MODELING THE EMPLOYMENT RATE IN RUSSIA: A SPATIAL-ECONOMETRIC APPROACH

The purpose of this study is to identify factors that affect the level of employment in Russian regions. However, Russia is not a homogeneous country, and this effect may not be the same for all regions. That is why we split the regions of Russia into three groups, depending on the state of the labor market in this and neighboring regions. The HH (high-high) group comprises regions with a favorable situation in their labor markets, and which are also surrounded mostly by prosperous regions. Two groups of regions with a less favorable situation are located respectively in the south of Russia (LL1, low-low group 1) and southern Siberia and Zabaikalye (LL2, low-low group 2). We considered the twelve-year period from 2005 to 2016. As explanatory variables, we used variables for the attractiveness of the region, demographic characteristics of the region, and the degree of diversity of employees by economic activities. We tested hypotheses about differences in 1) the spatial effects and 2) the impact of the various explanatory variables for these groups of variables.

To test our main hypotheses, we used spatial regression dynamic models estimated with the help of the generalized method of moments. Both main hypotheses received empirical confirmation. Spatial effects were different. The regions of the LL2 group are not affected by the situation in other local markets; regions of LL1 and HH groups are affected by the rest of Russia’s regions, and the extent of this influence decreases with the increase in geographical distance between regions. Moreover, the regions of the LL1 group compete with neighboring regions: if the situation in one of them improves, then it draws on the resources of the others.

Regarding the impact of the explanatory variables, the “group effect” was revealed for the variables: share of urban population, net migration rate, shares of people below and above working age, share of people with higher education. Our results can favor the better design of national and regional policies to improve labor market performance in Russia based on the heterogeneity of the Russian regions.

Keywords: employment, labor market, regional data, spatial effects, spatial models, labor policies, development policies

1. Introduction

The socio-economic development plan for the Russian Federation until 2020 states that the priorities of the state regional policy are (i) balanced socio-economic regional development, and (ii) the reduction of interregional disparities.

So, knowing how regions are distributed into high or low employment groups/clusters is a key empirical issue with significant policy implications. However, according to [1] Oschepkov and Kapelyushnikov (2015), there is no single joint Russian labor market; instead, there is a system of rather weak interrelated territorial/local labor markets. The reasons are mainly the low mobility of the Russian population and significant differences among regions located in different parts of Russia. The authors also note that there are two groups of regions that were quite stable in the time interval 2000–2014: “leaders” (with high employment, low unemployment, and high wages) and “outsiders” (with low employment, high unemployment, and low wages).

In our research, we sought to determine, by means of a dynamic spatial econometric approach, which factors affect one of the most important indicators of labor markets: the level of employment of the population. The focus was on the mutual influence of regions on each other. If we did not take account of such influence in the models used, we might have encountered the problem of shifting estimates due to the omission of an essential variable. At the same time, it was difficult to take account of the influence of regions on each other; in this case, the number of model parameters that would have to be estimated would exceed the number of observations. However, there are spatial-econometric models that enable the use of
several parameters to take the mutual influence of regions into account.

In the next section, we provide a brief overview of the key theoretical aspects and the main literature on regional aspects of the Russian labor market. In the third section, we describe the distinction of Russian regions into groups using Moran plots and the "leader-outsider" approach, present our data sources, discuss the choice of explanatory variables, and state the main research hypotheses. In the fourth section, we describe the methodology of econometric modeling. The sixth section sets out the results of the estimation and their interpretation. The last section contains some concluding remarks and policy implications.

2. The Theoretical Aspects and Literature Review

An original feature of this paper is its use of the employment rate and not the more traditional unemployment rate indicator. Here we briefly provide a short theoretical explanation for this choice.

Although the unemployment rate is still adopted in both theoretical and empirical studies, a growing number of economists have shown the key importance of the employment rate and its relative advantages with respect to the unemployment rate, especially because of the difficulties with this latter indicator in clearly defining the "active search for a job" as the crucial feature distinguishing unemployed people from inactive ones. In addition, some international institutions have started to define key policy objectives in terms of employment rates; the main example is the European Union that, within the framework of the European Employment Strategy, in 2000 at the Lisbon Council defined total and female employment rates as the labor market’s performance objectives, and a similar employment rate index has been confirmed with the "Europe 2020" strategy launched in 2010.

It should be stressed that the level and dynamic of the employment rate cannot be simply derived from the level and dynamic of the unemployment rate. Let us consider the relationship between the two labor market performance indicators. First, we define the unemployment rate \( UR \) as the percentage ratio between the number of unemployed person \( U \) (i.e. unemployed people actively searching for a job) and the labor force \( LF \) (i.e. employed plus unemployed persons); second, we define the employment rate \( ER \) as the percentage ratio between the employed persons \( E \) and the working age population \( P_{15-72} \); third, we define the participation rate \( PR \) as the percentage ratio between labor force \( LF \) and the working age population \( P_{15-72} \).

\[
UR = \frac{U \times 100}{LF}, \quad (1)
\]

\[
ER = \frac{E \times 100}{P_{15-72}}, \quad (2)
\]

\[
PR = \frac{LF \times 100}{P_{15-72}}. \quad (3)
\]

Starting from equations (1), (2) and (3), the employment rate can be redefined as the complement to one of the unemployment rate (divided by 100) multiplied by the participation rate:

\[
ER = \frac{E \times 100}{P_{15-72}} = \frac{LF - U}{LF} \times \frac{LF \times 100}{P_{15-72}} = \left(1 - \frac{UR}{100}\right) \times PR. \quad (4)
\]

From equation (4), we can derive the unemployment rate \( UR \) as the complement to one of the ratios between employment rate \( ER \) and participation rate \( PR \) (the result multiplied by 100).

\[
UR = \left(1 - \frac{ER}{PR}\right) \times 100. \quad (5)
\]

Considering equation (5), a complex relationship emerges between the unemployment and employment rates; in fact, for example, a reduction in the unemployment rate is compatible with a reduction in the employment rate if the absolute value of this latter is lower than the absolute value of the reduction in the participation rate. Hence, it is not surprising that the unemployment rate can have different dynamics over time with respect to the employment rate.

