The Study of Spatial Heterogeneity and Interregional Relations in the Processes of Attracting Banking Capital to the Russian Economy

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ABSTRACT

Increased spatial heterogeneity in recent years in the processes of attracting banking capital to the Russian economy negatively affects the pace of socio-economic development of regions. The purpose of the research is to assess the dynamics of changes in spatial heterogeneity in the processes of attracting banking capital in the Russian economy and to model the system of interregional relationships in these processes. Scientific novelty of research is the development of a methodological approach involving the systematic use of methods such as: spatial autocorrelation analysis according to the methodology of P. Moran and L. Anselin, regression analysis using panel data, testing cause-and-effect relationships using the Granger method, formation of a matrix of functional dependencies between regional systems. The developed methodological approach allowed to confirm the trend of increasing spatial heterogeneity in the processes of attraction of banking capital in the Russian economy, to identify regional centers with a high level of concentration and formation a matrix of interregional relationships. It is shown that almost all Russian banking capital is now concentrated in Moscow, St. Petersburg and the Kostroma region. The inflow of bank capital into the economy of these regions leads to its outflow from regions with inverse relationships (negative index of spatial autocorrelation). The results of the research can be used by the executive authorities of the federal and regional levels to find mechanisms to attract banking capital in the economy of regions. One such mechanism could be a reduction in the key rate of the Bank of Russia and State support for regional banks that use low interest rates for lending to households and enterprises in the real sector of the economy.

Keywords: banking capital; panel regression analysis; spatial autocorrelation analysis; Granger test; modeling of interregional relationships; regional systems

INTRODUCTION

The banking sector plays a key role in the development of economies of various levels of regional systems. It provides the real sector with financial resources for the implementation of investment projects aimed at the modernization and technological upgrading of production processes, the introduction of techno-technological, organizational and social innovation to diversify production and increase the competitiveness of products. In addition, banks and credit institutions perform another important function — provide settlement and cash services for enterprises, ensure the security of their financial resources. On the key role of the banking sector in providing credit resources to enterprises of the real sector of economy wrote S. Yu. Glazev [1], A. G. Aganbegyan [2], O. V. Motovilov [3], M. Yu. Alieva [4], V. I. Vagizova [5] and other researchers.

The banking sector forms the financial basis for the development of territorial systems at various levels, attracting investment in infrastructure projects, implemented strategic projects and socio-economic development programmes, investment in debt securities (state institutions, regions of the Russian Federation, municipalities), crediting their internal state debt. The capital attracted by banks contributes to the improvement of the budgetary security of the territories, and therefore — the solution of the acute socio-economic problems of their development.

R. W. Goldsmith [6], M. Pagano [7], P. J. Montiel [8], P. O. Demetriades and K. H. Hussein [9], S. Daly et al. [10], G. Uddin et al. [11] noted significant impact of investments and loans attracted by banks on the economic growth of territorial systems in own work.

Consider that banking sector at the center of the Territory's financial system, E. N. Ryabinina and A. F. Savderova gave the banking sector "a key role in ensuring the balanced development of the economy in the implementation of the strategy of socio-economic development" [12]. The authors wrote that "sustainable socio-economic development of regions is impossible without an adequate amount of financial resources and it is credit organizations that accumulate and mobilize money capital, turning them into a major source of funds for the economic entities". Y. V. Zhariy and Y. V. Krasnianska noted the "important role of banks in the implementation of strategies of socio-economic development of territorial systems, in particular their credit resources" [13].

However, the vast majority of researchers, while emphasizing the importance of banks in the socio-economic development of territorial systems, noted that "existing problems and limitations (lack of a strong resource base of Russian banks, high competition from international financial organizations, the problem of capitalization of the banking sector) are prevent the attraction of bank investments in the Russian economy at present" [14]. In particular, E. M. Magomadov argued that "underdeveloped banking network in the regions continues to prevent the expansion of investment activities. Successful financing of measures to promote the investment image of regions and create the necessary institutional and organizational conditions for large-scale investment is impossible without sustainable and competitive regional banks" [15].

According to V. V. Sofronova, "restructuring of the banking system of the regions, accompanied by a reduction in the number of credit organizations, a decrease in the capacity of the banking system of the regions, leads to the fact that banks do not provide enough of the region's economy with credit resources" [16], "resources of regional banks and their foreign affiliates are not enough not only for the development of regional economies, but also to maintain the established demand of organizations for short-term credit resources, the existing institutional structure of the banking sector

does not create financial stability and stability of the region's economy" [16].

S.D. Ageeva and A.V. Mishura noted in their research that "the displacement of regional banks by the federal makes it difficult to survival of the regional banking sector, which is the driver of regional development" [17]. O.L. Bezgacheva wrote that "Russian banking sector is unevenly developed, and the weaker the banking sector in the region, the weaker its economy" [18].

Spatial disparities in the development of the banking system were noted by V.V. Maslennikov and S.V. Maslennikov. They argued that "disparity in the territorial development of the banking sector reduces the opportunities of small banks, as well as competition in this sector" [19]. "Development of regional banking systems can ensure sustainable economic growth", noted by D.N. Chugurov and T.V. Schastnaya [20].

We see today that spatial heterogeneity (diversity) in the processes of attracting bank capital to the Russian economy, associated with the significant concentration of banks and other credit institutions in the central regions and their gradual liquidation in the other regions, reduces the availability of bank credit for the real, productive sector of the economy, households located in remote territorial systems from the center. As a result of the reduction of the network of regional banks in these regions, there are tendencies of decline in the volume of attracted bank investments in debt securities of regions of the Russian Federation, the volume of loans allocated to them, and this has a negative impact on the budget availability of remote from center of regions. In the context of the need to actively attract investment in the economy, the research of the heterogeneity of placement and use of bank capital, as well as its solution, become the most topical.

