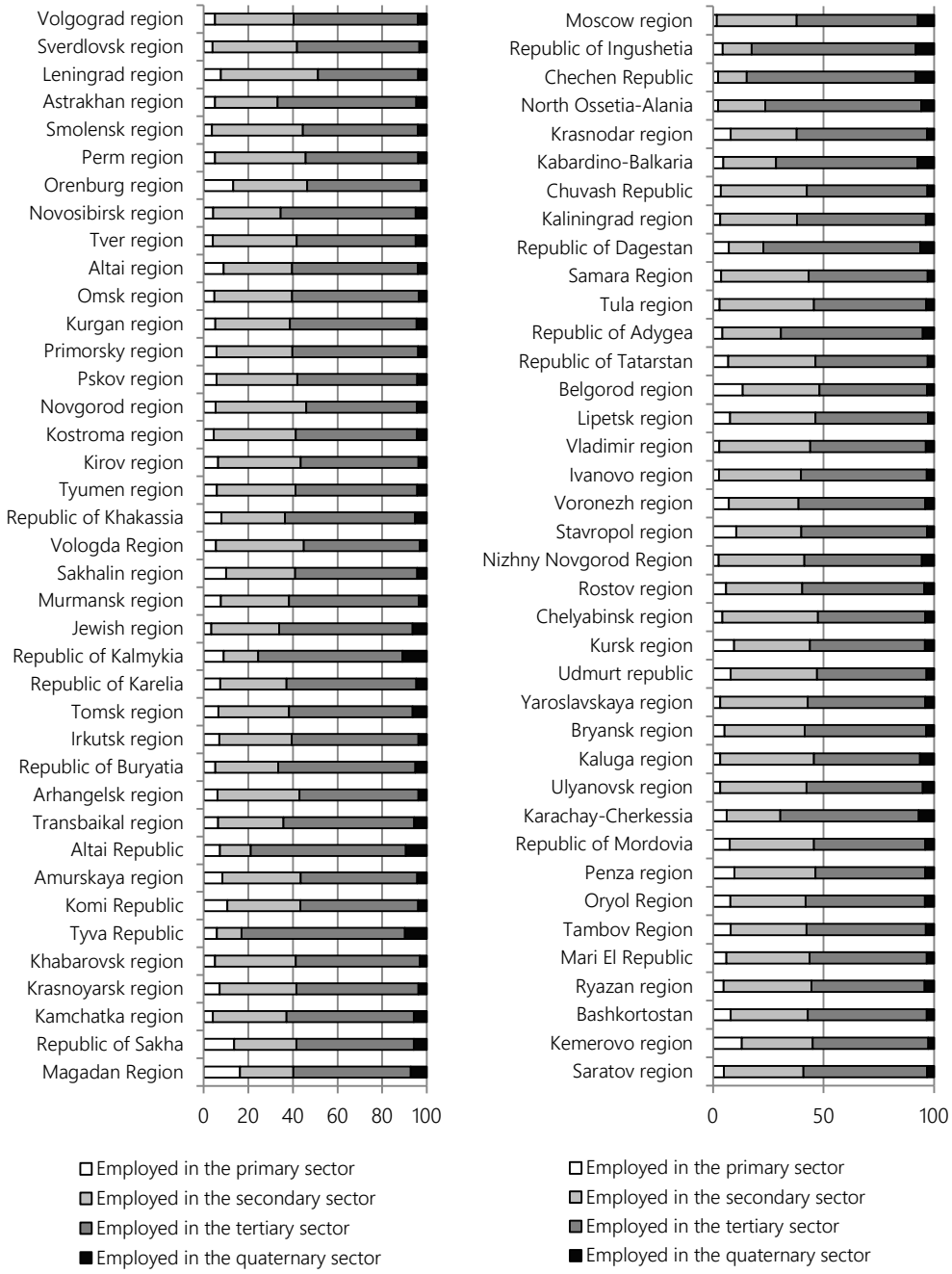

Figure 2. Sectors structure in GRP in Russian regions. Data used for the presentation of results are obtained from *Rosstat*, 2020 (https://rosstat.gov.ru/regional_statistics). In the public domain.

As it can be seen, the regions differ greatly in the share of the employed in the secondary sector of the economy. This is due to different resource bases, as well as the presence or absence of large industrial centers capable of processing raw materials into finished products. The comparison of share of the employed in the secondary sector of the economy and the population density by regions of Russia made it possible to compile a matrix (Table 2). On its basis, it is possible to distinguish nine types of regions with varying degrees of balanced development.