For the reasons above mentioned, we adopted the employment rate as the key indicator of labor market performance in our study applied to Russian regions.

A growing body of literature investigates labor market performance at regional (sub-national) level, especially in large countries. In particular, the mutual influence of regions on each other in modeling the unemployment rates of regions in one or several countries is more often taken into account with the help of spatial-econometric models [2] Caroleo and Pastore, 2010; [3] Mussida and Pastore, 2015, [4] Dolton et al., 2015; [5] Vega and Elhorst, 2016; [6] Manning and Petrongolo, 2017. There are several studies on the European regions, like [7] Head and Thierry (2006), [8] Ketterer and Rodríguez-Pose (2016). Some authors note the heterogeneity of the labor market and often identify clusters of regions, or they use 'core-periph-
In the twelve-year period from 2005 to 2016. The major studies focused on unemployment rates (e.g., [25] Danilenko et al., 2017). Considering the above-discussed relationship between unemployment rate and employment rate, it is not surprising that in this paper, we obtain empirical results different from those of other studies focused on unemployment rates (e.g., [25] Danilenko et al., 2017).

3. Data and Variables

3.1 Data

Our sample consisted of 80 regions during the twelve-year period from 2005 to 2016. The majority of the data used in the research were available for public access via the website of the Federal State Statistics Service (FSSS) of the Russian Federation. It was impossible to include earlier years in the research due to the different classification of industries before the year 2005.

Moreover, data on some regions were missing (the Republic of Chechnya, the Republic of Crimea and Sevastopol). In addition, the Kaliningrad region was not included in the study because it has no common borders with other regions of Russia. Moreover, during the reporting period, some regions underwent changes of an administrative-territorial nature. This altering of boundaries was taken into consideration, mitigated by an aggregating procedure (see Table 1).

3.2 The Splitting of Regions by Moran Plot

Russian regions are not homogeneous, and employment levels differ considerably among them. We distinguish a group of regions with an employment level above the average and a group of regions with a level of employment below the average. It is also necessary to take account of the weighted average employment rate in neighboring regions (the weights are given by the weighted matrix W matrix): it can also be above or below the average. Thus, we can distinguish four groups of regions. Traditionally used for such a division is the Moran chart, in which the horizontal axis states the standardized values of the employment rate $Z$, and the vertical axis states spatially weighted standardized values of the employment rate $WZ$.

In our analysis, a matrix of common borders was formed. It was represented by the following definition of $W$:  

| Date       | Merging regions               | Incorporated as          |
|------------|-------------------------------|--------------------------|
| 01.01.2007 | Taymyr Autonomous Okrug       | Krasnoyarsk Territory    |
| 01.01.2007 | Evenk Autonomous Okrug        | Krasnoyarsk territory    |
| 01.07.2007 | Kamchatka oblast               | Kamchatka territory      |
| 01.01.2008 | Ust-Orda Buryat Autonomous Okrug | Irkutsk region          |
| 01.03.2008 | Chita region                  | Zabaykalsky Territory    |
| 01.07.2012 | Moscow, Moscow oblast         | Moscow                   |
length in km of joint boundaries between regions i and j
where \( w_{ij}^{km} = \frac{\text{total length in km of all boundaries of region } i}{\text{total length in km}} \).

We used information on the length of joint boundaries taken from the State real estate cadastre.\(^1\) The matrix is line-normalized, so that \( w_{ij} \) accounts for the weights of a region; \( w_{ij} = 0 \), if there is no boundary between regions \( i \) and \( j \) or if \( i = j \). For each region, we have a point on the Moran scatterplot which can be in one of four quarters. The first quarter represents the High–High group: this means that in the given region the employment rate is high and it is surrounded by regions also with high employment; it is a group of the most prosperous regions that positively influence each other. The second quarter represents the Low–High group: the employment rate in the region is low, but the neighbor region has a high level of employment; it is a group of the most disadvantaged regions for its neighbors; this is a group of prosperous regions that can receive some benefits from proximity to prosperous regions. The third quarter represents the Low–Low group: both the region and its neighbors have low employment rates; this group comprises the most disadvantaged regions. The fourth quarter represents the High–Low group: the employment rate in the region is high for the region and low for its neighbors; this is a group of prosperous regions, but the situation in them may worsen due to proximity to unfavorable regions.

We thus obtained scatterplots for each year from 2005 to 2016.\(^2\) Each point was labeled by the number of the corresponding region. To determine the list of regions for each group, we counted how many times the corresponding points were in each quarter. We obtained the results set out in the table below.

It should be stressed that these groups of regions are close to, but not identical with, the group of four unemployment groups of regions in Russia discussed in [25] Danilenko et. al (2017).

In both cases, regions of LL group for employment and HH group for unemployment are geographically split into two parts: South of Russia and South of Siberia. We consequently decided to separate the LL (employment) group into two groups. Additionally, HL and LH groups contain, respectively, only 5 and 11 regions. We decided to add those regions to larger groups; to determine the destination group, we used the “leader-outsider” approach followed by [1] Oschepkov and Kapelyushnikov (2015, the details are in the next section).

### 3.3 The “Leader-Outsider” Approach

[1] Oschepkov and Kapelyushnikov (2015) concluded that regions had stable positions in time on all indicators considered. They distinguished between “leader” and “outsider” regions. High employment and purchasing power of nominal wages together with a low unemployment rate are observed in leading regions. By contrast, high unemployment and a low level of economic activity characterize “outsider” regions. The same authors highlight that it is possible to allocate leading and lagging regions to clusters by geographic location. In their analysis, the authors discussed only the first and last ten regions (leaders and outsiders). Moreover, they did not give the exact list of regions for each indicator.

Following the same approach of [1] Oschepkov and Kapelyushnikov (2015), we made a list of regions for three indicators: employment rate, unemployment rate, and the purchasing power of nominal wages using rankings. We took the data on the employment rate from 2005 to 2016 for each region from Table 2. Then, for each year, the regions were arranged in descending order by the employment rate and were ranked (the first region had rank 1, the second one rank 2, and so on). In the final list, the regions were arranged in ascending order by the mean rank for 12 years (the smallest mean rank corresponded to the region with the highest employment rate). The result was the list of regions that follows.