Based on the importance and relevance of this problem, the main purpose of the paper was to research the spatial heterogeneity of the attraction of bank capital in the Russian economy and modelling interregional relationships in the processes of its relocation. To achieve it, given the following tasks:

• theoretical analysis of methodical approaches to research of heterogeneity of processes of attraction of bank capital to the economy;

• formation of a systematic methodical approach to research of spatial heterogeneity of processes of attraction of bank capital in the Russian economy and modeling of interregional relationships in these processes;

• study of spatial features of formation and use of bank capital by institutional sectors and assessment of influence of factors on these processes by regression modelling;

• spatial autocorrelation analysis by the method of P. Moran and L. Anselin to establish regional centers of active attraction of bank capital, spatial clusters with a high level of its concentration, their influence zones and interregional relationships in these processes;

• study of cause-and-effect relationships between regions in the processes of attracting bank capital to the economy using the Granger test and their confirmation by means of regression modelling.

The solution of these tasks allowed to confirm the trend of increasing spatial heterogeneity in the processes of attracting bank capital into the Russian economy, to identify regional centers with a high level of concentration and form a matrix of interregional relationships. This matrix will allow in the future to form forecast scenarios of attraction of bank capital in the economy of regions and to determine the mechanisms of smoothing spatial heterogeneity.

THEORETICAL AND METHODOLOGICAL ISSUES OF RESEARCH

In the scientific literature there are several approaches to assessing the attraction of banking capital in the economy. A theoretical review of the papers showed that in order to research the spatial heterogeneity of the

attraction of banking capital in the region's economy usually use methods of regression analysis: geographically weighted regression, method of least squares on spatial data, spatial regression modeling using panel data; spatial autocorrelation methods, simulation modeling, etc. The most common method for the research of processes of attraction of bank capital to the economy of regions is regression analysis of data. It was used in the works by E. Demid [21], A. R. Nizamani et al. [22], Z. Kovtun [23]. Based on method of least squares and method of moments (generalized method of moments, GMM) was used in the works of Bashir U. et al. [24], H-u. Rahman et al. [25].

In research by S. D. Ageeva and A. V. Mishura, a two-step method of least squares was used to estimate the regional distribution of banking institutions for 2000–2013, while GDP and GRP per capita, population of the region, economic structure of the region, political weight of the region, linguistic and cultural characteristics, quality of higher education in the region, climate and geography were considered as factors [17]. This method allows to estimate the relationship between variables, but the significant disadvantage of regression data analysis is impossibility to determine the spatial features of the studied indicator.

Rajan and Zingales' approach was used by O. G. Vasilyeva, and J. A. Kovshun As a dependent variable, researchers applied the index of production for manufacturing industries, and as explanatory variables — the level of development of the financial sector of the region and the industry's dependence on external financing [26]. This approach is based on regression analysis of data and is comparable to the least squares method.

J. K. Ashton's research uses analysis of variance (ANOVA) and panel regression analysis to assess differences in interest rates on attracting banking services to regions [27]. The main limitation of this method is impossibilitydetermine the spatial features of the studied indicator.

K. K. Valiullin and S. L. Merzlyakova considered the features and trends of the spatial development of the banking sector in the Russian Federation [28]. To estimate the heterogeneous structure of the banking sector, the authors used the Herfindahl-Hirschmann index (HHI), and to assess the spatial aspects — the method of analysis. The Herfindahl-Hirschman index allows to determine the degree of concentration of the studied indicator, the main limitation of this method is the impossibility to determine interterritorial interactions between regions [28].

The nature and scale of regional financial disparities in Turkey was assessed by A. O. Birkan and S. K. Akdogu [29] using spatial econometrics techniques, namely: calculation of local Moran indices and geographically weighted regression. The use of these tools allowed them to identify "hot and cold points" attracting of bank loans in the regions in Turkey. Limitation of this methodical approach is heterogeneity of the obtained results depending on the type of used matrices of spatial weights.

In the research by M. Yu. Malkina [30] that using of the Herfindahl-Hirschman index, the index of interregional concentration of assets and liabilities of bank profit, and the coefficient of variation and the Gini coefficient was used to calculate the uneven provision of credit institutions to the population of the regions. This approach allows to calculate the concentration of bank assets and interregional uniformity of provision of regions with banking services, but does not allow to estimate spatial interactions between regions in the processes of attracting bank capital.

