Spatial econometric modeling of regional unemployment in Russia: comparison of resource-rich and resource-deficient regions

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Key words: regional unemployment, Russia, spatial effects, spatial econometric models

JEL Classification: R23, C21, J64.

Abstract

The unemployment rate is one of the main indicators of the socio-economic situation in the country. Despite the fact that the unemployment rate varies considerably from region to region, in various macroeconomic forecasts, policy programs, analytical materials, as a rule, only country level unemployment rate is analyzed. However, in so large and economically heterogeneous country as Russia, the country's unemployment rate can not reflect the fullness of the picture available for observation in the regional context. Many studies on the modeling of unemployment in the regions of Russia indicate the existence of a relationship between regional labour markets. Accounting for this relationship is important, first of all, because the presence of spatial effects plays an important role in the formation of regional policies in the sphere of labour and employment. In addition, the inclusion of spatial lags in econometric models that estimate the level of unemployment, allows you to avoid the coefficients bias for other regressors of the model, caused by the omission of an essential variable. The main feature of this study is the use of several weighting matrices, including an endogenous weighting matrix based on the structure of the gross regional product and designed for each year of the period under study. In this research all regions are divided into two groups: resource-rich and resource-deficient. Two main hypotheses were tested: 1) On the asymmetric impact of resource-rich and resource-deficient regions on each other, 2) About differences in factors explaining the dynamics of unemployment in resource-rich and resource-deficient regions. To test these hypotheses, we create a special model with four spatial matrices. This model was estimated by the panel data for 80 Russian regions for the period 2005-2013. Based on the results of the estimation of models by the GMM, both hypotheses have been empirically confirmed.

1. Introduction and brief literature review

The unemployment rate is one of the main indicators of the national socio-economic situation. Despite the fact that the unemployment rate varies considerably from region to region, in various macroeconomic forecasts, policy programs, analytical materials, as a rule, only the country level unemployment rate is analyzed. However, in such a large and economically heterogeneous country as Russia, the national unemployment rate cannot reflect the whole picture available for observation in the regional context. Many studies on the modeling of unemployment in the regions of Russia indicate relationships between regional labour markets.

Oschepkov and Kapelyushnikov (2015) emphasize that there is no single labour market in Russia, only a system of local labour markets, which remain rather loosely interconnected.

Thus, with the overall unemployment rate in Russia at 5.2% in 2014, the ratio between the minimum (1.4% in St. Petersburg) and the maximum (about 30% in Ingushetia) regional unemployment levels is over twenty (Oschepkov and Kapelyushnikov , 2015).

A descriptive analysis of the state of regional labour markers 2000-2015 edited by Gimpelson et al. (2017) indicates that local labour markets in Russia vary greatly in their degree of success: while some regions show record high employment (for example, 81.2% in the Chukotka Autonomous Region Okrug in 2014), other entities can not provide half of their working population with work (for example, Tyva - 48.4%). It also showed that Russian regions are prone to clustering, that is, it is possible to identify groups of leaders and outsiders in which labour markets work relatively well or poorly. Such clusters are territorially close, have a similar economic structure and climatic and geographic features.

One of Russia's features is its wealth of fuel and energy resources. However, these resources are located in a small number of regions that are part of the group of leaders in the labour market.

This paper investigates whether other Russian regions receive spillovers from regions rich in natural resources.

It can be assumed that one of the following impacts occurs: 1) neutral (when resource-rich regions do not affect the rest) 2) positive spillovers (when resource-rich regions lift resource-deficient regions), 3) negative spillovers (when resource-rich regions draw most resources to themselves and the situation in the remaining regions deteriorates). The study determines which of these occurs in Russia using spatial econometrics. This approach has become more and more popular in modeling of socio-economic processes taking place in the Russian regions.

Buccellato (2007), and Lugovoy et al. (2007) were the first to note the spatial components for Russian regional studies were non-negligible. The bias in the estimates of the coefficients under the ignorance of spatial effects was discussed in Vakulenko (2015), Semerikova and Demidova (2015). Kholodilin et al. (2012) showed that the overall speed of regional convergence in Russia is low in comparison with other countries, but there is a distinct tendency towards convergence in a cluster of rich regions surrounded by other rich regions. Kolomak (2011) demonstrated that the spatial externalities of economic growth were positive in the western regions of Russia and negative for in the eastern ones. Demidova et al. (2013) and Demidova (2015) revealed positive externalities for the western regions, and both positive and negative externalities for the eastern regions, as well as asymmetry in the mutual influence of the eastern and western regions on each other. These studies used weighting matrices based on the geographical proximity of the region for modeling links between Russian regions.

The advantage of geographical weighting matrices is their exogeneity. This assumption greatly facilitates the computational part of the research, allows us to use ready-made modules in many statistical packages (STATA, R, Matlab etc.), but it is too blunt an instrument. We consider a more realistic approach of Conley and Topa, (2002), which takes into account not only geographic, but also economic proximity of regions related to the similarity of their sectoral structure.

However, under using economic distance between regions, the corresponding weighting matrices will be endogenous and time-dependent. There are few articles devoted to the estimation of such models (Kelejian, Piras (2014) and Qu, Lee (2015)).

In this study, we used both geographic and economic matrices and the approach proposed by Kelejian and Piras (2014) to obtain consistent estimates of coefficients using endogenous weighting matrices.

The next section presents our data sources and variables. The third section describes the models and the results of the estimation. The last section contains some concluding remarks and policy implications.

2. Data and Variables

2.1. Data

We used data for 80 Russian regions in 2005-2013. Unfortunately, for earlier years there is no data on the sectoral structure of the regions. The majority of the data used in the research was available for public access via the website of the Federal State Statistics Service (FSSS) of the Russian Federation. Data on the Republic of Chechnya were not included in the study because of its absence for some years. 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 character. This altering of boundaries was taken into consideration, mitigated by an aggregating procedure (see Table A2 in Appendix).

