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SPATIAL MODELING OF VOTING PREFERENCES IN RUSSIAN FEDERATION

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Introduction (The relevance of the work)

The analysis of the political behavior of voters and the identification of factors related to the results of voting are among the most discussed and researched sections of the scientific literature. This topic is covered by researchers from completely different points of view. For example, researchers in empirical studies often study the relationship between election results and socio-economic factors that could influence them. In some papers authors try to assess in more detail the impact of the external environment, including the impact of participation in social groups and mobility on the willingness to vote for specific candidates in elections. Such an analysis requires the use of spatial econometrics, which becomes a necessary tool for researchers. Thus, the results strongly depend on the research question, assessment methods, country and the structure of its election system and the elections level (municipal, parliamentary or presidential elections). Thus, there is a wide range of areas and issues to study and elaborate on this topic.

This thesis is devoted to the application of spatial modeling methods using the example of the presidential elections in Russia in 2018 to identify key factors that are significantly related to the results of voting for the main candidate.

As possible factors of influence, it is proposed to consider a number of socio-economic indicators of the territories, as well as the influence of the electorate living in neighboring territories on each other (spatial effects). Particular emphasis is placed on the importance of including spatial effects for the correct assessment of the relationship between voting results and socio-economic factors. Many studies emphasize that the exclusion of spatial effects from consideration can lead to changes in the estimates of the coefficients of the final model (Anselin, 1988; Kim, Elliott, Wang, 2003; Semerikova, Demidova, 2015; Demidova, Ivanov, 2016).

In this paper, the analysis covers not only regional level, but also includes more detailed data from municipal and territorial election commissions (hereinafter

referred to as TEC): it is assumed that such granularity will improve the quality of models, especially given the scale and heterogeneity of Russian regions.

The thesis research is especially relevant now because it analyzes the election results in Russia. At the moment, most of the scientific literature is focused on the study of Western democracies. In studies devoted to the elections in Russia more emphasis is placed not on the use of spatial methods, but on the political and social aspects that determine turnout and voting results. At the same time, some researchers said about the authoritarian political structure of the country, as well as the need to take into account the regional aspect, since "some regional leaderships use their tight political control to produce strong electoral support in federal elections" (Moraski, Reisinger, 2010, p.2). In addition, as Moraski and Reisinger (2010) emphasize, voting trends in Russia include the formation of certain geographical clusters with leading regions influencing their neighbors: "other regions witnessed the behavior of deferential leaders, perceived the likely benefits of such action, and changed their behavior accordingly" (Moraski, Reisinger 2010, p.3). That is why the application of spatial econometric analysis methods to voting in Russia is particularly interesting and the results will not necessarily be similar to the results obtained for Western democracies. In the works devoted to the analysis of Russian elections, there is a large variation of subjects, research topics and assessment methods, which creates a space that does not allow us to draw unambiguous conclusions about the influence of certain factors on the results of voting. All of the above determines the importance of the contribution made by the presented work to the scientific literature.

The results obtained in the work allow, with some limitations, to make assumptions about exactly what factors may be associated with election decision-making, to what extent the electorate influences each other, and how economic decisions and actions of a candidate in any region will affect the voting results.

Brief literature review

1. The formation of the first theoretical approaches and the main works for Western democracies

The first articles on the topic of spatial modeling in voting appeared quite a long time ago, and these were precisely theoretical works that were referred to in the literature as spatial theory of voting. As a rule, in theoretical works, spatial modeling of electoral choice is represented, first of all, by correlating the positions of candidates and voters in elections in the n-dimensional political space: the candidate whose position turns out to be closest to the voter receives his vote (Downs, 1957; Akhremenko, 2007).

In the very first works on this topic, Downs (1957) introduced the so-called "*classical*" or "*proximity model of voting*", in which voters are rational agents and make decisions about voting for a particular candidate by comparing their own political views and preferences on various issues and positions candidates or parties on the same issues, maximizing their own utility (profit) from the victory of one or another party. This model has been reviewed, modified and expanded by many authors (Davis, Hinich, Ordeshook, 1970; Durlauf, 2004; Poole, 2005; Poole, Rosenthal, 1984).