A promising method for assessing the spatial heterogeneity of attracting bank capital into the region's economy is agent-based modelling. The models formed by this method allow high accuracy imitate behavior of different agents (banks) in a certain territory, for example at the level of the region or the country as a whole. In particular, this
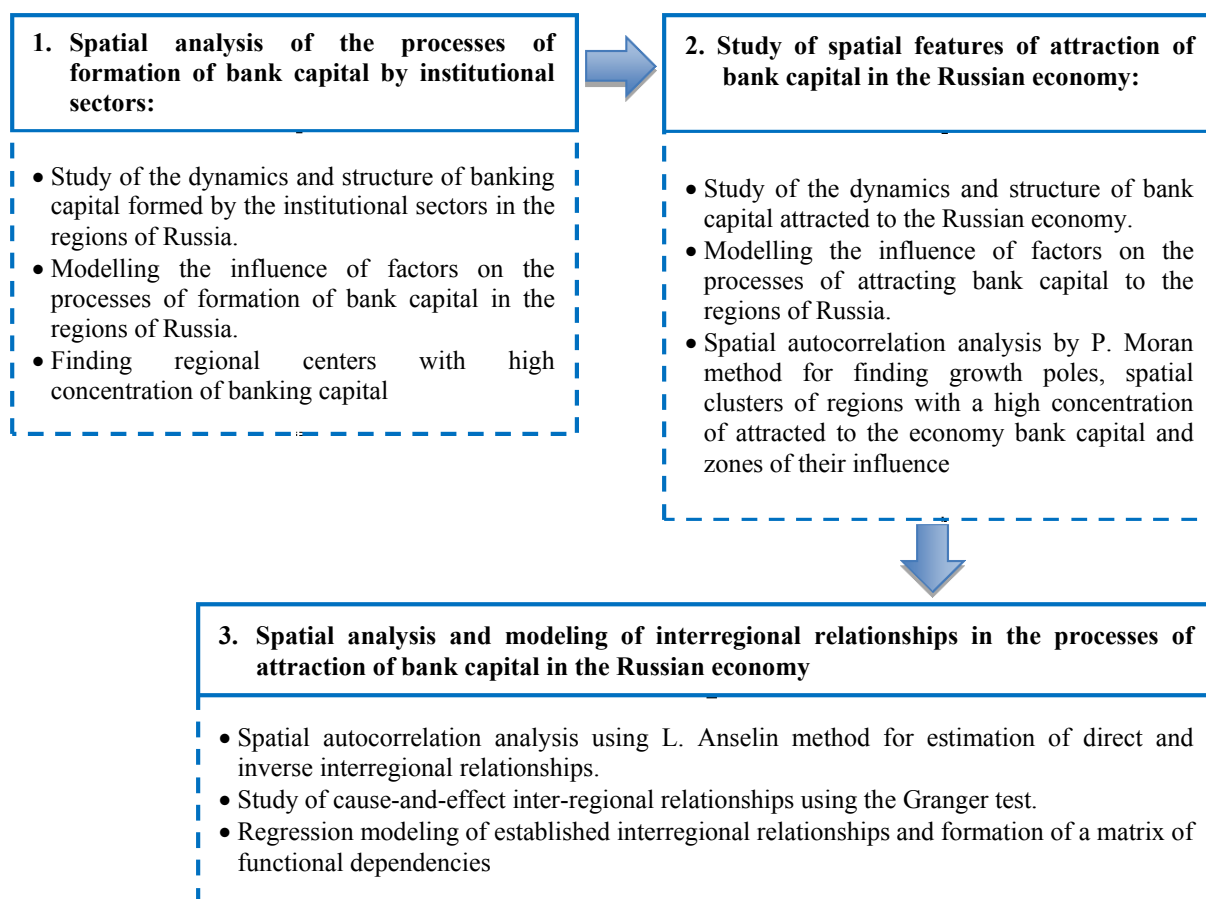
Fig. 1. **Algorithm of spatial heterogeneity research in the processes of attracting banking capital in the Russian economy**

Source: compiled by the authors.

approach was used to model European [31] and Russian banking systems [32].

Thus, the methods currently used do not allow assessment of interregional relationships, spatial features of attraction of bank capital, as well as cause-and-effect interregional relationships in the processes of attracting bank capital to the Russian economy. A systematic methodical approach based on methods of panel data regression analysis, spatial modeling and determining causation, with the aim of complex research of spatial heterogeneity of attraction of bank capital to the economy of regions of the Russian Federation. The need to take into account the spatial specificity of the formation and use of bank capital by the institutional sectors at the regional level, research and modeling of interregional

relationships in the processes of its involvement in the Russian economy for the further development of mechanisms to reduce spatial heterogeneity have led to the need to develop a new methodological approach. The algorithm of this methodical approach is presented on *Fig. 1*.

At the initial stage of the research, using statistical methods, the dynamics and structure of the formation of institutional sectors of bank capital in the regions of Russia are evaluated. At the same time, it is supposed to research the dynamics of such sources of formation of bank capital as: placed deposits and attracted funds of legal entities, deposits of individuals, funds of commercial organizations, budgetary institutions, State and other extra-budgetary funds on settlement accounts, as well as credits and

other funds received from credit organizations. In the research of the processes of formation of banking capital of the regions of Russia, it is expected to take into account the resources coming into the banking sector in both domestic and foreign currency.

For more correct display of spatial aspects of formation in regions of banking capital, it is proposed to systematize data both on regional banks and on branches of credit institutions registered in other territorial systems. Since in the vast majority of regions are no regional banks and the banking sector is represented only by branches of other credit institutions, this approach will allow more accurately estimate dynamics of bank capital formation of these regions.

To assess the impact of factors that attract resources from institutional sectors (financial and non-financial corporations, households and government), is expected to hold a regression modeling in the banking sector of the economy using panel data on 85 subjects of the Russian Federation for the period from 2006 to 2020. The modeling will test the influence of such factors as the volume of the gross regional product of regions of the Russian Federation, the average per capita income of the population, the balanced financial result of enterprises, the size of the interest rate of the Bank of Russia. Regression modeling will allow to establish key factors of formation of bank capital in regions.

To assess the spatial features of the formation of bank capital it is planned to use graphical and statistical methods of analysis to allocate three groups of regions:

• with a high level of resources attracted by the institutional sectors to the banking sector of the economy (beyond the limits, calculated of the formula (1);

• with the volume of attracted resources in the banking sector above the Russian average;

• with low level of resources involved.

$$X_{max} = \bar{X} + \sqrt{\frac{\Sigma\left(X_i - \bar{X}_i\right)}{n}}, \qquad (1)$$

where X_{max} — an indicator of the high volume of resources attracted to the banking sector, calculated for 85 subjects of the Russian Federation, mln rub.;

$\bar{X}$ — average Russian resources attracted to the banking sector, mln rub.;

X_i — average Russian resources attracted to the banking sector, mln rub.;

n — number of regions.

This analysis will identify regions that attract significant resources from institutional sectors to the banking sector of the economy and confirm the presence of spatial heterogeneity in the processes of banking capital formation at the regional level.

At the next stage of the research, it is supposed to assess the spatial features of the use of the banking capital formed in the regions, its attraction to the Russian economy. Based on the set task, at this stage, it is important to study the dynamics of the structure of the region's attracted to the economy of bank capital — both in institutional sectors and in areas of its use (lending to financial and non-financial organizations, individuals, investments in shares, discounted bills, debt securities — obligations of the Russian Federation and corporate debt securities). This analysis will establish the regional specificity of the use of bank capital. At this stage, regression modelling using panel data will identify factors that have a significant impact on the amount of bank capital attracted to the region's economy, and the built model can be further used to develop mechanisms to increase the financial resources of regions for progressive socio-economic development.