It should be noted that the list of leaders is almost the same for all three indicators. If we now consider Table 1 again, we find that regions from HH and HL groups are at the top of the list in Table 2, while regions from LL and LH groups are at its bottom.

Finally, according to the Moran plot for employment rate and “leader-outsider approach”, the Russian regions were divided into 3 final groups. HL and LH groups were attached to the corresponding groups (HL + HH, LH + LL). The LL group was split into two clubs: LL1 group (South of Russia) and LL2 group (South of Siberia) by geographical criteria. Regions 40 and 54 were “outliers”. To determine the relevant group, we calculated the mean value of the employment rate in those regions and clubs, and we joined “outliers”
with a group which had approximately the same mean. As a result, regions 40 and 54 were joined to the LL2 group.

The resulting division by employment groups is depicted below.

Regions from the LL1 group are mainly located in the south of Russia. These are mainly agricultural areas characterized by a high level of informal employment.

It should be noted that the authoritative experts on the Russian labor market in their report ([26] Gimpelson et al, 2017) also divide the Russian outsider regions into two groups: a group of southern republics and a group of regions of Southern Siberia (details can be found in [26]). They note that “the regions within each group have very similar structural and natural-geographical characteristics.”

In previous research (see [25] Danilenko et al., 2017), we analyzed the difference in spatial effects and the determinants of unemployment rate for three clubs of Russian regions (HH, LL, HL). In the
### Table 3

The list of Russian regions obtained by ranking

| Employment (from highest to lowest level)              | Unemployment (from lowest to highest level)              | Buying power of nominal wage (from highest to lowest) |
|------------------------------------------------------|--------------------------------------------------------|------------------------------------------------------|
| Chukotka Autonomous Okrug                           | Moscow                                                 | Nenets Autonomous Okrug                              |
| Yamal-Nenets Autonomous region                      | Saint-Petersburg                                       | Yamal-Nenets Autonomous region                       |
| Magadan region                                       | Chukotka Autonomous Okrug                              | Tumen region                                          |
| Saint-Petersburg                                     | Samara region                                           | Khanty-Mansi Autonomous Area — Yugra                  |
| Moscow                                               | Tula region                                             | Chukotka Autonomous Okrug                            |
| Khanty-Mansi Autonomous Area — Yugra                 | Yamal-Nenets Autonomous region                         | Magadan region                                       |
| Murmansk region                                      | Lipetsk region                                          | Moscow                                               |
| Kamchatka territory                                  | Belgorod region                                         | Saint-Petersburg                                     |
| Tumen region                                         | Republic of Mordovia                                    | Sakhalin region                                      |
| Nenets Autonomous Okrug                              | Yaroslavl region                                        | Republic of Komi                                      |
| Leningrad region                                     | Novgorod region                                         | Krasnoyarsk Territory                                 |
| Samara region                                        | Kostroma region                                         | Murmansk region                                       |
| Kaluga region                                        | Kaluga region                                           | Republic of Sakha (Yakutia)                           |
| Sakhalin region                                      | Leningrad region                                        | Kemerovo region                                      |
| Republic of Mordovia                                 | Magadan region                                          | Irkutsk region                                       |
| Republic of Tatarstan                                | Republic of Tataran                                     | Tomsk region                                          |
| Republic of Udmurtia                                 | Tver region                                             | Kamchatka territory                                  |
| Kostroma region                                      | Nizhny Novgorod region                                  | Arkhangelsk region                                   |
| Novgorod region                                      | Ryazan region                                           | Republic of Tataran                                   |
| Vologda region                                       | Penza region                                            | Sverdlovsk region                                    |

**Fig. Employment groups**
| Employment (from highest to lowest level) | Unemployment (from lowest to highest level) | Buying power of nominal wage (from highest to lowest) |
|------------------------------------------|---------------------------------------------|---------------------------------------------------|
| Nizhny Novgorod region                   | Chelyabinsk region                          | Zabaykalsky Territory                             |
| Sverdlovsk region                        | Tumen region                                | Leningrad grad                                    |
| Krasnoyarsk Territory                    | Ivanovo region                              | Republic of Karelia                               |
| Vladimir region                          | Voronezh region                             | Chelyabinsk region                               |
| Tver region                              | Vologda region                              | Omsk region                                      |
| Republic of Tatarstan                    | Kursk region                                | Republic of Bashkortostan                         |
| Smolensk region                          | Arkhangelsk region                          | Republic of Khakassia                             |
| Kirov region                             | Krasnodar Territory                         | Kaluga region                                    |
| Lipetsk region                           | Vladimir region                             | Amur region                                      |
| Khabarovsk Territory                     | Orel region                                 | Vologda region                                   |
| Arkhangelsk region                       | Sverdlovsk region                           | Belgorod region                                  |
| Chelyabinsk region                       | Khanty-Mansi Autonomous Area — Yugra        | Khabarovsk Territory                             |
| Republic of Sakha (Yakutia)              | Bryansk region                              | Novosibirsk region                               |
| Republic of Komi                         | Ulyanovsk region                            | Novgorod region                                  |
| Republic of Karelia                      | Orenburg region                             | Republic of Tyva                                  |
| Tula region                              | Republic of Bashkortostan                   | Astrakhan region                                 |
| Republic of Chuvashia                    | Krasnoyarsk Territory                       | Yaroslavl region                                 |
| Ivanovo region                           | Smolensk region                             | Republic of Buryatia                              |
| Astrakhan region                         | Stavropol Territory                         | Lipetsk region                                   |
| Perm territory                           | Khabarovsk Territory                        | Tula region                                      |
| Primorsky Territory                      | Amur region                                 | Orenburg region                                  |
| Pskov region                             | Saratov region                              | Perm territory                                   |
| Republic of Marii El                     | Rostov region                               | Republic of Udmurtia                             |
| Novosibirsk region                       | Novosibirsk region                          | Primorsky Territory                              |
| Belgorod region                          | Tambov region                               | Nizhny Novgorod region                           |
| Orenburg region                          | Sakhalin region                             | Saratov region                                   |
| Kursk region                             | Kamchatka territory                         | Krasnodar Territory                              |
| Irkutsk region                           | Pskov region                                | Samara region                                    |
| Omsk region                              | Kirov region                                | Jewish Autonomous area                           |
| Orel region                              | Nenets Autonomous Okrug                     | Tver region                                      |
| Kemerovo region                          | Republic of Udmurtia                        | Volgograd region                                 |
| Ulyanovsk region                         | Perm territory                              | Penza region                                     |
| Volgograd region                         | Volgograd region                            | Smolensk region                                  |
| Amur region                              | Murmansk region                             | Orel region                                      |
| Republic of Bashkortostan                | Kemerovo region                             | Bryanzan region                                  |
| Bryansk region                           | Republic of Karelia                         | Kostroma region                                  |
| Saratov region                           | Omsk region                                 | Rostov region                                    |
| Tomsk region                             | Republic of Khakassia                       | Kursk region                                     |
| Republic of Northen Ossetia — Alania     | Primorsky Territory                         | Republic of Chuvashia                            |
| Rostov region                            | Republic of Chuvashia                       | Vladimir region                                  |
| Penza region                             | Altai Territory                             | Republic of Marii El                             |
| Krasnodar Territory                      | Tomsk region                                | Ulyanovsk region                                 |
| Altai Territory                          | Republic of Marii El                        | Pskov region                                     |
| Republic of Khakassia                    | Republic of Sakha (Yakutia)                 | Republic of Ingushetia                           |
| Ryazan region                            | Jewish Autonomous area                      | Kurgan region                                    |
| Voronezh region                          | Astrakhan region                            | Voronezh region                                  |
| Republic of Altai                        | Republic of Komi                            | Bryansk region                                   |
| Stavropol Territory                      | Republic of Adygea                          | Kirov region                                     |
| Tambov region                            | Republic of Northen Ossetia — Alania        | Republic of Mordovia                             |