In 2023, a monograph was published (Okunev, 2023), in which the author examines in detail the role of spatial geography in modeling the electoral process. The paper highlights the theoretical and methodological aspects of assessing the relationship of spatially close units (described, for example, in (O'Loughlin, 2003; Shin, 2009; Linke, 2015)), as well as estimates of the degree of influence of such a relationship on the electoral behavior of citizens.

In empirical works, the authors often emphasize how difficult it is to correctly identify the key factors associated with the choice of a particular candidate in the elections. For example, if a voter has spatial mobility between regions, he may change his preferences at a moment due to the factor of "*social conformity*"

(Coleman, 2018). Coleman (2004, 2007, 2018) emphasizes that voters' preferences are usually influenced by the preferences of their affiliated group: family, relatives, friends, colleagues. It has been observed that people compare their behavior with others by correcting their position using widespread behavioral patterns or accepting a generally accepted opinion (Gerber, Rogers, 2004).

In addition, using the "proximity model" (Downs, 1957), many researchers in the field of political science have suggested that the opinions and positions of voters living in neighboring territories may be interconnected due to the so-called "*contextual effects*", which mean the effect of the social environment, listening to the mass media, the influence of political campaigning (Burbank, 1997; Cox, 1968; Durlauf, 2004; Huckfeldt, Sprague, 1991). Some researchers study contextual effects through the lens of the economic and social environment during elections. For example, the authors of the work (Cutts et al., 2014) studied the results of the "spillover effects" on the example of the British elections in 2010. In particular, the authors examined the impact of financing political campaigns in one locality on the results of voting in neighboring localities. The authors suggest that voters in neighboring localities listen to the same media, move freely between territories and are aware of the political activities taking place in their neighbors. In this regard, choosing the right region for a political campaign allows you to expand the scale of the campaign's influence on the electorate.

2. Empirical research based on Russian data

This section is devoted to the analysis of Russian elections. Among the review papers, a series of articles stands out (Akhremenko, 2007, 2009), where author examines in detail the development of spatial models of electoral choice, the formation of the first theoretical approaches in this field, and how they are reflected in applied research.

Among the empirical works, several areas of research can be noted: the use of econometric methods and spatial analysis methods to identify spatial

autocorrelation and factors connected with voting results (Sharafutdinova, Turovsky, 2017; Turovsky, Gaivoronsky, 2017; Turovsky, Korneeva, 2018; Korneeva, 2021), as well as the study of the dynamics and characteristics of the behavior of the electorate for different elections (Aleskerov, Golubenko, 2003; Aleskerov et al., 2005; Moraski, Reisinger, 2010; Sharafutdinova, 2013; Turovsky, 2018; Turovsky, Sukhova, 2018).

In the paper (Korneeva, 2021) the author, using the example of the parliamentary and presidential elections in Russia in 1995-2016, emphasizes the presence of a strong spatial dependence, especially for municipalities, which indicates "the existence of special trends at the local voting level".

In Moraski and Reisinger (2010), the authors investigated the spatial features of Russia's political development and loyalty to the current political party in power in different regions. The authors showed that the republics and the southern regions supported the Kremlin more than other regions in almost all elections. The number of regions with a high level of Kremlin support increased over time, and by 2004 there were seven regions with consistently high levels of votes for the Kremlin, including Kabardino-Balkaria and the Republic of Tatarstan. According to the authors, such an increase in loyal regions may be due to an increase in federal subsidies and budget funds.

Turovsky and Gaivoronsky (2017) came to similar conclusions. The authors showed that variables such as the wealth of the region, the political influence of the governor (measured by expert ratings), ethnic composition (especially relevant for southern regions), geopolitical vulnerability (areas claimed/influenced from abroad) and election campaigns (for example, support for projects or initiatives aimed at one candidate or another) turned out to be significant factors influencing state "politically sensitive" transfers to regions (Sharafutdinova, Turovsky, 2017; Turovsky, Gaivoronsky, 2017).