To research the spatial heterogeneity of the processes of attraction of bank capital formed in the regions to the Russian economy at this stage, spatial autocorrelation analysis using the Patrick Moran method with standardized and traditional matrices of spatial weights (inverse distances) on related boundaries, linear distances and roads is assumed. More detailed methodological bases of this

analysis are revealed in our earlier works [33]. Calculation of global and local indexes of spatial autocorrelation on several matrices of spatial weights will allow more correct and reasonable study of spatial heterogeneity of processes of attraction of bank capital into the Russian economy, on diagram dispersion of autocorrelation indices to identify regions that are centers of attraction of bank capital (growth poles), spatial clusters of regions similar in volume of attracted capital, as well as zones of their strong and weak influence, which are necessary for further analysis of interregional relationships in the processes of attracting bank capital to the economy.

For their study in the third stage, it is assumed to carry out spatial autocorrelation analysis using the method of Luc Anselin using the above-mentioned matrices of spatial weights. Selection in its matrix of local indexes of spatial autocorrelation values above the average values calculated for positive and negative indexes, will identify potential interregional relationships in the processes of attracting bank capital to the Russian economy. At the same time, positive local autocorrelation indices of Anselin will establish direct interregional relationships (both regions actively attract bank capital), and negative indices — inverse, opposite interregional relationships (one region actively attracted bank capital, while the second — almost none).

To confirm the established interregional relationships in the processes of attracting bank capital to the economy at this stage it is expected to test them with the help of the Granger test on casuality. This test will determine cause-effect relationships in the processes of attracting bank capital to the economy in interconnected regions, establish the directions of these relationships (regions influencing the processes of attracting bank capital).

Regression modeling of cause-effect relationships established by Granger will confirm their validity and form a matrix of

functional dependencies between regions in the processes of attracting banking capital to the economy. This approach to the modelling of interregional relationships was discussed in more detail in our work [34]. Its use in this study is necessary to confirm the processes of increasing heterogeneity of banking capital attracted to the Russian economy, active development of interregional relationships in the zones of its concentration.

Presented in this article a methodical approach, involving the systematic use of statistical methods of analysis, regression modeling, spatial autocorrelation analysis and testing cause-relationships, allows complex and reasonably to study the spatial heterogeneity of the processes of attracting bank capital in the Russian economy, to identify factors contributing to its concentration and use in certain regions, establish and confirm emerging interregional relationships in the processes of attracting bank capital to the economy.

RESULTS OF THE RESEARCH

A study of the dynamics of resources attracted by financial and non-financial corporations, households and the public administration sector to the Russian banking sector of the economy showed that the sector has built up significant financial potential over the past 14 years (68 526.4 bln rub. as of 2020). Between 2006 and 2020, the volume of resources attracted by the institutional sectors increased 5.1 times. At the same time, a significant part of these resources (42%) were deposits of individuals (households). The share of attracted resources in the structure of the banking capital formed in the regions has hardly changed. Significant changes in the structure of banking capital formed in the regions occurred in the sector of non-financial corporations: the share of borrowed funds in bank deposits rose (from 16.4 to 31.7%) and the share of deposited funds in current accounts of credit institutions decreased (from 25.1 to 14.4%). In the structure of bank capital

Table 1

Transformation of spatial features of the formation of banking capital in Russia

2006			2020		
Region	The volume of resources attracted to the banking sector, mln rub.	The level of concentration of Russian banking capital in the region, %	Region	The volume of resources attracted to the banking sector, mln rub.	The level of concentration of Russian banking capital in the region, %
Moscow	9 379 900	70.1	Moscow	50 613 971	73.9
St. Petersburg	676 362	5.1	St. Petersburg	13 566 704	19.8
Tyumen region	361 062	2.7	Kostroma region	985 225	1.4
Republic of Tatarstan	236 579	1.8	Republic of Tatarstan	680 517	1.0
Sverdlovsk region	206 876	1.5	Sverdlovsk region	511 258	0.7
Moscow region	204 533	1.5	Tyumen region	344 679	0.5
Samara region	166 916	1.2	Amur region	268 272	0.4
Krasnodar region	119 757	0.9	Republic of Crimea	178 004	0.3
Republic of Bashkortostan	102 892	0.8	Samara region	158 013	0.2
Nizhny Novgorod region	98 570	0.7	Krasnodar region	155 545	0.2
Novosibirsk region	97 966	0.7	Chelyabinsk region	119 777	0.2
Chelyabinsk region	97 640	0.7	Primorsky Krai	114 914	0.2

Source: compiled by the authors. URL: http://www.cbr.ru/archive/region/info/ek/credit-orgs/ (accessed on 13.12.2021).

of the regions of Russia, the share of borrowed loans of Russian and foreign financial corporations significantly decreased (from 16.2 to 11.9%). This indicates a gradual recovery of financial sustainability of the banking sector in the regions after the 2009 crisis. Then in

the structure of its capital the share of credit resources was 21%. During this period the spatial features of formation of bank capital also changed significantly (*Table 1*).

If the resources attracted by the institutional sectors to the Russian banking

The results of regression modeling of the influence of the interest rate of the Bank of Russia on the volume of attracted resources in the banking sector of regions (with fixed effects)

Variables	Coefficient	Standard error	t-stat	p-value
const	7.16	0.75	9.49	1.22E-20***
IR	1.18	0.34	3.46	0.00056***
The results of regression statistics				
LSDV R-squared	0.53		P-value (F)	5.1E-136***
LSDV F (82, 1147)	15.68			
Criterion Schwartz	6056.6		Criterion Acaike	5632.1
Parameter rho	0.87		Criterion Hennan-Quinn	5791.8
Breusch-Pagan test statistic:			LM = 2087,3	0.0000***
Wald test to heteroscedasticity (null hypothesis — observations have a common error variance):			Chi- square (82) = 56 844.9	0.0000***
Wooldridge test for estimating autocorrelation:			Test statistic: F (1, 82) = 490.9	3.99E-36***
Null hypothesis — normal distribution:			Chi — square (2) = 112.5	3.79E-25***

Source: compiled by the authors.