*End of table on the next page*
### Table 3

| Employment (from highest to lowest level) | Unemployment (from lowest to highest level) | Buying power of nominal wage (from highest to lowest) |
|------------------------------------------|--------------------------------------------|------------------------------------------------------|
| Jewish Autonomous area                  | Irkutsk region                             | Tambov region                                       |
| Kurgan region                            | Zabaykalsky Territory                      | Republic of Northen Ossetia — Alania                |
| Republic of Kalmykia                     | Kurgan region                              | Stavropol Territory                                 |
| Zabaykalsky Territory                    | Republic of Buryatia                       | Republic of Adygia                                   |
| Republic of Karachaev-Chekeressia        | Republic of Altay                          | Altay Territory                                      |
| Republic of Buryatia                     | Republic of Karachaev-Chekeressia          | Republic of Altay                                   |
| Republic of Adygia                        | Republic of Kabardino-Balkaria             | Republic of Kabardino-Balkaria                       |
| Republic of Dagestan                      | Republic of Dagestan                        | Ivanovo region                                       |
| Republic of Kabardino-Balkaria           | Republic of Kalmykia                       | Republic of Karachaev-Chekeressia                    |
| Republic of Tyva                          | Republic of Tyva                           | Republic of Kalmykia                                 |
| Republic of Ingushetia                   | Republic of Ingushetia                     | Republic of Dagestan                                 |

### Table 4

| Number | Region            | Number | Region                         |
|--------|-------------------|--------|--------------------------------|
| 1      | Belgorod region   | 41     | Republic of Marii El           |
| 2      | Bryansk region    | 42     | Republic of Mordovia           |
| 3      | Vladimir region   | 43     | Republic of Tatarstan          |
| 4      | Voronezh region   | 44     | Republic of Udmurtia           |
| 5      | Ivanovo region    | 45     | Republic of Chuvashia          |
| 6      | Kaluga region     | 46     | Perm territory                 |
| 7      | Kostroma region   | 47     | Kirov region                   |
| 8      | Kursk region      | 48     | Nizhny Novgorod region         |
| 9      | Lipetsk region    | 49     | Orenburg region                |
| 10     | Orel region       | 50     | Penza region                   |
| 11     | Ryazan region     | 51     | Samara region                  |
| 12     | Smolensk region   | 52     | Saratov region                 |
| 13     | Tambov region     | 53     | Ulyanovsk region               |
| 14     | Tver region       | 54     | Kurgan region                  |
| 15     | Tula region       | 55     | Sverdlovsk region              |
| 16     | Yaroslavl region  | 56     | Tumen region                   |
| 17     | Moscow            | 57     | Khanty-Mansi Autonomous Area — Yugra |
| 18     | Republic of Karelia| 58    | Yamal-Nenets autonomous region |
| 19     | Republic of Komi  | 59     | Chelyabinsk region             |
| 20     | Arkhangelsk region| 60     | Republic of Altay              |
| 21     | Novens Autonomous Okrug | 61     | Republic of Buryatia           |
| 22     | Vologda region    | 62     | Republic of Tyva               |
| 23     | Leningrad region  | 63     | Republic of Khakassia          |
| 24     | Murmansk region   | 64     | Altay Territory                |
| 25     | Novgorod region   | 65     | Zabaykalsky Territory          |
| 26     | Pskov region      | 66     | Krasnoyarsk Territory          |
| 27     | Saint-Petersburg  | 67     | Irkutsk region                 |
| 28     | Republic of Adygia | 68    | Kemerovo region                |
| 29     | Republic of Kalmykia | 69   | Novosibirsk region             |
| 30     | Krasnodar Territory| 70    | Omsk region                    |
| 31     | Astrakhan region  | 71     | Tomsk region                   |
| 32     | Volgograd region  | 72     | Republic of Sakha (Yakutia)    |
| 33     | Rostov region     | 73     | Kamchatka territory            |
| 34     | Republic of Dagestan | 74    | Primorsky Territory            |
| 35     | Republic of Ingushetia | 75     | Khabarovsk Territory           |
| 36     | Republic of Kabardino-Balkaria | 76    | Amur region                    |
research reported here, we decided to test similar hypotheses for three employment groups.