After analyzing the existing literature, several important gaps were identified that could be filled with this study:

1) As already emphasized above, most empirical work focusing on the use of spatial-econometric tools to analyze the influence of neighbors on each other has been conducted for Western democracies. Russia is characterized by a different political system, and therefore the possibility of extrapolating conclusions to it is controversial;

2) The author is not aware of works where, using Russian data, a detailed assessment of the spatial influence of territories on each other would be carried out using various tools and methods of spatial analysis (for example, clustering of territories and identification of cluster regions, evaluation of models of spatial lags or spatial error, etc.). However, understanding the importance of the influence of territories on each other is extremely important for the correct assessment of factors that may be related to the results of voting for a particular candidate. In this regard, the paper proposes a spatial econometric analysis of factors correlating with the results of the 2018 elections;

3) Most studies of elections in Russia are based on data for the period 1990-2000, where the minimum available unit of observation is the region. This paper analyzes the recent presidential elections using data at the municipal & territorial election commissions level.

Based on the above, the purpose was set and research objectives were formulated.

Goals and objectives of the study

The purpose of this study is to identify key factors related to the results of voting, taking into account the spatial interaction of neighboring territories, at the level of territorial election commissions and municipalities of Russia (using the example of the 2018 elections). To do this, the paper tests the hypothesis of a positive spatial autocorrelation of voting results (repeatedly proven for Western

countries, in particular, for the United Kingdom and the United States) and the importance of taking into account the influence of neighboring territories on each other when analyzing social and economic factors related to voter preferences and voting results. At the same time, due to the heterogeneity of the economic situation of the country's regions and the political views of voters, the main focus of the study is on the application of various methods of spatial analysis specifically to Russian data.

The key variable of interest (also referred to in this study as the *dependent variable*) is the results of voting for the main candidate (V. V. Putin). In some cases, models were evaluated for other candidates in the 2018 elections in order to compare the results and draw better conclusions. The paper also uses the term "*opposition candidate*", which means K.A. Sobchak. She was chosen as an "opposition" candidate because she represented the so-called "non-systemic" opposition in the 2018 elections. Other candidates belonged to the "systemic" opposition, that is, they regularly participated in elections from the same parties with similar political statements. And K.A. Sobchak participated in the elections for the first time in 2018, and without belonging to any active political party.

To achieve the goal, the following objectives are necessary to complete:

1. To analyze research on elections and the identification of factors related to voting results in order to understand modern approaches, techniques and tools of analysis, the main trends and results;

2. Collect data on the results of voting in Russia for the 2018 elections from the website of the Central Election Commission, as well as collect data on the territorial boundaries of the subjects of Russia and the main socio-economic indicators of the territories;

3. To assess the mutual influence of neighboring territories on voting results using global spatial dependence indices: Moran's I (Moran, 1950), Geary's C (Geary, 1954), Getis-Ord's G (Fisher, Wang, 2011);

4. To cluster regions based on significant local spatial dependence indices;

5. To develop tools for assessing the relationship between socio-economic factors and voting results with a detailed study of the mutual influence of neighboring territories on each other;

6. Apply the developed tools to identify factors correlating with the results of voting on the example of one of the regions of Russia;

7. To assess the need to take into account spatial factors when analyzing the relationship between socio-economic factors and voting results using the example of one of the regions of Russia;

8. To evaluate the possibility of extrapolating the results obtained for the rest of the Russian regions.

The novelty

In this work, various spatial modeling techniques were used to complete objectives (1)-(8), which were either not covered at all in the literature on the analysis of Russian elections, or were only slightly affected. Thus, a contribution was made to the methodology of spatial econometric models, and the use of such analysis tools as:

• Global and Local indexes of spatial autocorrelation;

• Spatial autoregression models;

• Decomposition of spatial lags depending on the proximity of territories to each other to assess their mutual influence.

