

Regional Specialization and Agglomeration Effects in the Russian Economy



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Abstract. The main goal of economic science which is the search for ways to meet the existing needs by means of limited resources is of particular relevance today in the context of the Covid-19 pandemic, the rapid recession of the world economy, reduced export volumes and energy prices decline. Agglomeration effects represent savings of the region's assets from their more efficient distribution based on specialization. The purpose of the research is to develop theoretical and methodological aspects of specialization and agglomeration effects, which determined the need to solve the following tasks: (1) to provide an overview of approaches related to the study issues, (2) to assess the regional specialization of Russia and calculate agglomeration effects in agriculture, mining and processing sectors of industry, and the service sector, (3) to build a model of agglomeration effects impact on the regions' economic development. The article presents the systematization of research on agglomeration processes through the allocation of groups of works that are based on the classification of Duranton and Puga, territorial and geographical

For citation: Rastvortseva S.N., Snitko L.T. Regional specialization and agglomeration effects in the Russian economy. *Economic and Social Changes: Facts, Trends, Forecast*, 2020, vol. 13, no. 3, pp. 46–58. DOI: 10.15838/esc.2020.3.69.4

approaches, the study of related diversity, the use of the cross-sectional analysis results, sorting processes, and agglomeration economy analysis. The economic point of evaluating a region's specialization is to identify the industries in which it has competitive advantages in order to attract targeted resources. The assessment of agglomeration effects in Russia has shown that not all regions fully realize the advantages of specialization. The constructed models allowed to determine that (1) labor remains the key factor of development in agricultural and industrial regions; (2) roads are not a significant infrastructure indicator of development; (3) agglomeration effects in agriculture and services do not provide the desired result of the per capita GRP increment; (4) the manufacturing sector development is still an important condition. The article proposes a model allowing the assessment of the impact of agglomeration factors and regional specialization, the results of which can become an information basis for the development of regulatory actions in regional management. The research can be valuable for both the researchers and decision-makers in the field of spatial development.

Key words: regional specialization, agglomeration effects, regional economy, new economic geography, economy of localization, regions of Russia.

Introduction

New challenges emerging in the economy today – the spread of the Covid-19 pandemic, a sharp and significant decline in energy prices – threaten the countries' and regions' development stability. Russia is already experiencing and predicting an economic downturn, rising unemployment, the closing of small businesses, and a crisis in a number of industries. In the current circumstances, any actions in the sphere of regional economic policy should be carefully thought through and scientifically justified.

Agglomeration effects are the region's invisible resources allowing additional competitive advantages based on the existing specialization to be obtained. Their study and development analysis allow economic policy to be more targeted, since improving the quality of management decisions at the regional level is impossible without a deep analysis of the resources available in the region, their sources and directions of use [1]. For example, in an earlier study [2], it was shown that narrow specialization in industry is combined with a high level of socio-economic development in those regions that are engaged in mining. For

other constituent entities of the Federation, specialization in a particular sector does not bring economic benefits.

The purpose of the research is to develop theoretical and methodological aspects of specialization and agglomeration effects with testing of the proposed approach to their assessment in the regions of Russia and modeling the impact of agglomeration processes on the per capita GRP level, which will help to identify additional reserves of socio-economic development and can be used in the development and implementation of regional economic policy.

The scientific novelty of the research consists in the systematization of works on the study of agglomeration processes in economic science, the proposal of an approach to determining the full use of the advantages of regional specialization to achieve agglomeration effects, modeling the impact of agglomeration effects on the regions' socio-economic development.

The work will be structured as follows. In the first part, we present theoretical studies of regional specialization and agglomeration

effects. In the second section, we analyze the level and character of specialization in Russian regions and determine the resulting agglomeration effects. The research methodology and model specification are presented in the third part of the article, and the analysis of the results is presented in the fourth part. In conclusion, the main recommendations are presented.

1. Theoretical studies of regional specialization and agglomeration effects.

The processes of globalization taking place in the world require a high level of competitiveness from the Russian economy, which largely depend on the external and internal efficiency of regional development [3], their specialization and the ability to use the emerging agglomeration effects. Research in this area is currently one of the most relevant areas in location theories. A bibliometric analysis of research has shown that the number of publications on the keyword “*Location theory*” from 1991 to 2018 grew exponentially by 10% per year. Since 2004, an average of 172 papers have been published annually.