H1: spatial effects for the HH, LL1, and LL2 groups differ;

H2: the determinants of employment for the HH, LL1, and LL2 groups differ.

3.4 The Data, the Dependent and the Explanatory Variables

As said, our sample consisted of 80 regions. Due to data availability, the employment rate was calculated on the population aged between 15 to 72.

To explain existing levels of employment rate (variable empl) and to test two research hypotheses, three groups of variables were chosen: 1) variables concerning the attractiveness of the region; 2) socio-demographic variables; and 3) variables concerning the industrial structure of the employed population. The first group of variables consisted of four indicators: (i) GRP per capita (variable grpper_cap_1, thousand rubles in prices of basic year), (ii) population density (variable density, people per square km), (iii) the share of urban population (variable urban_share, %), (iv) net migration rate (migration_1, number of migrants per 10 000 population, may be positive or negative). The socio-demographic features of the population consisted of variables characterizing the age structure of the population and the stock of human capital. To illustrate the age structure, the shares of people below and above working age were taken as variables (below and above, %). Working age in Russia is above 16 and below retirement age, which was 60 years for men and 55 for women during the studied period. The stock of human capital was measured as the share of the employed population with a higher education (variable high_educ, %), where ‘higher education’ means that someone has at least a higher professional education according to the FSSS classification. The sectoral structure is one of the most important features in explaining the regional employment rate. Consequently, we used the Hirschman-Herfindahl Index (variable hh 1) to characterize the industrial structure of each region; and it is used as a measure of the region’s degree of sectoral specialization.

\[
HHI = S_1^2 + S_2^2 + \ldots + S_n^2, \tag{7}
\]

where \(S_1, S_2, \ldots, S_n\) are shares of people employed in sectors of economic activity (agriculture, construction, wholesale and retail trade, public sector (consisting of education and health services), mining, manufacturing, services). The region is more monopolized if the hh value is closer to 1.

To avoid the problem of endogeneity, we used the first time lag of the variables grpper_cap, migration, hh.

We now compare the descriptive statistics of variables for different groups (see Table 4).

There are disparities between HH, LL1 and LL2 groups. For example, almost all mean values for variables that characterize the attractiveness of the region are higher in the HH group.

4. Methodology of the Econometric Modeling

To test the two main research hypotheses, we used the following modification of the SAR (Spatial Auto Regression) model:

\[
\begin{aligned}
Y_{hh}^{t} &= Y_{hh}^{t-1} + \rho_{HH} \begin{pmatrix}
0 \\
0
\end{pmatrix}_t + \rho_{LL1} \begin{pmatrix}
WY_{d1}^{t} \\
WY_{d2}^{t}
\end{pmatrix}_t + \\
&+ \begin{pmatrix}
0 \\
0
\end{pmatrix}_t
\end{aligned}
\]

\[
\begin{aligned}
&+ \begin{pmatrix}
\beta_{HH} \\
\beta_{LL1}
\end{pmatrix}_t \begin{pmatrix}
X_{h1}^{t} \\
X_{d1}^{t}
\end{pmatrix}_t + \\
&+ \begin{pmatrix}
\alpha_{HH} \\
\alpha_{LL1} \\
\alpha_{LL2}
\end{pmatrix}_t \begin{pmatrix}
u_{h1}^{t} \\
u_{d1}^{t} \\
u_{d2}^{t}
\end{pmatrix}_t,
\end{aligned} \tag{8}
\]

where \(Y\) is employment in group 15–72, \(WY\) is spatial lag, \(X\) is a matrix of explanatory variables, \(\alpha\) is a vector of fixed effects, \(u\) is a vector of errors (we split them in three parts), \(c\) is a vector of time effects (set of dummy variables for 2007–2016 years).

Let us formulate our hypotheses in a form convenient for empirical verification:

**Hypothesis 1.** There are no differences of spatial effects in regional groups.

**Alternative hypothesis 1.** There are differences of spatial effects in regional groups.
Table 5

Descriptive statistics for the variables

| Variable     | Mean  | Std. Dev. | Min   | Max   | Observations |
|--------------|-------|-----------|-------|-------|--------------|
| **All Russia** |       |           |       |       |              |
| empl overall | 62.528| 5.955     | 16.500| 81.200| N = 960      |
| between      | 5.505 | 34.475    | 78.783| 85.833| n = 80       |
| within       | 2.345 | 44.553    | 73.673| 58.653| T = 12       |
| wcbempl      | 62.939| 3.777     | 36.439| 78.836| N = 960      |
| between      | 3.386 | 46.110    | 76.357| 64.295| n = 80       |
| within       | 1.713 | 53.267    | 70.137| 56.713| T = 12       |
| widempl      | 62.138| 2.345     | 41.332| 65.947| N = 960      |
| between      | 1.836 | 49.799    | 64.295| 62.853| n = 80       |
| within       | 1.600 | 53.671    | 70.137| 56.713| T = 12       |
| grppercap_1  | 96963.860| 117139.900| 2133.539| 1035858.000| N = 960 |
| between      | 101129.200| 11409.280| 589271.300| 589271.300| n = 80   |
| within       | 60095.540| 387423.000| 543550.500| 543550.500| T = 12 |
| urbanshare   | 0.694 | 0.126     | 0.260 | 1.000 | N = 960 |
| between      | 0.126 | 0.278     | 1.000 | 0.738 | n = 80 |
| within       | 0.011 | 0.653     | 0.738 | 0.347 | T = 12 |
| below        | 17.701| 3.548     | 12.100| 34.400| N = 960 |
| between      | 3.450 | 13.025    | 31.158| 13.025| n = 80 |
| within       | 1.836 | 49.799    | 64.295| 62.853| T = 12 |
| above        | 21.397| 4.931     | 5.500 | 16.905| N = 960 |
| within       | 4.638 | 8.258     | 28.125| 0.738 | n = 80 |
| migration_1  | 0.755 | 0.095     | 0.573 | 1.000 | N = 960 |
| between      | 0.096 | 0.588     | 1.000 | 0.738 | n = 80 |
| within       | 0.011 | 0.715     | 0.800 | 0.347 | T = 12 |
| density      | 73.322| 387.276   | 0.069 | 3752.572| N = 960 |
| between      | 388.906| 0.070     | 3482.613| 3482.613| n = 80 |
| within       | 21.661| 146.362   | 343.280| 343.280| T = 12 |
| high Educ    | 26.654| 5.678     | 12.500| 50.000| N = 960 |
| between      | 4.443 | 18.925    | 47.758| 47.758| n = 80 |
| within       | 3.567 | 14.671    | 40.521| 40.521| T = 12 |
| hh_1         | 0.293 | 0.060     | 0.204 | 0.635 | N = 960 |
| between      | 0.056 | 0.215     | 0.557 | 0.557 | n = 80 |
| within       | 0.023 | 0.196     | 0.560 | 0.560 | T = 12 |