Thus, the following distinctive features of this study can be noted, which contribute to the scientific literature:

1) Using global spatial dependence indicators (Moran's I, Geary's C, Getis-Ord's G), the hypothesis of positive spatial autocorrelation for the results of voting

for the main candidate (neighboring territories vote in a similar way) at the level of territorial election commissions was confirmed;

2) Using local spatial dependence indices calculated at the level of territorial election commissions, it was possible to identify local clusters and local "outliers" among the regions of Russia. Tatarstan is of particular interest, which includes territories where people voted both in a similar and different way compared to their neighbors. In other works, attempts have also been made to identify certain clusters of regions, for example (Turovsky, Gaivoronsky, 2017), but local spatial dependence indices were used for this purpose for the first time in this dissertation study;

3) For a detailed study of the influence of neighboring municipalities on each other, using the example of the Republic of Tatarstan and neighbors, an approach to data analysis was developed (decomposition of the spatial lag depending on the territorial location of the municipality);

4) Using the decomposition of the spatial lag in the work, the mutual influence of the border municipalities of the Republic of Tatarstan and its neighbors on each other was obtained. Using the example of this region and its neighbors, the main factors correlating with the results of voting for the main candidate at the municipal level were highlighted: the length of highways, the number of families with subsidies, the number of goods of their own production;

5) The spatial autoregression model was used to assess the significance of the mutual influence of all municipalities of Russia on each other using both spatial lag and fictitious variables for each region. Differences in estimates of models with included and not included spatial factors are demonstrated, taking into account such data granularity (data are presented at the municipal level).

6) The work contributed to understanding the relationship between the quality of life in municipalities and the results of voting for the main candidate. The main factors correlating with the results of voting for the main candidate in Russian

municipalities were identified, namely: street lighting, the proportion of citizens with social support, population growth, the proportion of residential premises, distance from the regional center, and the quality of roads. The paper offers options for taking these results into account in order to develop and improve the effectiveness of various political campaigns.

The results submitted for the thesis defense:

1. 1. In the work (Podkolzina, Demidova, Kuletskaya, 2020) the hypothesis of a positive spatial autocorrelation of the results of voting for the main candidate at the TECs level was confirmed: in general, the percentages of votes for candidates in neighboring localities are similar in the country (and, moreover, clustering of predominantly high values is observed).

2. Based on the calculated local indices of spatial dependence in the work (Podkolzina, Demidova, Kuletskaya, 2020) the list of regions was presented with those TECs whose local indices of territories turned out to be significant according to individual levels of significance. Most regions form similar clusters of homogeneous territories (with a predominantly high number of votes for the main candidate), but the Republic of Tatarstan stands out: unlike other regions, the republic has TECs that are simultaneously included in groups with similar and heterogeneous voting results compared to its neighbors, which indicates the need for a separate detailed study of elections in this region and verification of the thesis well-known in the scientific literature that Tatarstan is a leading region, contributing to an increase in the number of votes for the main candidate in the border municipalities of other regions due to its economic development and historical loyalty to the Kremlin (Moraski, Reisinger, 2010; Reisinger, Moraski, 2009).

3. In the work (Podkolzina, Kuletskaya, Demidova, 2022) it was concluded that voters in both central and border municipalities of Tatarstan voted quite high for the main candidate on average and, moreover, there is a positive significant

spatial relationship between the border municipalities of Tatarstan and their neighbors from other regions.

4. Politicians can take this information into account when planning large-scale political campaigns: campaigns aimed at strong leading regions that are the economic center of their environment (with a large population, with a large number of enterprises employing more employees, with developed transport infrastructure, with a large number of urban development projects) will be held with greater coverage. More importantly, it is necessary to take into account the mutual influence of municipalities indicated in the work: special focus of campaigns should be placed on the border municipalities with the greatest potential to influence neighbors from other regions (these may be large economically strong municipalities). Thus, it is possible to competently build a regional launch of a political campaign from the point of view of both the budget and the coverage of the population;

5. The conclusions drawn in the work (Kuletskaya, Demidova, Semerikova, 2023) additionally confirmed the positive spatial autocorrelation of voting results at the municipal level. Based on the evaluated models, it was concluded that the model with included spatial lags turned out to be the best in terms of information criteria, in addition, the coefficient with spatial lag turned out to be significant. Within the framework of these criteria, the model has also performed well, including only a set of fictitious variables reflecting the belonging of a municipality to a particular region.