In modern economic science, research on agglomeration processes has become an independent field. Let us pay attention to several approaches in this area.

The first is presented by the studies based on *the classification of Duranton and Puga* which can be divided into a separate group; this research distinguishes external savings from (a) sharing resources, suppliers, specialized infrastructure, and institutions (*sharing*); (b) greater opportunities for selecting the best employees, suppliers, intermediaries, partners and investors due to their concentration on a given territory (*matching*); (c) ease of learning new technologies, management methods, faster progress along the experience curve (*learning*) [4]. This approach has some disadvantages and needs to be developed [5], but it has become the basis for many successful studies.

The second is *territorial approach* to the economy of agglomerations, in which the static analysis proves that a high level of efficiency is the determining factor of urban growth, while the dynamic analysis considers this relationship depending on the size of the city. It is shown that in each size class, the agglomeration economy has its own impact on the growth of the city [6].

The third is *geographical approach* explaining agglomeration processes through the growth of small cities located near the large ones – the spread of agglomeration effects [6, 7].

The fourth is the study of agglomeration processes through the definition of the industries cognitive proximity, which occurs together with the transfer of knowledge, attitudes, and ideas between the partners of various organizations [8] with the concentration of economic activity on the territory. *Related diversity* occurs between sectors that tend to complement and share skills (contributing to the study of Jacobs externalities). Unrelated diversity leads to the formation of a “portfolio effect” – a diversified economy that can withstand external negative impacts and risks [9, 10].

Fifth, modern research using *cross-sectional analysis*, which was initiated by Ciccone and Hall. They showed that doubling the number of people employed in the economy will lead to a 6% increase in its productivity [11]. Considerable attention in this group of works is paid to the study of cause-and-effect relationships. For example, if we can predict that increasing population density will increase productivity, it is logical to assume the opposite – regions with high productivity attract more skilled workers.

Sixth, this is research based on *sorting processes*. Thus, Combes and his co-authors showed that employees’ individual skills play an important role in explaining wage inequality

between cities (regions), the proof of which was based on skill sorting [12].

Seventh, analysis of *the economy of heterogeneous agglomeration processes*.

One of the current tasks today is *to determine the conditions and effects of locating economic activity in the space* [13]. Empirical evidence of the economists in the field of urban and regional development and geography shows that the effects of concentration (agglomeration and congestion) have a significant impact on the difference in the efficiency between the economic entities [14].

Spatial concentration or agglomeration of economic activity leads to the emergence of effects in the form of collective resources use [15]. This contributes not only to the better dissemination of knowledge [16], but also allows firms to gain a competitive advantage [17]. The foundations of the economic category of “agglomeration effects” were already laid in the works of I. von Tunen, A. Weber and A. Lesh.

Today, in the whole set of approaches to the study of agglomeration effects, it is customary to distinguish two directions: (1) the effects of localization economy – the effects of MAR or Marshall [18, 19] and (2) the effects of urbanization economy – the effects of Jacobs [20]. Positive externalities of agglomeration economies represent a mutual benefit for companies from their joint location in a geographical area (Brenner 2000), which is a result of:

- direct effects between the existing firms in the industry – inter-firm collaboration, local information side effects, or the provision of venture capital by the existing participants;
- indirect consequences, when the companies’ activity improves production conditions for the existing agents and contributes to the entry of new companies into the market – human capital accumulation, infrastructure or

institutional support adapted to the needs of the industry);

- cross-industry effects when the supplier industry relies on the growth of the consumer sector [13].

The issues of the impact of agglomeration economy on the region’s innovative development and economic growth were raised in [21], after which the topic became particularly relevant. Individual research schools have been emphasizing the positive impact of localization economies, showing that industry specialization in the regions is a positive factor for innovation development, as firms tend to learn from local firms in the same industry. Other researchers argued that a more diversified regional economy (i.e., Jacobs’ externalities) will be more conducive to spreading knowledge, as firms get new and better ideas from other local firms working in other sectors of the economy [9].