**HH group**

| Variable     | Mean  | Std. Dev. | Min   | Max   | Observations |
|--------------|-------|-----------|-------|-------|--------------|
| empl overall | 65.681| 3.855     | 57.700| 81.200| N = 528      |
| between      | 3.417 | 61.800    | 78.783| 70.748| n = 44       |
| within       | 1.853 | 58.898    | 70.748| 70.748| T = 12       |
| wcbempl      | 64.648| 2.691     | 58.622| 78.836| N = 528      |
| between      | 2.341 | 60.473    | 76.357| 67.666| n = 44       |
| within       | 1.369 | 60.239    | 76.357| 67.666| T = 12       |
| widempl      | 62.897| 1.521     | 59.289| 65.947| N = 528      |
| between      | 0.598 | 61.473    | 64.295| 61.473| n = 44       |
| within       | 1.401 | 59.961    | 65.113| 65.113| T = 12       |
| grppercap_1  | 124489.100| 146080.500| 2133.539| 1035858.000| N = 528 |
| between      | 125809.100| 34761.040| 589271.300| 589271.300| n = 44   |
| within       | 76432.750| 359897.800| 570757.700| 570757.700| T = 12 |
| urbanshare   | 0.755 | 0.095     | 0.573 | 1.000 | N = 528 |
| between      | 0.096 | 0.588     | 1.000 | 1.000 | n = 44 |
| within       | 0.011 | 0.715     | 0.800 | 0.800 | T = 12 |
| below        | 16.929| 2.629     | 12.100| 24.800| N = 528 |
| between      | 2.501 | 13.025    | 23.858| 23.858| n = 44 |
| within       | 0.887 | 15.496    | 19.288| 19.288| T = 12 |
### Table 5

| Variable     | Mean   | Std. Dev. | Min    | Max    | Observations |
|--------------|--------|-----------|--------|--------|--------------|
| **above**    |        |           |        |        |              |
| overall      | 21.580 | 5.011     | 5.500  | 30.200 | N = 528      |
| between      | 4.704  | 8.258     | 28.125 |        | n = 44       |
| within       | 1.855  | 17.089    | 27.989 |        | T = 12       |
| **migration_1** | -7.242 | 57.181    | -223.000 | 197.000 | N = 528 |
| overall      | 4.704  | 8.258     | 28.125 |        | n = 44       |
| between      | 48.814 | -142.333  | 107.500 |        | T = 12       |
| within       | 30.604 | -190.325  | 174.591 |        |              |
| **density**  |        |           |        |        |              |
| overall      | 107.836 | 519.274  | 0.069  | 3752.572 | N = 528      |
| between      | 523.951 | 0.070    | 3482.613 |        | n = 44       |
| within       | 29.178 | 17.089    | 35.189 |        | T = 12       |
| **high_edu** |        |           |        |        |              |
| overall      | 26.414 | 6.174     | 12.500 | 50.000 | N = 528      |
| between      | 5.142  | 19.035    | 47.758 |        | n = 44       |
| within       | 3.497  | 17.089    | 35.189 |        | T = 12       |
| **hh_1**     |        |           |        |        |              |
| overall      | 0.291  | 0.069     | 0.205  | 0.635  | N = 528      |
| between      | 0.064  | 0.215     | 0.557  |        | n = 44       |
| within       | 0.028  | 0.193     | 0.558  |        | T = 12       |