6. Thus, it can be concluded that the importance of taking into account spatial factors is especially strongly manifested in the analysis of certain territories, and at the level of the whole country it is enough only to take into account the factor of belonging of territories to certain subjects of Russia.

7. In the work (Kuletskaya, Demidova, Semerikova, 2023), it was found that most of the factors characterizing the level of comfort of living in Russian

municipalities are significantly related to the results of voting for the main candidate. Most likely, this is explained by the fact that the municipalities of the southern regions, which historically have high rates of votes for the main candidate, have the highest values (compared with other regions) of such indicators as population growth, the share of citizens with social support. It also turned out that the higher the distance from the regional center, the higher the support of the main candidate. This is due to the large number of hotbeds of movements of opposition parties and candidates in large cities. From the point of view of the activation of various political campaigns, it can be concluded that:

1) It is especially important to activate political campaigns in the major economic centers of the country, to influence the largest cities, as well as in territories with the status of republics. As mentioned earlier, the main focus should also be on the border municipalities of economically strong regions, thus the reach and strength of political campaigns can be significantly increased;

2) From the point of view of filling political campaigns, it seems important to focus on supporting population growth, social support programs, improving the quality of life (increasing road lighting, developing the construction of new residential buildings, expanding transport infrastructure). Even by influencing only certain municipalities (economically strong, large municipalities) with such a political program, it is possible to significantly improve its results.

Methodology

The thesis consists of 4 chapters. The first one covers general methodological issues related to all subsequent parts of the study (observation units, collected data, work with missing values in the data and other limitations of the study). In the remaining chapters the stated problems are being solved, obtained results discussed and applied approaches presented. This section provides a brief description of the methodology used in the work.

1. Data

Observation units

Data on the voting results were presented at the municipal level and at the TEC level. The territorial division of a country into TECs is more detailed than into municipalities: one municipality may include several TECs. For example, Ufa (which is one municipality) includes several TECs: Demskaya, Kalininskaya, Kirovskaya, Leninskaya, Oktyabrskaya, Ordzhonikidzevskaya, Sovetskaya.

Therefore, to solve the tasks of this study, which involve the use of only voting data, the initial results of voting at the TECs level were used. To carry out the necessary calculations, a neighborhood matrix was compiled at the TECs level.

The minimum available level of detail for socio-economic factors is the level of municipalities, therefore, in order to solve problems that involve the use of these data, the aggregation of voting results from the TECs level to the municipal one was provided.

Data sources and composition

1) Information on the results of voting in the presidential elections in Russia in 2018 at the level of regions and TECs was collected from the website of the Central Election Commission (http://www.cikrf.ru, http://www.vybory.izbirkom.ru), on the results of the presidential elections of Russia in 2018 at the regional level and at the level of territorial election commissions. The data contains information on the number and percentage of voters who voted for candidates and turnout at polling stations.

2) To construct the matrix of the neighborhood of TECs W ($w_{ij} = 0,$ if TEC j does not border on TEC i and w$w_{ij} = \frac{1}{n_i}$ if TEC j borders on TEC i, where n_i is the number of TECs that share a border with TEC i), open data about TECs was used. The matrix itself was built manually.

3) To construct the neighborhood matrix of municipalities W ($w_{ij} = 0$ if municipality j does not border with municipality i and $w_{ij} = \frac{1}{n_i}$ if municipality j borders with municipality i, where N_i is the number of municipalities sharing a border with municipality i) , open data about TECs was used. The matrix itself was built manually.