Agglomeration effects are tested empirically. By the example of the American States, Siccone and Hall [22] it was shown that agglomeration effects are much stronger than the effects of congestion. Sveikauskas [23] found a positive correlation between labor productivity and the number of residents of the US cities. Shefer [24], Beaudry, and Schiffauerova [20] concluded that MAR effects are observed in 47% of cases, and urbanization effects are observed in 45%. Double growth of the city leads to an increase in productivity by 3–8% [25].

Let us analyze the level and nature of the Russian regions’ specialization and determine the resulting agglomeration effects.

2. Specialization and agglomeration effects in the Russian regions

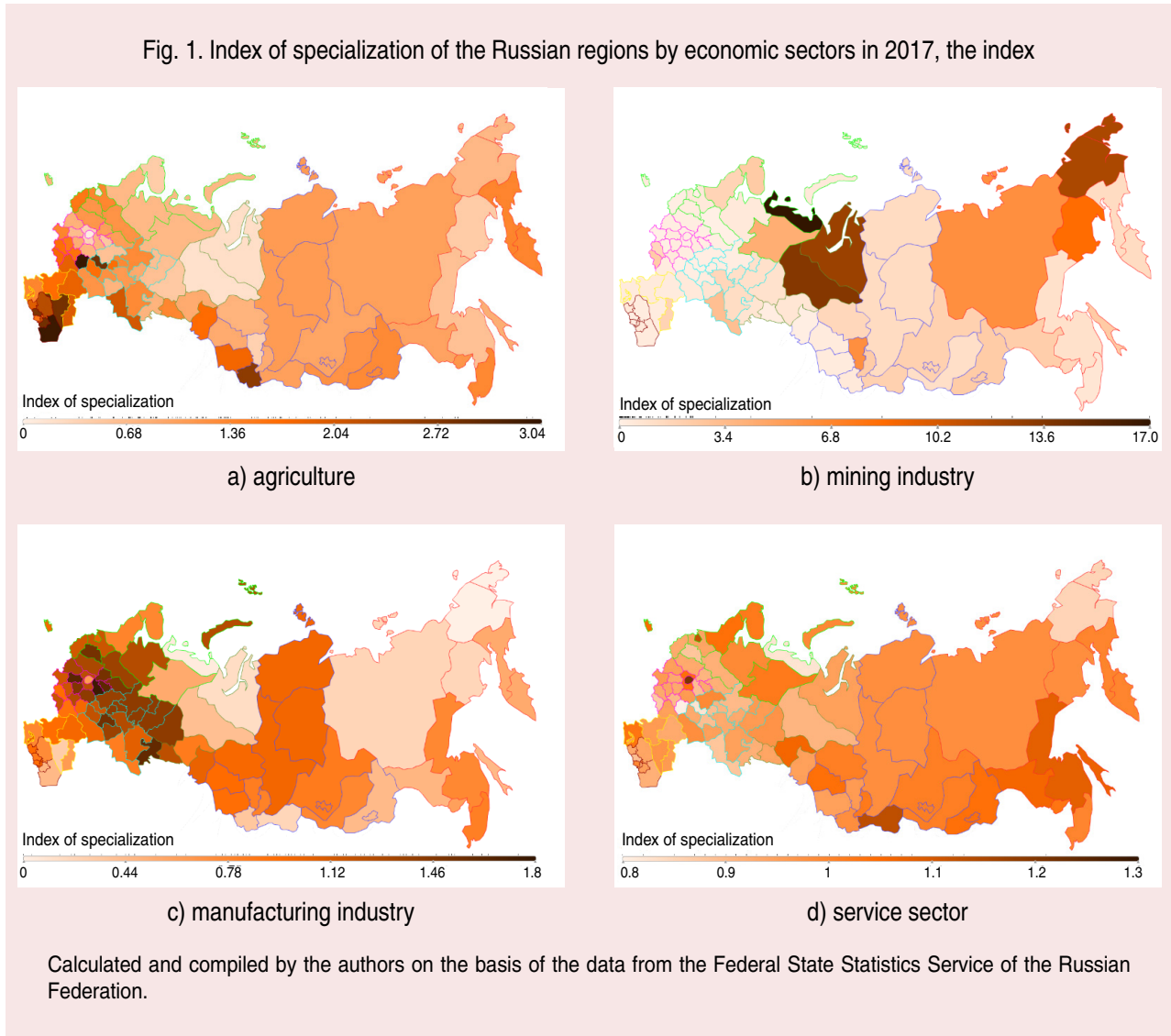
Analyzing the changes in the Russian regions’ specialization, we can note that there were no significant changes in the period of 2005–2017. In agriculture, the level of