#### LL1 group

| Variable     | Mean   | Std. Dev. | Min    | Max    | Observations |
|--------------|--------|-----------|--------|--------|--------------|
| empl         | 58.474 | 6.710     | 16.500 | 67.300 | N = 264     |
| overall      | 58.474 | 6.710     | 16.500 | 67.300 | N = 264     |
| between      | 5.966  | 34.475    | 62.725 |        | n = 22      |
| within       | 3.306  | 40.499    | 74.799 |        | T = 12      |
| wcempl       | 60.236 | 4.420     | 36.439 | 67.223 | N = 264     |
| overall      | 60.236 | 4.420     | 36.439 | 67.223 | N = 264     |
| between      | 3.800  | 46.110    | 64.996 |        | n = 22      |
| within       | 2.387  | 50.565    | 107.500|        | T = 12      |
| widempl      | 60.688 | 3.500     | 41.332 | 65.159 | N = 264     |
| overall      | 60.688 | 3.500     | 41.332 | 65.159 | N = 264     |
| between      | 2.887  | 49.799    | 63.220 |        | n = 22      |
| within       | 2.064  | 52.212    | 68.686 |        | T = 12      |
| grppercap_1  | 59339.110 | 43394.850 | 3310.776 | 291518.000 | N = 264 |
| overall      | 59339.110 | 43394.850 | 3310.776 | 291518.000 | N = 264 |
| between      | 35287.700 | 11439.280 | 161948.200 |         | n = 22 |
| within       | 26267.330 | -33631.360 | 188908.800 |         | T = 12 |
| urbanshare   | 0.608  | 0.106     | 0.384  | 0.767  | N = 264     |
| overall      | 0.608  | 0.106     | 0.384  | 0.767  | N = 264     |
| between      | 0.108  | 0.413     | 0.760  |        | n = 22      |
| within       | 0.011  | 0.580     | 0.644  |        | T = 12      |
| below        | 17.756 | 4.102     | 13.600 | 33.400 | N = 264     |
| overall      | 17.756 | 4.102     | 13.600 | 33.400 | N = 264     |
| between      | 4.127  | 14.233    | 30.425 |        | n = 22      |
| within       | 0.713  | 15.431    | 20.731 |        | T = 12      |
| above        | 22.358 | 4.960     | 7.600  | 29.900 | N = 264     |
| overall      | 22.358 | 4.960     | 7.600  | 29.900 | N = 264     |
| between      | 4.839  | 9.408     | 27.592 |        | n = 22      |
| within       | 1.472  | 19.533    | 26.474 |        | T = 12      |
| migration_1  | -2.585 | 55.750    | -499.000 | 148.000 | N = 264 |
| overall      | -2.585 | 55.750    | -499.000 | 148.000 | N = 264 |
| between      | 37.061 | -86.667   | 75.833 |        | n = 22      |
| within       | 42.332 | -485.169  | 161.832 |        | T = 12 |
| density      | 45.202 | 26.455    | 3.726  | 143.530 | N = 264     |
| overall      | 45.202 | 26.455    | 3.726  | 143.530 | N = 264     |
| between      | 26.944 | 3.803     | 130.743 |        | n = 22      |
| within       | 2.066  | 29.739    | 57.989 |        | T = 12      |
| high_edu     | 28.120 | 4.833     | 16.600 | 46.000 | N = 264     |
| overall      | 28.120 | 4.833     | 16.600 | 46.000 | N = 264     |
| between      | 3.054  | 23.233    | 36.417 |        | n = 22      |
| within       | 3.797  | 17.461    | 41.986 |        | T = 12      |
| hh_1         | 0.308  | 0.045     | 0.238  | 0.456  | N = 264     |
| overall      | 0.308  | 0.045     | 0.238  | 0.456  | N = 264     |
| between      | 0.043  | 0.253     | 0.433  |        | n = 22      |
| within       | 0.016  | 0.268     | 0.406  |        | T = 12      |

#### LL2 group

| Variable     | Mean   | Std. Dev. | Min    | Max    | Observations |
|--------------|--------|-----------|--------|--------|--------------|
| empl         | 58.990 | 3.977     | 45.800 | 65.900 | N = 168     |
| overall      | 58.990 | 3.977     | 45.800 | 65.900 | N = 168     |
| between      | 3.625  | 48.225    | 62.917 |        | n = 14      |
| within       | 1.882  | 52.032    | 62.932 |        | T = 12      |

*End of table on the next page*
Formal main and alternative hypotheses 1:

\[ H_0 : \rho_H = \rho_{L1} = \rho_{L2} \]

\[ H_1 : \rho_H \neq \rho_{L1} \text{ or } \rho_H \neq \rho_{L2} \]

**Hypothesis 2.** There are no differences in the influence of the factors on employment rates in the regions belonging to different regional clubs.

Alternative hypothesis 2. There are differences in the influence of the factors on employment rates in the regions belonging to different regional clubs.

Formal main and alternative hypotheses 2:

\[ H_0 : \beta_H = \beta_{L1} = \beta_{L2} \]

\[ H_1 : \beta_H \neq \beta_{L1} \text{ or } \beta_H \neq \beta_{L2} \]

The split spatial lags in our model were endogenous. To resolve the problem of endogeneity difference, we adopted the GMM ([27] Arellano and Bond, 1991) method of estimation. However, application of this method to our initial specification (with all explanatory variables, divided into several parts) required a number of instruments much larger than the number of regions.

According to Roodman (2009), this leads to a bias in the parameter estimation. To avoid this problem we had to use the Arellano–Bond approach for the estimation and drastically restrict the number of instruments. Moreover, in order to consider the possible bias in the parameters’ estimation at a small time interval but with a large number of observation units, we adopted a GMM modification for models with fixed effects, similarly to [28] Lee and Yu (2010). In addition, a large number of variables may also lead to the problem of multicollinearity of the data. To increase the efficiency of the estimates, we removed groups of insignificant variables from the model one by one (after a preliminary test of the corresponding statistical hypotheses). The technique that we used was an extension of the conventional backward stepwise method. To test the robustness of the result of the estimation, we re-estimated our model with an inverted distance weighted matrix instead of the matrix of common borders. The results of the estimation are presented in the next section.
5. The Results of the Estimation

In this section, we present the final results of our main estimations (Table 6). For each model, we also present the results of post-estimation procedures. Estimates of the coefficients obtained by the Arellano-Bond method are consistent under the following conditions ([29] Greene, 2012, p. 400): 1) errors $u_t$ must be serially uncorrelated; 2) moment conditions (consisting in the orthogonality of the errors and instruments) must be correct. The Arellano-Bond approach, using the equations in difference, makes it possible to avoid the endogeneity problem with the elimination of individual effects. It is for this reason that the errors in the difference equation must be identified as first-order autocorrelations and not revealed as higher-order autocorrelations (Arellano and Bond test). The second condition is verified by the Sargan test of instruments’ validity. These two conditions are verified for all the models estimated.

Spatial effects for the three employment groups were different. For the LL2 group of regions, the spatial effects were insignificant; hence employment in the regions of the LL2 group does not depend on the local labor markets of other regions. For the group of HH regions, only spatial effects for the inverse distance weighting matrix are significant. Consequently, each region of the HH group is affected by the rest of Russia’s regions, and the extent of this influence decreases with the increase in geographical distance between regions. Employment in the HH region group varies according to the general situation in the country.

The most interesting spatial effects were revealed for the regions in the LL1 group. For a common boundary weighting matrix, they were negative, and for a weighting matrix of inverted distances, they were positive. Thus, in the LL1 group of regions (in the south of Russia), there is a mechanism of competition for labor resources with neighboring regions. If in one of the southern regions the situation on the labor market improves, then it draws labor resources from neighboring regions. At the same time, if the overall employment situation in Russia improves (or worsens), then similar changes occur in the LL1 group of regions.