4) Socio-economic factors of municipalities were used as explanatory variables, collected both directly from the website of the Federal State Statistics Service (Rosstat)[1] and from the open database "Database of indicators of municipalities of Russia for 2006-2020. (data-in.ru)[2]" for 2017 and 2018. This database also consists of the data "Indicators of municipalities" of Rosstat. At the same time, the final calculations included data for 2017 (it was assumed that the opinion of voters was formed during the year preceding the elections).

Explanatory variables

When choosing explanatory variables, the principle of "visible" economic results for voters in municipalities was used. It was assumed that voters are primarily guided by easily tangible results related to the current situation in the region/municipality (for example, the number of houses commissioned, the level of social support, developed infrastructure, etc.). The choice of a candidate is also related to the remoteness of the municipality from the center of the region. Proximity to the center of the region allows voters to see the result of a political support program (for example, in the form of advertising a candidate on banners, billboards), because the biggest part of campaigning programs are launched in large cities.

[1] Source: https://rosstat.gov.ru/free_doc/new_site/bd_munst/munst.htm (date of application: 2021-2022).
[2] Source: http://data-in.ru/data-catalog/datasets/115/ (date of application: 2021-2022).

2. Methodology

Modeling of voting results on the example of one of the regions of Russia

A modified spatial autoregression (SAR) model was used to assess the influence of spatial variables and socio-economic factors. Instead of a single spatial WY lag reflecting the overall influence of neighboring municipalities, several spatial lags were introduced reflecting the influence of central municipalities (not bordering municipalities in other regions) on each other and on border municipalities. A similar approach to the spatial analysis of regions was proposed in the work (Demidova, 2014), where the author analyzed the differences in spatial effects between the western and eastern regions of Russia. In order to further check the relationship between different groups of regions, the author divided the neighborhood weight matrix into four parts in such a way that each of the matrices reflected, firstly, the region's belonging to one of the groups: to the West or East, and secondly, the presence or absence of a common border with the regions of another group. This division allows us to assess the possible difference in the mutual influence of regions from different groups.

The final models with several spatial lags are represented by models (1) and (2), respectively:

$$Y = X\beta + \rho_1 WY * D_{T_T} + \rho_2 WY * D_{T_{NT}} + \rho_3 WY * D_{NT_T} + \varepsilon, \quad (1)$$

$$Y = X\beta + \rho_1 WY * D_{T_{NT}} + \rho_2 WY * D_{NT_T} + \rho_3 WY * D_{NT_{NT}} + \varepsilon, \quad (2)$$

where Y is a dependent variable (the share of votes for a candidate); X is a matrix of explanatory variables (regressors), W is a weighted neighborhood matrix of size $N \times N$, where N is the number of municipalities ($w_{ii} = 0$ if two territories do not have common borders), $w_{ij} = \frac{1}{N_i}$ if two territories have a common border), N_i is the number of municipalities that share a common border with municipality i, $i \neq j$), WY is the spatial lag (the average share of votes for a candidate in neighboring municipalities).

D_{T_T} is a dummy variable = 1, if the municipality is located in Tatarstan and does not have border(s) with municipalities of other regions;

$D_{T_{NT}}$ is a dummy variable = 1, if the municipality is located in Tatarstan and has a border(s) with municipalities of other regions;

D_{NT_T} is a dummy variable = 1, if the municipality is NOT located in Tatarstan and has a border(s) with municipalities of Tatarstan.

All four spatial lags are not included in the model ($WY * D_{NT_{NT}}, WY * D_{T_T}, WY * D_{T_{NT}}, WY * D_{NT_T}$) at the same time, due to the problem of strong multicollinearity, since spatial lags are closely interrelated.

In this study it was assumed that residents of neighboring municipalities influence each other when making decisions about voting for a particular candidate, therefore the spatial lag WY is endogenous (the shares of voters who voted for the nominated candidate in one municipality and in its neighboring municipalities correlate). In this regard, it would be incorrect to simply evaluate models (1) and (2) using a usual OLS, since the estimates of the corresponding coefficients will be biased.