specialization increased slightly in 26 regions of the country (from 0.1 percentage points), decreased in 16 regions, and remained at the same level in 41 regions. In the extractive sector of the economy, the increase in specialization took place in the Nenets, Chukotka and Khanty-Mansi Autonomous okrugs (by 6.64, 5.27 and 1.78 percentage points, respectively), Astrakhan and Magadan oblasts (by 1.47 and 1.24 percentage points, respectively); in 22 regions, the level of specialization decreased slightly, while in the rest it remained constant.

In the manufacturing sector, specialization is not dictated by any natural factors, and there

is little evidence that there are some changes in dynamics. In 30 regions, its level during the analyzed period increased slightly (within 0.7 percentage points), in 25 regions it decreased (within 0.2 percentage points). In the service sector, the decrease in the level of specialization (over 0.1 percentage points) occurred only in five regions of the country: the Khanty-Mansi, Chukotka, Nenets Autonomous okrugs (presumably in favor of the mining industry), in Chechnya and Ingushetia (in favor of agriculture). The regions' distribution by their specialization level in 2017 is shown in *Figure 1*.

Fig. 1. Index of specialization of the Russian regions by economic sectors in 2017, the index



We may see that the regions with a high level of specialization in different sectors of the economy are different. These include the Tambov Oblast, the republics of Dagestan, Chechnya, Mordovia, Kalmykia, Altai, Ingushetia, Kabardino-Balkaria, Stavropol Territory, and others. In these regions, specialization is determined by the natural and climatic conditions. But in the future analysis, we will see that it is important to use the available resources effectively, to identify a specific sector of the economy or a set of industries, the development of which will stimulate the emergence of agglomeration effects.

28 regions of Russia specialize in the mining sector of the economy. The leaders by this indicator include the Nenets, Khanty-Mansi, Yamalo-Nenets, Chukotka Autonomous okrugs, Magadan and Kemerovo regions, Yakutia and Komi. These regions' specialization is explained by the availability of minerals and may or may not create agglomeration effects, depending on the effectiveness of the existing prerequisites use.

Traditionally, a third of the regions have a higher-than-average level of specialization in the manufacturing industry [26]. In 2017, specialization in the manufacturing industry was observed in 38 regions of Russia (the index of specialization exceeded 1). The highest values can be noted in the Vladimir (1.74), Kaluga (1.64), Ivanovo (1.62), Chelyabinsk (1.59), Ulyanovsk (1.53), Novgorod (1.52), Yaroslavl (1.51) and other oblasts.

Only 20 regions of the country in 2017 had a specialization in the service sector (in 2005, there were 29 of them). Among the leaders are Moscow (the specialization index 1.21), Tyva (1.13), Saint Petersburg (1.12), Khabarovsk Territory (1.08). However, taking into account the fact that most labor resources of the country's economy are involved in the service