In regard to the impact of the explanatory variables, the “group effect” was found for the variables share of urban population, net migration rate, shares of people below and above working age, share of people with higher education.

The influences of GRP per capita and on the level of employment was insignificant.

For LL2 and HH groups of regions, employment was not dependent on the share of the urban population. This can be explained by the presence of two opposite tendencies: in a city, it is usually easier to find a job; but for monotowns, of which there are more than 300 in Russia when the city-forming enterprise closes, the situation changes to the op-

| Dependent Variable | modelwcb | modelwid |
|--------------------|----------|----------|
| Weighted matrix    |          |          |
| empl               |          |          |
| L1. (time lag)     | 0.562*** | 0.553*** |
| Spatial lags       |          |          |
| wcbemplL1          | -0.184***  |
| wcbemplL2          | 0.105   |
| wcbemplH           | 0.125   |
| widemplL1          | 0.101*  |
| widemplL2          | 0.234   |
| widemplH           | 0.391*** |
| urbandshareL1      | -51.186*** | -29.216*** |
| belowL1            | -1.017*** | -0.785*** |
| belowL2            | -0.415***| -0.139  |
| belowH             | -0.373** | -0.154  |
| aboveL1            | 0.821*** | 0.813*** |
| migr_1L1           | 0.006*** | 0.007*** |
| migr_1L2           | 0.006*  | 0.004   |
| migr_1H            | -0.007***| -0.006***|
| dens               | -0.004***| -0.003* |
| high_edL2          | 0.129*** | 0.147** |
| hh_1               | 5.017*** | 4.857*** |
| d2007              | 0.206   | 0.239   |
| d2008              | -0.164  | -0.332  |
| d2009              | -1.188** | -1.138** |
| d2010              | 0.175   | -0.062  |
| d2011              | 0.583   | 0.122   |
| d2012              | 1.237*** | 0.338   |
| d2013              | 0.698   | -0.235  |
| d2014              | 1.272** | 0.095   |
| d2015              | 0.992*  | -0.206  |
| d2016              | 1.301***| -0.098  |
| _cons              | 35.103***| 11.964* |

| Number of instruments | 62 | 62 |
| p-v AB test for zero autocorrelation in first-differenced errors |   |
| order 1               | 0.000 | 0.000 |
| order 2               | 0.133 | 0.12  |
| p-v Sargan test       | 0.477 | 0.254 |
The increase in the share of urban population reduced employment in the Low-Low1 group. This can be explained by the fact that a large proportion of businesses in the southern regions are engaged in agriculture.

With an increase in the population aged under 16, the level of employment was reduced according to both estimated models only in the LL1 group of regions. This can be explained by the fact that in the North Caucasus regions that belong to this group, the share of young people is very high, and for them, it is difficult to find jobs. Conversely, increasing the proportion of the population over working age increases employment in the LL1 group, because in these regions there are relatively low wages; therefore, on reaching retirement age, people often leave the labor market, preferring informal employment and work on personal plots of land.

The influx of migrants stimulates employment in the LL1 group of regions and decreases employment in the group of HH regions. This may be because more educated migrants able to compete for well-paid jobs go mainly to the regions of the HH group.

An increase in the proportion of the population with higher education stimulates employment only in the LL2 group of regions.

Group effects were not found for the variables density and Herfindahl-Hirschman index.

The negative dependence of employment on population density can be explained 1) by competition for jobs, 2) by the problem of monotowns mentioned above, 3) by the favorable situation in the labor markets of some sparsely populated northern regions. Perhaps, for this variable, a functional dependence more flexible than the linear one should be used.

A higher Herfindahl-Hirschman index is associated with higher employment. The higher the Herfindahl-Hirschman index, the more the level of specialization in the given region. Thus, in 2005–2016 in Russia Marshallian effects prevailed.

The results of the estimation also make it possible to draw a conclusion about the negative impact of the 2008–2009 crisis on the level of employment, whereas the crisis of 2014 did not affect it. This is probably because the 2008–2009 crisis was global, while the crisis in 2014 had a local character with effects more delayed and distributed over time.

6. Conclusions

In this paper, we have investigated the spatial effects for the regional employment groups in Russia and the differences in the impact factors that explain regional employment. The key results are the following: (1) boundary spatial effects for three groups are different; (2) the differing influence for selected groups of regions was apparent for the share of urban population, net migration rate, the shares of people below and above working age, the share of people with higher education; (3) the influence of GRP is insignificant.

According to our results, these are several (general and specific) policy implications. From a general perspective, (national and regional) economic and labor policies must take the specificity of each group of regions into account; in fact, the same policy measures can generate significantly different consequences in HH, LL1 and LL2 groups of regions; moreover, policies should consider that the (positive) impact on a group of regions can indirectly (negatively or positively) affect other groups of regions. As regards the specific policy implications, the following aspects seem most important: (i) policies favoring a higher level of specialization are suggested due to the positive employment effects in all groups of regions; (ii) an increase in the share of urban population with higher educated proportion of the labor force is recommended because it would increase employment in the South of Siberia and in Zabaikalye; (iii) the increase in migration flows favorably affects the employment of only the LL1 group of regions, where the agricultural sector is well developed; therefore, it is desirable to create favorable conditions for migrants in the South of Russia, while in more densely populated regions of Russia, migrants can compete for jobs with indigenous people, worsening both wage and working conditions; (iv) national and regional economic, educational and labor policies could focus especially on improving the dramatic employment quantity and quality in the group of regions LL1, especially considering the supply-demand mismatch and the difficulties of transition — from education and from unemployment — to employment, also reducing the problem of competing for resources with neighboring regions.

These results are consistent with the findings of the report based on [26] that federal policy in the labor market in Russia should be built with “possible consideration of the heterogeneity of the regions”, there are no “simple and quick solutions” to smoothing the differentiation of Russian regions, this problem requires a “strategic and integrated approach.”

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