Note: *** — the value level of the coefficient: if the coefficient is significant at a significance level of 1%, it corresponds to "***", if at a significance level of 5%, it "**", and if only at a significance level of 10%, it "*".

sector were concentrated in several regions in 2006: in Moscow (70.1%) and St Petersburg (5.1%), Republic of Tatarstan (1.8%), Tyumen region (2.7%), Sverdlovsk region (1.5%), Moscow region (1.5%), Samara region (1.2%), while by 2020 its heterogeneity (diversity) increased significantly. Almost all Russian banking capital is now concentrated in Moscow (73.9%) and St Petersburg (19.8%). Panel regression analysis showed that the main factor that influenced the formation of banking capital in the regions is the interest rate of the Bank of Russia (*Table 2*). Its increase of 1%, according to the built model, contributes to an additional inflow of resources to the banking sector of the regions at 1.18% of the current level.

Additional inflow of funds to the banking sector of the economy with an increase in the interest rate is due to the deposits of financial and non-financial corporations, government sector and households, investments in government and corporate debt securities attracted by these sectors.

The capital formed by the banking sector is actively attracted to the Russian economy. From 2006 to 2020, the volume of lending to non-financial organizations increased by 3.9 times (to 33.8 trn rub.), to financial organizations — by 6.7 times (to 8.9 trn rub.), to individuals — by 8.4 times (to 17.7 trn rub.). The volume of investments in shares rose by 3.1 times (up to 2 trn rub.), in debt securities — obligations of the Russian Federation — by

Results of regression modeling the influence of the interest rate of the Bank of Russia on the volume of bank capital attracted to the regional economy (with fixed effects)

Variables	Coefficient	Standard error	t-stat	p-value
const	16.06	0.89	18.14	7.36E-65***
IR	−2.28	0.36	−6.26	5.38E-10***
The results of regression statistics				
LSDV R-squared	0.66		P-value (F)	5.6E-211***
LSDV F (82, 1147)	26.71			
Criterion Schwartz	5072.3		Criterion Acaike	4647.8
Parameter rho	0.87		Criterion Hennan-Quinn	4807.5
Breusch-Pagan test statistic:			LM = 3388.6	0.0000***
Wald test to heteroscedasticity (null hypothesis — observations have a common error variance):			Chi- square (82) = 109949	0.0000***
Wooldridge test for estimating autocorrelation:			Test statistic: F (1, 82) = 230.6	2.05E-25***
Null hypothesis — normal distribution:			Chi − square (2) = 1094.7	1.9E-238***

Source: compiled by the authors.

3.5 times (up to 3.4 trn rub.), in corporate debt securities — by 7.4 times (up to 8 trn rub.).

At the same time, analysis of the dynamics of the structure of bank investments allowed to establish a number of negative trends:

• significant decline in resources for the non-financial corporations' sector, which includes both the real and the productive sectors of the economy (the share of bank investments in the sector decreased from 71.2 to 59.3%);

• reduction of the share of attracting bank capital in the public sector (from 6.4 to 4.7%);

• significant increase in the share of credit allocated to households in the composition of bank capital (from 13.7% to 23.9%), which confirms the current trend of increasing debt load of households;

• growth of lending by the banking sector of other financial institutions actively engaged in speculative operations with foreign currency, shares and debt securities of foreign issuers, high-risk derivative financial instruments. Their share in the structure of bank capital attracted to the economy increased from 8.7 to 12.1%.

Regression modelling using the panel data for the research period from 2006 to 2020, the results of which are presented in *Table 3*, showed that to actively attract bank capital to the economy of the regions it is necessary to reduce the interest rate of the Bank of Russia:

$$V = e^{16.06} * IR^{-2.28}, \qquad (2)$$

where V — volume of bank capital attracted to the economy of regions, mln rub.; IR — interest rate of the Bank of Russia, %.

The reduction of the interest rate of the Bank of Russia by 1% will contribute to
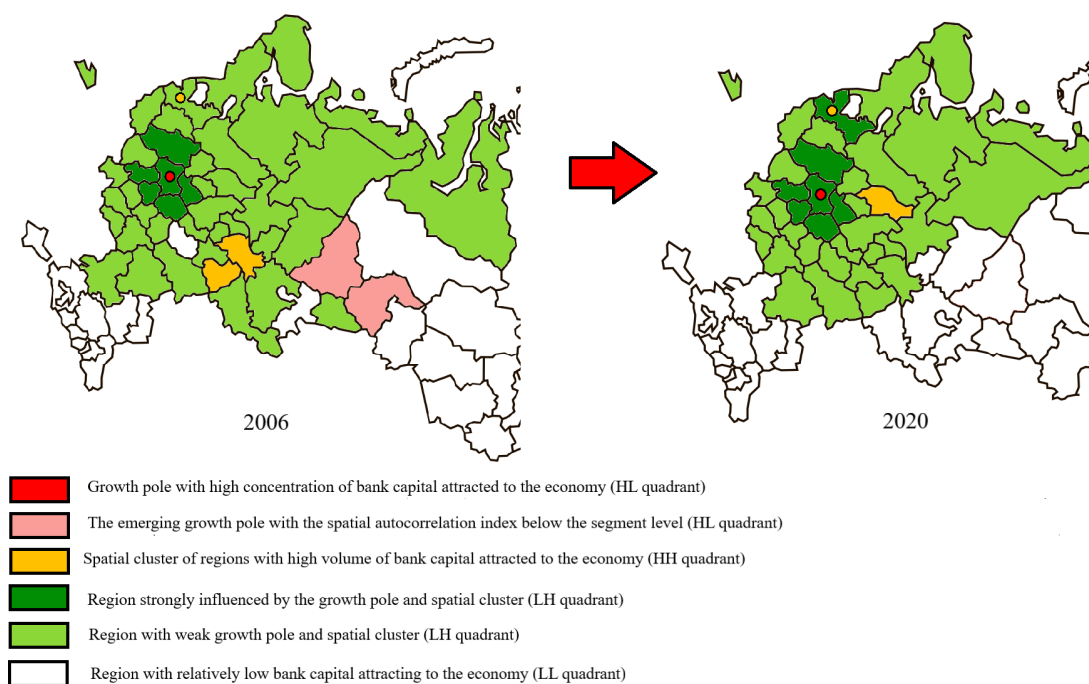
Fig. 2. **Transformation of P. Moran's scatter diagram in terms of the volume of bank capital attracted to the regional economy for the period 2006–2020**