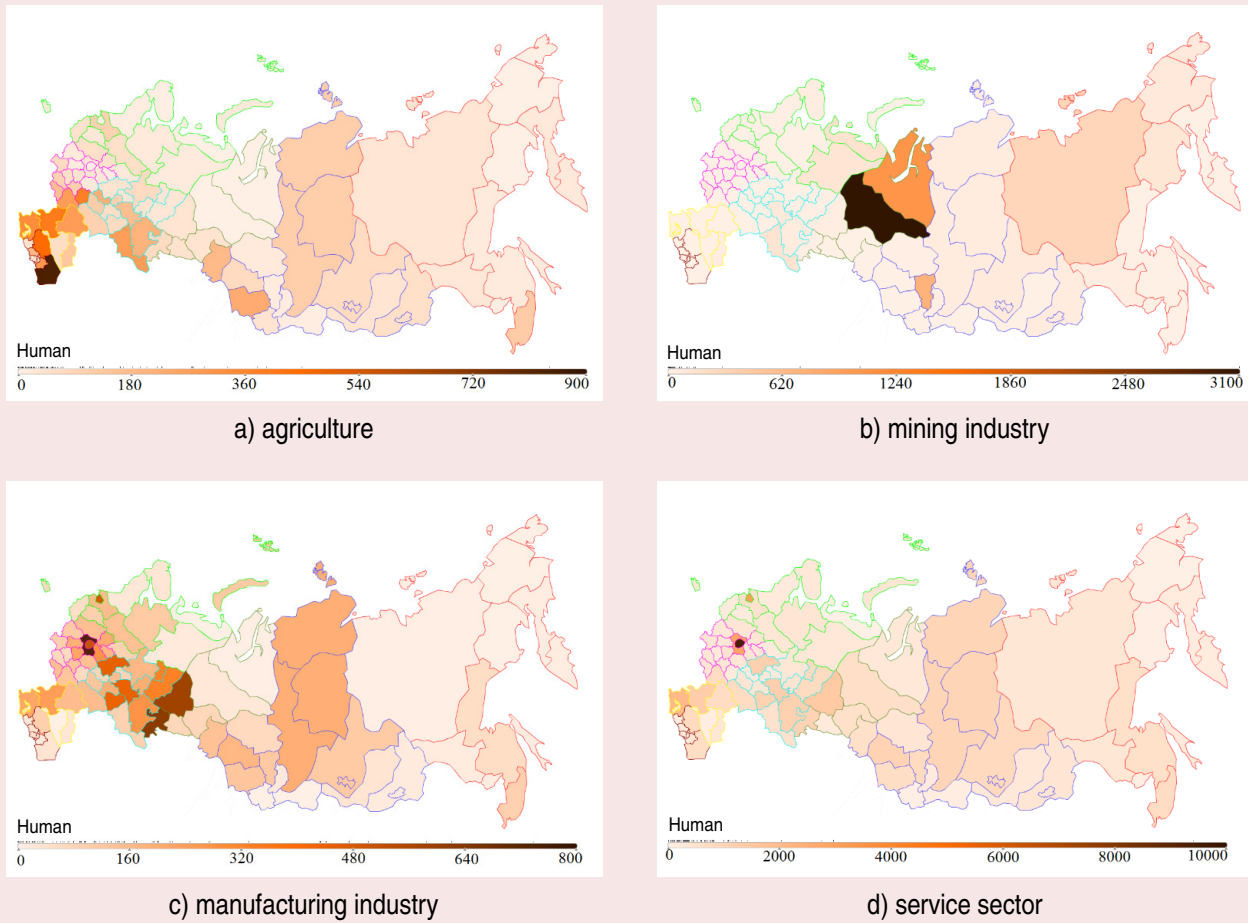
sector, even a low level of specialization can contribute to significant agglomeration effects.

The economic sense of regional specialization is to identify those sectors of the economy in which the region can specialize, and to involve more resources in its development. Agglomeration effects are traditionally estimated by the number of employees (*Fig. 2*).

Agglomeration effect in agriculture is observed in many regions of the Federation, but in twelve regions it is more significant (over 200 people per year). We should note Dagestan (agglomeration effect is 840 people, growth since 2005 is 265 people), the Tambov Oblast (379 and 81 people respectively), Mordovia (221 and 82 people). In general, the size of the agglomeration effect for the period of 2005-2017 tends to decrease (by 2600 people). In the after-crisis period (2010 and 2011), there was a slight increase in the effect (by 1.19 and 0.48%, respectively), in the period of foreign trade relations complication (2015) there was a decrease by 12.44%. The calculations and conclusions obtained confirm the new economic geography (namely, the "core-periphery" model) in the following: when transport costs increase (which means all the conditions that complicate trade and lead to additional costs), economic activity tends to a more uniform spatial distribution, while improving the conditions for trade, it is concentrated in certain regions with a higher level of efficiency.