In this case, estimates of the model parameters are obtained using instrumental variables. The most popular approach to the choice of the instruments was presented in the article (Kelejian, Prucha, 1998), where the columns of the matrices X, WX, W^2X are tools for the endogenous variable WY. Therefore, to evaluate models (1) and (2), the instrumental variables $Z_1, Z_2, \dots Z_l$ ($l \geq 1$) were used, which are columns of the matrices WX, W^2X multiplied by $D_{T_T}, D_{T_{NT}}, D_{NT_T}, D_{NT_{NT}}$.

Modeling of voting results for all regions of Russia

The methodology for assessing significant spatial and socio-economic factors in this chapter is very similar to the methodology that was used to analyze data from Tatarstan and its neighbors (see the description above).

Initially, according to the methodology presented in (LeSage, Pace, 2009), the Durbin spatial model was used as the main model, supplemented by a set of dummy variables for regions (each municipality belongs to one of the regions):

$$Y_i = \alpha_0 + \sum_{r=2}^{R} \alpha_r D_{ir} + \rho \sum_{j=1}^{n} w_{ij} Y_j + \sum_{j=1}^{k} \beta_j X_{ji} + \sum_{m=1}^{k} \theta_m \sum_{j=1}^{n} w_{ij} X_{mj} + \varepsilon_i, \quad (3)$$

where *i =1,…,n (n = 2314)* is the number of the municipality *r = 1,…, R (R = 80)* is the number of the region, Y_i is the value of the dependent variable for the *i*-th municipality (in this case it is the share of votes for the main candidate), $X_{1i}, \dots, X_{ki}$ –explanatory variables for the *i*-th municipality,

w_{ij} – elements of the neighborhood matrix W, with which spatial lags of the dependent and explanatory variables are created,

D_{ir} – dummy variables equal to 1 if the *i*–th municipality is included in the *r*-th region (the dummy variable for the first region is not included in the regression equation to avoid theoretical multicollinearity), ε_i are the regression errors, $\alpha_0, \alpha_2, \dots, \alpha_R, \rho, \beta_1, \dots, \beta_k, \theta_1, \dots, \theta_k$– estimated parameters.

Since the right side of the model (3) includes the spatial lag of the dependent variable $WY = \left(\sum_{j=1}^{n} w_{1j} Y_j, \dots, \sum_{j=1}^{n} w_{nj} Y_j\right)'$ and this is an endogenous variable, then the method of instrumental variables was used. In this case, the variables $X_1, \dots, X_k$, $WX_1, \dots, WX_k$, $W^2X_1, \dots, W^2X_k$ were also used as instruments according to the methodology described in the work (Kelejian, Prucha, 1998).

However, if all the factors are included in the initial model, then the problem of multicollinearity arises (the calculated value of CI (the conditionality index for the factors included in the matrices *X* and *WX*), turned out to be 29.28, which does not allow to assume the absence of multicollinearity). Therefore, after evaluating the initial model, hypotheses about the equality of coefficients to zero for a group of variables were consistently tested, if the hypothesis was not rejected, then the

corresponding variables were not included in the model, and the model was evaluated with a new set of factors. Therefore, the final model has the form of *SAR*, it includes the spatial lag of the dependent variable, but not the spatial lags of the explanatory variables. «The tests performed showed the heteroscedasticity of the errors of the estimated models, therefore, standard errors in the White form were used.» (Kuletskaya, Demidova, Semerikova, 2023).

Discussion of the research

Preliminary results were discussed at all the stages of the research and were presented at seminars, Russian national and international conferences, and also published in indexed reviewed scientific journals.

Conferences

1. Presentation of preliminary research results and discussion of work within the framework of the XIII Russian Summer School of Institutional Analysis (RSSIA 2019) (Moscow, Russia, HSE, June 30 – July 6, 2019). Topic of the report (co-authored): "Spatial modeling of electoral preferences in the Russian Federation".