Source: compiled by the authors.

the growth of bank capital attracted to the region's economy by an average of 2.3%. Constructed non-linear regression models for each region separately identified the areas in which this factor has a greater influence. These regions include: Stavropol region, in which a 1% reduction in the interest rate of the Bank of Russia will contribute to the growth of bank capital attracted to the economy by 5.8%, Nizhny Novgorod region (4.2%), Novgorod region (4.2%), Novosibirsk region (4%), Republic of Kabardino-Balkaria (3.9%), Republic of Mordovia (3.3%), Krasnodar region (3.1%), Rostov region (2.9%), Kirov region (2.7%), Chelyabinsk region (2.7%). The constructed models showed that the current policy of the Bank of Russia, aimed at maintaining a high interest rate, contributes to a stronger outflow of bank capital far from the central part of the regions.

The elasticity coefficient of the effect of the interest rate of the Bank of Russia on the volume of attracted bank capital in the central regions is significantly lower than the average of 2.3%. For example, in the Tula region it is

only 1.9%, Smolensk region — 1.8%, Vladimir region — 1.7%, Ivanovo region — 1.6%, Ryazan region — 1.6%, Kursk region — 1.6%, Tambov region –1.4%, Orlov region — 1.3%, Belgorod region — 1.2%, Lipetsk region — 1.6%.

The worsening geopolitical situation in Russia and the severe sanctions imposed, especially on the financial sector, have already led to a significant increase in the interest rate of the Bank of Russia (to 20%). This has attracted significant financial resources from households, financial and non-financial corporations to the banking sector in the form of securities investments and deposits, which our early studies have shown [34], will be used by credit institutions exclusively for speculative purposes. The increase in the interest rate will contribute to an even deeper spatial centralization of the attracted bank capital in the Russian economy and its outflow from the Stavropol region, Nizhny Novgorod region, Novosibirsk region, Rostov region, Kirov region, Chelyabinsk regions, Republic of Kabardino-Balkaria, Republic of Mordovia and Krasnodar region.

Results of a spatial autocorrelation analysis of the volumes of attracted bank capital to the economy of Russian regions in 2020

Indicators	Road distance matrix (normalized)	Road distance Matrix	Linear distance matrix (normalized)	Linear distance matrix
Moran global index	−0.025	−0.030	−0.021	−0.025
sd(Ii)	0.0001	0.0001	0.0001	0.0001
E(Ii)	−0.000003	−0.000004	−0.000003	−0.000004
Z-score	−269.10	−290.33	−261.04	−283.97
p-value	0.000	0.000	0.000	0.000
Direct interregional links			Backward interregional backward links	
Moscow	St. Petersburg		Moscow	Moscow, Vladimir, Kaluga, Tula, Ryazan, Tver, Yaroslavl regions
	Kostroma region		St. Petersburg	Leningrad region

Source: compiled by the authors.

The research of the dynamics of lending and investment activity of the banking sector in the regions allowed to establish a trend of increasing spatial heterogeneity (diversity) not only in the processes of formation of institutional sectors of bank capital, but also in the processes of its attraction to the Russian economy (*Fig. 2*). The diagram of spatial autocorrelation by P. Moran clearly shows the high concentration of bank capital attracted to the economy in Moscow. The region was an obvious growth pole throughout the period under review, with its well-established zone of strong influence on surrounding regions. However, in addition to it, in 2006 two other growth poles were allocated — Sverdlovsk and Tyumen regions, which attract significant banking capital to the economy.

These regions were classified by us as potential emerging growth poles, as they did not have a zone of strong influence on

the surrounding regions as Moscow, their local spatial autocorrelation indexes were significantly below average. By 2020, due to the elimination of a significant number of regional banks and the high concentration of bank capital in the central regions, these regions have ceased to be growth poles. The volume of attracted bank capital also decreased significantly in the economy of the Samara region and the Republic of Tatarstan, to the regions, which in 2006 were the so-called spatial clusters (similar territories in terms of the amount of attracted bank capital). During the period under review, the concentration of bank capital attracted to the economy in the central part of Russia, in particular in St. Petersburg and the Kostroma region, increased significantly. The influence of growth poles and formed spatial clusters on the surrounding regions, in particular Moscow —on the Moscow, Tver, Kaluga, Tula,

Table 5

Results of modeling of interregional relationships in the processes of attracting banking capital to the economy