Agriculture and mining industries are low-mobility sectors of the economy, and if in the first of them changes in the agglomeration effect occur with some delay from changes in trade conditions, in the second it is much faster. Thus, in 2008, the value of the agglomeration effect increased by 45%, and in 2009 it decreased by 32.4% (mainly due to the Khanty-Mansi Autonomous Okrug). Since 2014, there have been no significant deviations in the value

Fig. 2. Agglomeration effect of the Russian regions by economic sectors in 2017, people



Calculated and compiled by the authors.

of the effect, as Russia's foreign economic policy has not affected this sector. It should be noted that the agglomeration effect (in the amount of more than 200 people) occurs in only four regions of the country – the Khanty-Mansi and Yamalo-Nenets Autonomous okrugs, in the Kemerovo Oblast and Yakutia.

Let us consider the dynamics of the agglomeration effect in manufacturing and services-sectors that theoretically should respond to the changes in the complexity of trade relations more strongly. The agglomeration effect in production more strictly follows the assumptions of the new economic geography: in 2009, the agglomeration effect

decreased the most, by 13.35%, but already in 2010, its value has partially recovered. As for the service sector, the size of the agglomeration effect here exceeds the considered industries, in 2017, it amounted to 52,780 people in all Russian regions. The service sector is the most flexible one, foreign policy changes do not affect the agglomeration effect so clearly, in general, its value is tending to increase.

Analysis of the agglomeration effects presence showed that not all regions use the advantages of specialization. A case in point is Moscow where with a low specialization in the service sector (1.21), the agglomeration effect reaches 9,401 people (2017).

3. Research methodology and model specification

To determine the full use of the advantages of regional specialization in order to generate agglomeration effects, we propose a methodological approach including six main stages.

1. *Setting the assessment task* – to determine the nature and dynamics of regional specialization, calculate the agglomeration effects arising in the economy, and identify their impact on the socio-economic development of the region as a whole.

2. *Enunciating a general development model, selecting factors and directions of influence.* Conceptually, the agglomeration effects achieved in the region have a positive impact on the overall economic development. Modeling such an impact can be carried out in two ways. First, it is studying the indicators and locations of new foreign firms in the region. This analysis allows determining and justifying the companies’ motives when locating their enterprises regarding the possibility of obtaining agglomeration effects. This approach is used in the works of strategic management (Alcácer and Chung, 2014). Second, it is using averaged indicators for the regions including labor productivity, wages, the level and number of employees, and the number of new employees [27]. This approach is observed in the works of economic variety, so we will stick to it. Thus, the defining model will be as follows:

$$Y = F(L, K, Infr, Innov, Aggl), \quad (1)$$

where Y is a dependent variable of socio-economic development,

L is labor indicators,

K is capital indicators,

$Infr$ is infrastructure development,

$Innov$ is innovation factors,

$Aggl$ is agglomeration effects.

3. *Mathematical formulating of the problem, forming a system of indicators, calculating and analyzing the indicators of regional specialization and agglomeration effects.* We use indicators of agglomeration effects in four aggregated sectors of the economy – agriculture, mining, manufacturing and services. Besides, we propose to include a number of factors dictated by the provisions of neoclassical theory, endogenous growth, and some approaches determining the impact of innovation on the economic development of the region into the economic and mathematical model. Neoclassical models emphasize the role of physical capital as the main factor of economic development, while endogenous theories emphasize human capital as the main condition.

The dependent variable of the model defines the per capita gross regional product (GRP). The model will include the following factors: labor productivity (lab_{prod}), the region’s share in the total number of employees employed in the economy (lab_{share}), the cost of fixed capital of the region’s enterprises ($capital$), the density of paved roads ($roads$), the cost of technological innovations in enterprises ($tech_{innov}$), the agglomeration effects obtained in the region in agriculture (agg_{agr}), in mining (agg_{mining}), in manufacturing industry (agg_{manuf}) and in the service sector (agg_{serv}). The resulting regression model with constant elasticity will be as follows:

$$\ln(Y_{it}) = \alpha_{it} + \beta_{i2} \ln(lab_{prod_{it}}) + \beta_{i2} \ln(lab_{share_{it}}) + \beta_{i3} \ln(capital_{it}) + \beta_{i4} \ln(roads_{it}) + \beta_{i5} \ln(tech_{innov_{it}}) + \beta_{i6} \ln(agg_{agr_{it}}) + \beta_{i7} \ln(agg_{mining_{it}}) + \beta_{i8} \ln(agg_{manuf_{it}}) + \beta_{i9} \ln(agg_{serv_{it}}) + \varepsilon_{it}, \quad (2)$$

where Y_{it} is the GRP per capita projected over t time period;

α is a free term of the equation;

lab_{prod} , lab_{share} , etc. are the factors included in the regression model;

b_i are the parameters of the equation – regression coefficients for the studied factors;
 i – the factor's sequential number.

The research period is 2008–2017, the object is 83 regions of Russia¹, the sources of primary statistical information are the collections and databases of the Federal State Statistics Service. Model calculations were made in the Gretl program.

4. *The analysis of the regional specialization and agglomeration effects indicators* was carried out in section 2 of this work.

5. *Building a system of economic and mathematical models of the impact of agglomeration effects on the region's socio-economic development.*

6. *Analysis and interpretation of the results obtained.* The fifth and sixth stages of the proposed methodological approach will be presented in the following sections of the work.

4. Analysis of the results obtained

To build an econometric model and determine the nature of the impact of agglomeration effects on the region's socio-economic indicators, it is necessary to identify the regions with a high level of specialization in agriculture, mining, manufacturing, and services². The group of regions with a high level

of specialization in agriculture includes 35 subjects of the Federation (the average index was 1.66 in 2008 and 1.8 in 2017); in the mining industry – 24 regions (4.56 and 4.48), and in manufacturing – 24 regions (1.35 and 1.38).

Let us consider the impact of agglomeration effects on the regions' socio-economic development. Three models were built for this purpose, for a group of regions with a high level of specialization in agriculture (Model 1), in the mining industry (Model 2), and in manufacturing (Model 3) (*Table 1*).

The analysis allows drawing some conclusions. First, we can conclude that today labor (productivity and the region's share of the total number of employed in the economy) is a more significant factor for the Russian regions' development than capital (the cost of basic funds and the density of paved roads). An exception is a group of regions of the mining industry, where the growth of fixed assets by 1% provides an increase in per capita GRP by 0.107%. Moreover, for the regions of this group, the population factor is statistically insignificant, and the impact of labor productivity on the region's socio-economic development is inferior to other groups (it provides 0.8778% of the per capita GRP against 1.149% in the agricultural group and 1.065% in the manufacturing group). For a group with a specialization in mining industries, technological innovations are relevant (0.025% impact).

Second, agricultural regions receive the main incentive for development by increasing labor productivity, rather than by formally increasing the cost of fixed assets. These two trends can be connected as follows: investments in fixed assets have a negative impact on the socio-economic situation of the region in the current period (their impact is estimated

¹ The study does not include Crimea and Sevastopol due to insufficient statistical information.

² As a result of the grouping, only the cities of Moscow and Saint Petersburg, the Novosibirsk Oblast and the Primorye Territory were classified as regions mainly specializing in the service sector. Since the index of specialization in services for these regions was slightly higher than that for other sectors, it was decided not to exclude these regions from the sample, but to include them in other groups. So, the cities of Moscow and Saint Petersburg will be included in the group of regions with specialisation in the manufacturing sector (the index of specialization in services – 1.254, in manufacturing industry – 0.71; for St. Petersburg – 0.968 and 1.183 respectively). The Novosibirsk Oblast and Primorye Territory will be included in the groups of regions with agricultural specialization (Novosibirsk Oblast – 1.041 in services, 1.002 in agriculture; Primorye Territory – 1.059 and 1.015, respectively).