Table 2
Typology of Russian regions according to the balance of extensive/intensive development

		Share of employed in the secondary sector of the economy		
		High (1)	Middle (2)	Low (3)
Population density	High (A)	Tula region, Vladimir region, Samara Region, Tatarstan Republic, Chuvash Republic, Nizhny Novgorod Region, Lipetsk region, Ivanovo region	Moscow region, Kaliningrad region, Belgorod region, Rostov region, Voronezh region	Krasnodar region, Stavropol region, Republic of Adygea, Kabardino-Balkaria, North Ossetia-Alania, Republic of Dagestan, Republic of Ingushetia, Chechen Republic
	Middle (B)	Leningrad region, Chelyabinsk region, Kaluga region, Smolensk region, Perm region, Novgorod region, Ryazan region, Yaroslavl region, Ulyanovsk region, Udmurt republic, Republic of Mordovia, Sverdlovsk region, Mari El Republic, Tver region	Penza region, Bryansk region, Saratov region, Bashkortostan, Tambov Region, Kursk region, Oryol Region, Orenburg region, Kemerovo region, Novosibirsk region	Astrakhan region, Karachay-Cherkessia
	Low (C)	Vologda Region, Kirov region	Archangelsk region, Kostroma region, Khabarovsk region, Pskov region, Volgograd region, Tyumen region, Amursky region, Omsk region, Krasnoyarsk region, Primorsky region, Kurgan region, Kamchatka region, Komi Republic, Irkutsk region, Tomsk region, Sakhalin region, Murmansk region, Altai region, Jewish region	Republic of Karelia, Transbaikal region, Republic of Khakassia, Republic of Buryatia, Republic of Sakha, Magadan Region, Republic of Kalmykia, Altai Republic, Tyva Republic

In Russia, in the current economic situation and under the current policy of the federal center, the effectiveness of innovative activity above the average is typical for regions with a relatively high population density. A technological development takes place in the old developed territory of Russia—the European part and the Urals. But here, the territory of the so-called zone of inner periphery is also large: these are regions with "weak" regional centers and physically and conceptually obsolete fixed assets.

There is a decline in the innovation activity in the peripheral regions (Ingushetia for example) and its building-up in the regional centers; the growth of localization of innovative activity in the largest regions—centers (Moscow and St. Petersburg, Nizhny Novgorod region, Sverdlovsk region).

Quantitative values of indicators of innovative and economic development have been reported in Preobrazhenskiy's study (2020).

The approach applied made it possible to take into account "Three Ds" for the regional development of Russia and identify the types of regions according to the degree of development balance (extensive or intensive). It is essentially a center–peripheral approach. It shows that for the regions of types A1, A2, and B1, the most relevant is the problem of technological innovative development of modern industries, whose products can occupy their niches in the world market. For the regions of type C1, the factor of distance from innovation centers is critical. For the regions B2 and C2, one can note the lack of supporting population centers capable of organizing the territory. Finally, the regions of the C3 type are characterized by a low population density with the development of mining and forestry industries.

The study revealed that there is a reason to use the findings of our analysis to recommend effective areas of regional policy. The mechanisms of agglomeration processes and the tendency to divergence of Russian territories are of a technological and structural nature and are currently being strengthened.

As a result, technological development in the regions of the inner periphery stalled using technologies of three and four technological structures created during the Soviet period. This, with few exceptions (petrochemicals, fertilizer production), does not allow their economies to be competitive even within the country. In fact, one cannot speak here about either intensive or extensive development. On the contrary, there is a polarization process—pulling together the population and economic activity into few separate centers. At the same time, the spatial distribution pattern of population turns out to be more stable in its configuration in comparison with a more flexible economic spatial system, but it also eventually shrinks (Figure 3).