Region	St. Petersburg (SP)	Leningrad region (Len)	Vladimir region (Vlad)	Kaluga region (Kalug)	Moscow (M)	Moscow region (Mos)	Tver region (Tv)	Tula region (Tul)	Ryazan region (Ryaz)
Kirov region (Kir)							Kir = 25 696.5 + 0.97 * Tv	Kir = 25 241 + 0.62 * Tul	Kir = 11 913.2 + 1.13 * Ryaz
Nizhny Novgorod region (NN)			NN = – 8121.4 + 7.39*Vlad	NN = 5.8 * Kalug			NN = 60 242.4 + 6.73 * Tv		NN = 7.3 * Ryaz
Penza region (Penz)	Penz = 0.004 * SP		Penz = 3327.6 + 0.62 * Vlad		Penz = 0.0005 * M	Penz = 0.07 * Mos			
Republic of Mari El (RME)							RME = 578.5 + 0.59 * Tv		RME = –7101.8 + 0.67 * Ryaz
Republic of Mordovia (RM)							RM = 10 589.4 + 0.93 * Tv		
Republic of Tatarstan (RT)				RT = 13.42 * Kalug			RT = 14.83 * Tv	RT = 546044.8 + 3.23 *Tul	RT = 474908.1 + 5.92 * Ryaz
Samara region (Sam)							Sam = 228955.8 + 10.89 * Tv		Sam = 14.04 * Ryaz
Saratov region (Sar)		Sar = 49 357 + 1.75 * Len					Sar = 49 118.1 + 1.17 * Tv		
Ulyanovsk region (Ul)	Ul = 0.004 * SP								
Chuvash Republic (Chu)	Chu = 0.006 * SP				Chu = 0.0007 * M			Chu = 7967.5 + 0.62 * Tul	
Arkhangelsk region (Arkh)	Arkh = 0.004 * SP		Arkh = 2103.4 + 0.65 *Vlad	Arkh = 0.57 * Kalug		Arkh = 0.07 * Mos	Arkh = – 877.3 + 0.87 * Tv	Arkh = 4181.84 + 0.45 * Tul	Arkh = 0.73 * Ryaz
Vologda region (Volog)	Volog = 0.02 * SP	Volog = 45 545 + 2.08 * Len			Volog = 0.002 * M		Volog = 2.28 * Tv		Volog = 25902.5 + 1.62 * Ryaz

Table 5 (continued)

Region	St. Petersburg (SP)	Leningrad region (Len)	Vladimir region (Vlad)	Kaluga region (Kalug)	Moscow (M)	Moscow region (Mos)	Tver region (Tv)	Tula region (Tul)	Ryazan region (Ryaz)
Novgorod region (Novg)			Novg = −119.6 + 0.48 * Vlad						
/ Pskov region (Psk)							Psk = 262 + 0.48 * Tv		
Republic of Karelia (Kar)	Kar = 0.003 * SP				Kar = 0.0004 * M	Kar = 0.06 * Mos	Kar = −379.2 + 0.61 * Tv	Kar = 829.2 + 0.36 * Tul	
Republic of Komi (Komi)					Komi = 0.000 * M	Komi = 7800.8 + 0.09 * Mos	Komi = 4549.1 + 0.93 * Tv	Komi = 7601.5 + 0.53 * Tul	Komi = −4318.7 + 0.98 * Ryaz
Belgorod region (Bel)									
Bryansk region (Bryan)		Брян = 0.97 * Len							
Vladimir region (Vlad)	Vlad = 0.006 * SP				Vlad = 0.0007 * M	Vlad = 0.12 * Mos		Vlad = 6227.9 + 0.63 * Tul	Vlad = −7745.1 + 1.16 * Ryaz
Voronezh region (Voron)							Voron = 6.18 * Tv	Voron = −24248 + 4.31 * Tul	Voron = −105 110.3 + 7.56 * Ryaz
Ivanovo region (Iv)					Iv = 0.0005 * M	Iv = 10240.3 + 0.05 * Mos	Iv = 5110.7 + 0.61*Tv		
Kaluga region (Kalug)	Kalug = 0.009 * SP								
Kostroma region (Kostr)			Kostr = 641 380.6 − 7.92 * Vlad					Kostr = 593 141.9 − 5.04 * Tul	
Kursk region (Kursk)	Kursk = 0.007 * SP				Kursk = 0.0008 * M		Kursk = 14 822.5 + 0.91 * Tv		
Lipetsk region (Lip)	Lip = 0.007 * SP				Lip = 0.0009 * M		Lip = 15 319.9 + 1.06 * Tv		

Table 5 (continued)

Region	St. Petersburg (SP)	Leningrad region (Len)	Vladimir region (Vlad)	Kaluga region (Kalug)	Moscow (M)	Moscow region (Mos)	Tver region (Tv)	Tula region (Tul)	Ryazan region (Ryaz)
Moscow region (Mosc)			Mosc = −32 532.2 + 8.67 * Vlad	Mosc = 6.45 * Kalug			Mosc = 26 397.1 + 8.55 * Tv		Mosc = −72 053.5 + 9.39 * Ryaz
Orel region (Orel)	Orel = 0.002 * SP		Orel = 552.7 + 0.33 * Vlad						
Ryazan region (Ryaz)	Ryaz = 0.007 * SP		Ryaz = 9049.4 + 0.79 * Vlad		Ryaz = 0.0007 * M	Ryaz = 16 829.8 + 008 * Mos	Ryaz = 8981.9 + 0.96 * Tv		
Smolensk region (Smol)	Smol = 0.005 * SP								
Tambov region (Tamb)					Tamb = 0.0003 * M		Tamb = 2500.9 + 0.43 * Tv		
Tver region (Tver)	Tver = 0.005 * SP			Tver = 0.68 * Kalug	Tver = 0.0006 * M	Tver = 0.09 * Mos			
Tula region (Tula)	Tula = 0.008* SP				Tula = 0.0009 * M	Tula = 0.15 * Mos			
Yaroslavl region (Yaros)			Yaros = −13 192.9 + 2.43 * Vlad	Yaros = 1.73 * Kalug			Yaros = 2.31 * Tv	Yaros = 9519.8 + 1.39 * Tul	Yaros = 2.16 * Ryaz
Volgograd region (Volg)	Volg = 0.009 * SP				Volg = 0.001 * M	Volg = 16163.3 + 0.16 * Mos	Volg = 1.89 * Tv		

Source: compiled by the authors.