Table 1. Results of modeling of agglomeration effects influence on the regions' socio-economic development, 2008–2017

| Variable | Model 1 | Model 2 | Model 3 |
|-------------------------------|----------------------|----------------------|----------------------|
| <i>l_const</i> | 10.307*** (1.324) | 6.223*** (0.136) | 9.002*** (0.827) |
| <i>l_lab_prod</i> | 1.149*** (0.055) | 0.8778*** (0.041) | 1.065*** (0.022) |
| <i>l_lab_share</i> | 0.389*** (0.13) | | 0.278*** (0.083) |
| <i>l_capital</i> | -0.09** (0.042) | 0.107*** (0.032) | -0.053** (0.021) |
| <i>l_roads</i> | -0.098*** (0.01) | -0.056*** (0.013) | |
| <i>l_teh_innov</i> | | 0.025*** (0.006) | |
| <i>l_agg_agr</i> | -0.055** (0.023) | | -0.024*** (0.007) |
| <i>l_agg_mining</i> | | 0.032*** (0.009) | |
| <i>l_agg_manuf</i> | 0.05*** (0.017) | 0.038*** (0.014) | -0.055*** (0.02) |
| <i>l_agg_serv</i> | -0.251*** (0.09) | -0.288*** (0.041) | -0.141** (0.071) |
| <i>St. model error</i> | 0.14 | 0.099 | 0.062 |
| <i>R²</i> | 0.926 | 0.987 | 0.985 |
| <i>Number of observations</i> | 350 | 218 | 240 |

*** – 1% significance level.

** – 5% significance level.

The standard error is shown in parentheses.

Compiled by the authors, the models are based on data from the Federal State Statistics Service.

negatively at the level of 0.09% of per capita GRP), but in the future they can increase labor productivity, which will have a positive impact on the region's development (impact at the level of 1.149%). We can draw similar conclusions for the regions of the manufacturing industry, with the difference that investments in fixed assets have a less negative impact on the region's development in the current period, and labor productivity growth brings less return in the future.

Third, the negative relationship between the density of roads with hard cover and per capita GRP in agricultural and industrial regions and the lack of such a relationship in mining areas indicate not that roads are not needed, but that they are no longer the main

type of transport. Today, railway, sea (river) and air transport are becoming important, and in the mining industries pipeline transport is relevant for Russia. This specificity should be realized and taken into account when developing and implementing regional economic policy.

Fourth, agglomeration effects in agriculture do not have a positive impact on socio-economic development, even in agricultural regions. A similar conclusion can be drawn from the concentration of labor resources in the service sector, it does not bring an increase in per capita GRP. In agricultural regions, it is necessary to develop not only agriculture, but also manufacturing industry (the impact on per capita GRP is at the level of 0.05%).

Agglomeration effects in the manufacturing industry are also important for the mining regions. While in the regions with a high share of manufacturing industry, they are not sufficient for a positive impact on socio-economic development.

Conclusion.

Studying specialization and agglomeration effects in regional economic science is becoming more and more relevant. Among the set of works, we can distinguish such research groups that are based on the classification of Duranton and Puga, territorial and geographical approaches, the study of related diversity, the use of the cross-sectional analysis results, sorting processes, and the analysis of agglomeration economy. Agglomeration effects represent a mutual benefit for companies from their joint location on the geographic territory. The effects of localization and urbanization are highlighted. Agglomeration effects are tested empirically.

The analysis of the Russian regions' specialization and the agglomeration effects occurring in their economy has shown that not all regions can effectively use the existing level and nature of specialization. Modeling the impact of agglomeration effects on social and

economic development has shown that in the groups of agricultural and industrial regions, labor remains the most significant factor, rather than capital; agglomeration effects in agriculture and in the service sector do not have a positive impact on the GRP level. The manufacturing sector development remains an important condition.

The proposed author's approach to determining the full use of the advantages of regional specialization will reveal the resources reserves in the economy, expressed in agglomeration effects. This method can be taken as a principal for regular monitoring of the regional economy effectiveness to obtain information about the nature and dynamics of specialization, the possibility of obtaining agglomeration effects in various sectors and the most significant factors of socio-economic development in general.

The research results will allow the Russian regions' government authorities to conduct a more reasonable economic policy in relation to the development of the existing specialization and related industries, as well as in the sphere of supporting business initiatives in the most efficient sectors of the economy.

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Received April 17, 2020.