2. VII International Conference "Modern Econometric Tools and Applications – META 2020" and II seminar "Applied Econometrics" 09/23/2020 (Nizhny Novgorod, Russia, September 22-26, 2020, online format). Topic of the report (co-authored): "Spatial modeling of electoral preferences in the Russian Federation".

3. The 43rd meeting of the international scientific school-seminar "System modeling of socio-economic processes" (Voronezh, Russia, October 13-18, 2020, online format). Topic of the report (co-authored): "Spatial modeling of electoral preferences in the Russian Federation". The report received a Diploma named after Naum Yakovlevich Krasner.

4. Seminar of the research working group "Center for Spatial Econometrics in Applied Macroeconomic Research" (Moscow, Russia, HSE, October 28, 2020,

online format). Topic of the report (co-authored): "Spatial modeling of voter preferences: The "Mystery" of the Republic of Tatarstan".

5. The Fourth Russian Economic Congress (REC-2020) (Moscow, Russia, December 21-25, 2020, online format). Topic of the report (co-authored): "Spatial modeling of electoral preferences in the Russian Federation".

6. XXII April International Academic Conference on Economic and Social Development (Moscow, Russia, HSE, April 13-30, 2021, online format). Topic of the report (co-authored): "Spatial modeling of voter preferences: The " Mystery" of the Republic of Tatarstan".

7. FES Seminar for Junior Economists – 2021 (Moscow, Russia, HSE, December 8-16, 2021, online format). Topic of the report (co-authored): "Spatial modeling of voter preferences: The " Mystery" of the Republic of Tatarstan".

List of author's original articles

1. Podkolzina E.A., Demidova O.A., Kuletskaya L.E. Spatial Modeling of Voting Preferences in Russian Federation // Prostranstvennaya Ekonomika = Spatial Economics, 2020, vol. 16, no. 2, pp. 70–100. https://dx.doi.org/10.14530/se.2020.2.070-100 (In Russian).

2. Kuletskaya L.E. Spatial Modeling of Voter Choice: The Survey of Theoretical and Empirical Approach // Prostranstvennaya Ekonomika = Spatial Economics, 2021, vol. 17, no. 2, pp. 127–164. https://dx.doi.org/10.14530/se.2021.2.127-164 (In Russian)

3. Podkolzina E., Kuletskaya L., Demidova O. Spatial modeling of voting preferences: The "Mystery" of the Republic of Tatarstan // Applied Econometrics, 2022, vol. 67, pp. 74-96.

4. Kuletskaya L. E., Demidova O. A., Semerikova E. V. (2023). Spatial econometric approach to modeling election results in Russia: Municipal level //

Economics and Mathematical Methods, 59, 3, pp.137-148 DOI: 10.31857/S042473880024435-7 (in Russian).

The results of the thesis were also used:

1) to prepare methodological materials for lectures and seminars on the course of econometrics for students of the 3rd year of the Bachelor's degree of the Higher School of Economics and on the course of econometrics for graduate students of the Higher School of Economics;

2) to conduct research seminars for the Higher School of Economics students (faculty of economics).

In addition, thesis results were used in scientific reports of the research working group "Center for Spatial Econometrics in Applied Macroeconomic Research" of the Higher School of Economics (faculty of economics).

Policy implication and theoretical value of the research

Policy implication of the study, first of all, is to expand the understanding of the possibilities of using spatial-econometric analysis methods, as well as to understand the importance of taking into account the mutual influence of neighboring territories on each other when analyzing any social events. This work will help researchers to familiarize themselves and learn more about different methods of evaluating voting results, which can probably be applied to other research objects. In addition, the study contains a detailed analysis of the factors related to the results of voting for the main candidate on the example of the 2018 elections in Russia. The results obtained in the work enable politicians, based on assessments of the degree of interconnection of territories, to correctly build an election campaign plan, including the selection of priority projects and certain municipalities, the improvement of which is important in the first place.

The theoretical value of the study is to expand the possibilities of using spatial econometric tools and give impetus to the further development and application of these methods for the correct assessment of various large-scale social events.

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