Vladimir, Ryazan regions and St. Petersburg — on the Leningrad region has increased.

As can be seen in *Fig. 2*, the influence of the centers of attraction of bank capital narrowed and concentrated in the central part of Russia.

Spatial autocorrelation analysis by the methods of P. Moran and L. Anselin using different matrices of spatial weights not only confirmed the heterogeneity of the processes of attracting bank capital to the Russian economy (global Moran indices has negative values), but also direct and inverse interregional relationships in these processes (*Table 4*). Positive indexes of spatial autocorrelation in the Anselin matrix were established between Moscow and St. Petersburg, Kostroma region, which indicates the similarity of these regions in the processes of attracting bank capital, the potential direct relationships between the regions.

Bank capital growth in one region can contribute to growth in an interconnected region. Negative indexes of spatial autocorrelation (inverse relationships) established between Moscow and Moscow region, Vladimir, Kaluga, Tula, Ryazan, Tver, Yaroslavl regions, between St. Petersburg and Leningrad region, confirm the identified growth poles and spatial clusters as shown in the Moran dispersion diagram (*Fig.2*). These regions are characterized by opposite trends in the processes of attracting bank capital to the economy: inflow of attracted to the economy of bank capital in Moscow, according to the results of spatial autocorrelation analysis, leads to its outflow from the surrounding regions.

For a more detailed study of interregional relationships, the Granger test on causality in the processes of attracting bank capital to the Russian economy was conducted. This test allowed to establish cause-and-effect relationships between regions in these processes, to determine the spatial directions of data relationships. Regression models of influence of some regions on others in the processes of attraction of bank capital in the economy were built on the basis of the relationships established by the Granger test. Part of the regression models, formed by regions related to growth poles, spatial clusters and zones of their influence, are represented in *Table 5*.

For example, according to the modelling results, it was found that the growth of bank capital attracted to the economy in Moscow by 1 bln rub. contributes to its growth in the Penza region by 0.5 mln rub., Vologda region — by 2 mln rub., Vladimir region — by 0.7 mln rub., Ivanovo region — by 0.5 mln rub., Kursk region — by 0.8 mln rub., Lipetsk region — by 0.9 mln rub., Ryazan region — by 0.7 mln rub., Tambov region — by 0.3 mln rub., Tver region — by 0.6 mln rub., Tula region — by 0.9 mln rub., and Volgograd region — by 10 mln rub.

Inverse relationships were established between the Kostroma, Vladimir and Tula regions. Inflow of attracted to the economy of banking resources in the Vladimir region for 1 mln rub. contributes to the outflow of these resources from the Kostroma region for 7.9 mln rub., and additional inflow of bank capital in the Tula region in the amount of 1 mln rub. causes its outflow from the Kostroma region by 5 mln rub.

In the course of the research, models of relationships for other regions were built, but because the spatial autocorrelation analysis did not identify these regions as poles of growth, spatial clusters or zones of their influence, these inter-regional relationships were found to be insignificant.

Thus, the developed methodical approach allowed to establish a tendency of strengthening of spatial heterogeneity of processes of attraction of bank capital into economy, to identify and model interregional relationships. The formed models showed the urgent need to reduce the interest rate of the Bank of Russia to attract more active bank capital in the Russian economy, especially now, in the context of the deteriorating

geopolitical situation and severe financial sanctions. The reduction of this rate will make bank loans more accessible to non-financial corporations, households and the public administration sector in remote regions, will contribute to the development of the system of regional banks serving the interests of the population and enterprises of the real sector of economy. Regional banks that actively attract investment in the economy, support economic and social infrastructure projects and provide credit to households and non-financial corporations at reduced interest rates, targeted public support should also be provided.

CONCLUSION

Theoretical analysis of works devoted to the study of spatial aspects of formation and attraction of bank capital in the economy showed that spatial heterogeneity of these processes negatively affects the socio-economic development of territorial systems. Review of research in this field substantiated the need for systematic use of methods of statistical, regression and spatially autocorrelation analysis for assessment of dynamics of spatial heterogeneity of processes of attraction of bank capital in economy and modeling of interregional relationships in these processes. The methodical approach presented in the article allowed to establish the features of formation and use of banking capital of regions by institutional sectors, to identify the different impact of the interest rate of the Bank of Russia on these processes. The novelty of the developed approach was the systematic use of methods of regression analysis and spatial autocorrelation by the method of P. Moran and L. Anselin to identify regional centers of attraction of banking resources, spatial clusters of similar regions by the volume of bank capital attracted to the economy and their influence zones. This approach allowed to establish an increase in the concentration of banking capital attracted to the economy in the central part of Russia (Moscow, St. Petersburg and the Kostroma region) and formed inverse relationships with regions, forming a zone of strong influence of growth poles and spatial clusters (with the Moscow, Tver, Kaluga, Tula, Vladimir, Ryazan and Leningrad regions). The research showed that regions having an inverse relationship (negative index of spatial autocorrelation) are characterized by opposite tendencies in the processes of attracting bank capital to the economy: inflow of bank capital attracted to the economy in Moscow and St. Petersburg leads to its outflow from these regions.

Testing with the help of Granger established in the course of spatial autocorrelation analysis of direct and inverse relationships between the growth poles, spatial clusters and regions, forming their zone of influence, allowed more in-depth investigation of cause-and-effect relationships between regions in the processes of attracting bank capital to the Russian economy, and regression analysis — form a matrix of functional interregional relationships in these processes.

The developed methodical approach helped to substantiate the hypothesis on the strengthening of spatial heterogeneity in the processes of attracting bank capital to the Russian economy, to establish and model interregional relationships, which can then be used to construct forecasts and search for mechanisms to smooth this heterogeneity for more efficient spatial distribution of banking capital.

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