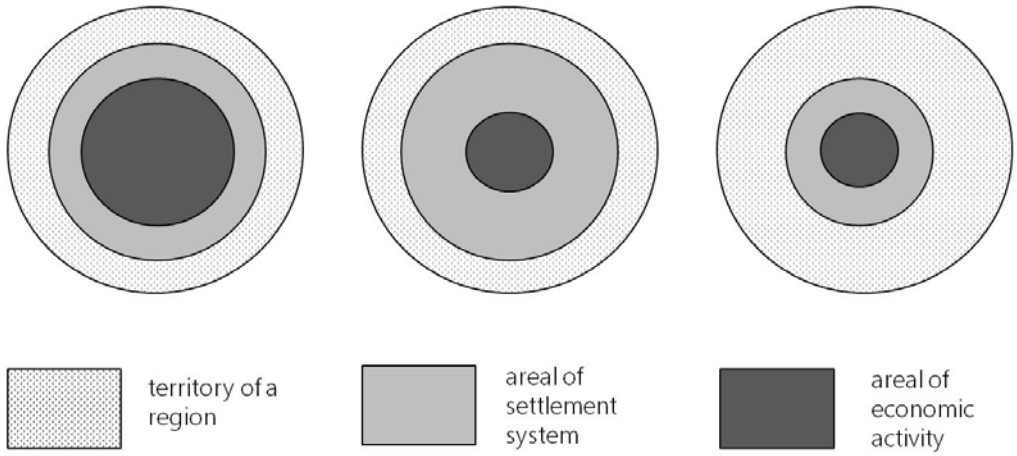

Figure 3. Polarization processes of the spatial distribution pattern of population and economy.

We note that in the European part of the country many deposits have been exhausted and mothballed, while the development of new ones is unprofitable due to the small volumes of mineral resources and the complexity of their production. As a result, the process reverse to extensive development can be observed.

Structural shifts in the industry of regions have a specific manifestation in the territorial organization of the industry. The latter should be considered at a deeper (lower) hierarchical level than the regional level. As a rule, only some small part of it, one or two main microdistricts, is "responsible" for the shifts in the structure of the region's economy. This may be due to the implementation of the investment project, or the development of new industries. At the same time, the rest of the region's territorial economic system may remain relatively stable. It is advisable to consider either economic microdistricts, or individual centers and sites in the territorial economic system of the region.

In this situation, the creation of a holistic innovation space becomes an extremely important factor. It will make it possible to overcome the viscosity of the geographic space and make it possible to exchange knowledge (primarily of a new technological structure) between individual centers, increasing the area of the semi-periphery. Crescenzi and Jaax (2017) examine the territorial dynamics of knowledge creation in Russia, finding local knowledge flows and injections of foreign knowledge. Knowledge spillover refers to the occurrence of the external effects of research activities (for example, in universities), which are used by other actors of regional innovation systems (Aldieri, Kotsemir, & Vinci, 2018; Kaneva & Untura, 2019).

Despite the positive consequences of concentration and agglomeration and the effectiveness of the knowledge spillover and innovations diffusion, excessive concentration of economic activity will lead to an increased interregional differentiation in the country (Preobrazhenskiy & Firsova, 2020). The need to bridge the differences is limited by a lack of resources.

Conclusion

Our research has shown the importance of using an integrated approach in the analysis of regional development (in particular, the influence of "Three Ds" factors). For this, its economic, innovative, resettlement aspects are viewed through the prism of the center–periphery model. The study found that regional development is not determined by geographic determinants alone. Nevertheless, they still largely determine the development of regions with an old technological base (three and four technological structures). It should be borne in mind that the structure of the economy of most Russian regions is not balanced: the tertiary sector is disproportionately large due to the underdeveloped industrial sector. This is a consequence of the country's de-industrialization processes.

Technological development can be considered as a process of spatial replacement of extensive development with intensive. The industrial and sectoral structure of the economy is changing under the influence of technological development. With an intensive type of development, the ability of a regional innovation system to generate knowledge and use external data and transmit it across the region is crucial.

Not all the Russian regions have conditions suitable for an intensive type of development. As a result, an extensive type of development prevails in most of the country. At the same time, the process of polarization of the population and economy is characteristic of the country's national innovation system. This is a response to the sparseness of innovative resources. In this context, the systemic properties of the innovation system allow maintaining the innovation potential in a few points (cities) of the country. However, an expanded innovation process is possible only with the generation of technologies of a new, sixth technological structure, as well as in their distribution of the country's territory, enriching the sociocultural landscape with new meanings based on the principles of sustainable development. This will change the sectoral structure of employment in regional economies. An increase in the share of the quaternary sector of the economy will help strengthen the knowledge spillover and will partly remove the problem of long distances in the country.

An analysis of interregional interaction can provide a more holistic understanding of the processes of innovative (intensive) development; statistical data in the case of Russia on it is clearly insufficient. This would make it possible to assess the contribution and place of each region in intensive development on the basis of its incoming and outgoing broadcasts (transactions). As a result, it would be possible to build a center-peripheral model of the Russian innovation and economic system with intensive cores and extensive periphery. The further study of these issues is associated with the greater number of factors of intensive development, determining the limiting values of its indicators, as well as identifying the prerequisites for the effective spatial distribution of knowledge and innovations.

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