As noted above, all regions of Russia were divided into resource-rich and resource-deficient. The criterion for classifying the region as rich in fuel and energy resources was the share in the total volume of extraction of fuel and energy resources exceeding 3%.

With this criterion, eight regions were classified as resource-rich: the Republic of Tatarstan, the Orenburg Region, the Khanty-Mansi Autonomous Area-Yugra, the Yamalo-Nenets Autonomous District, the Krasnoyarsk Territory, the Kemerovo Region, the Republic of Sakha (Yakutia) and the Sakhalin Region. The remaining 72 subjects were attributed to the poor in terms of the availability of fuel and energy resources to the regions.

A list of 8 resource-rich and 72 resource-deficient regions is given in Table A1 in Appendix.

Descriptive statistics of the unemployment rate for the two groups of regions are presented in Table 1.

Analysis of Figure 1 shows that unemployment in the resource-deficient regions in 2005-2013 was higher than in the resource-rich.

Fig. 1. Dynamics of the average unemployment rate in Russia in 2005-2013.

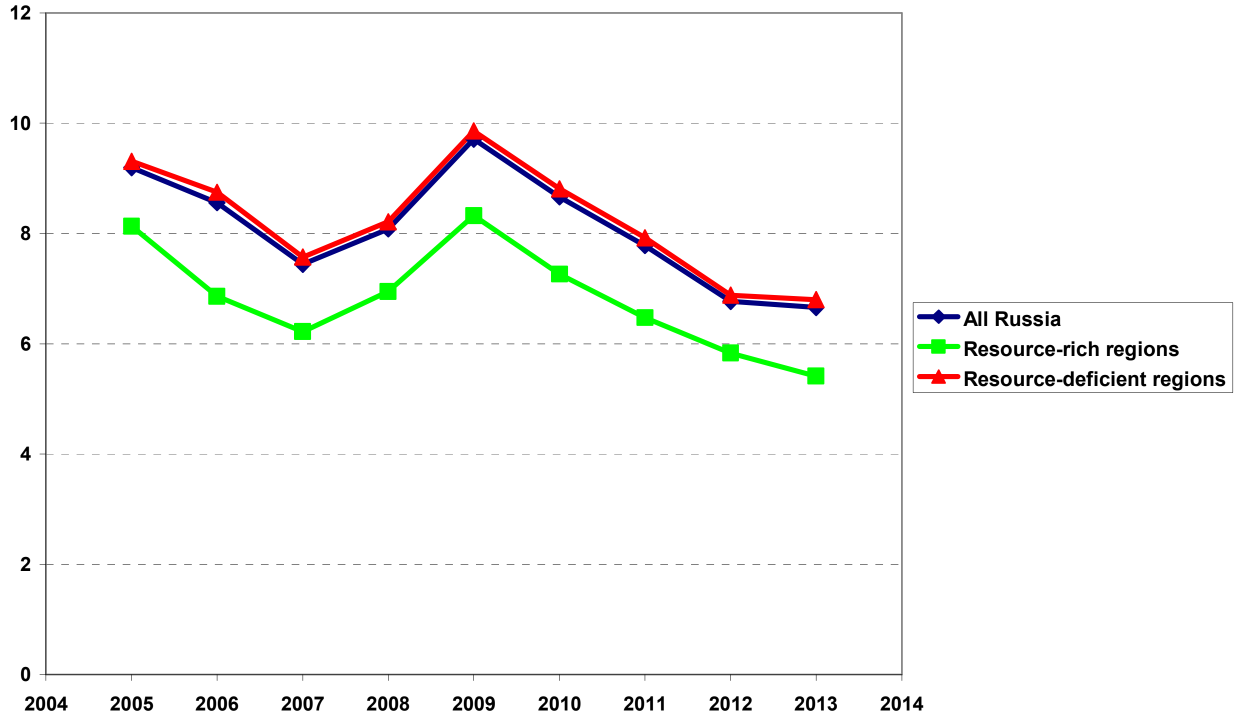

Table 1. Descriptive statistics for the unemployment rate

Unemployment rate	Number of observation	Mean	Standard deviation
All Russia	720	8.099	0.982
Resource-rich regions	72	6.832	0.927
Resource-deficient regions	648	8.240	0.991

2.2. Weighting matrices

To test whether we need to take into account the spatial heterogeneity of Russian regions, we calculated Moran's indices for three weighting matrices: the binary contiguity, W_b, matrix of inverse distance between the capitals of the regions by road, W_{id}, and an endogenous matrix reflecting the proximity of the industry structure of regions, W_{end}.

For each region, we used the annual Rosstat data on the sectoral structure of gross value added for 2005-2013. There are 15 types of economic activity, their names are given in Table A3 in Appendix.

From a mathematical point of view, each region corresponds to a 15-dimensional vector. The economic distance between these vectors was measured as Euclidean.

All the weighting matrices were normalized in rows.

Moran's indices are significant for most years, which allows us to conclude that it is necessary to include spatial lags in the models under consideration (see Table 2).

Table 2. Moran's spatial correlation index for the variable unemployment

	Binary contiguity weighting matrix			**Inverted distance weighting matrix**			**Endogenous weighting matrix**		
Year	All Russia	Resource-rich regions	Resource-deficient regions	All Russia	Resource-rich regions	Resource-deficient regions	All Russia	Resource-rich regions	Resource-deficient regions
2005	0.076	0.358***	0.153***	0.096**	0.398***	0.215***	-0.004**	0.021***	0.002***
2006	0.119**	0.321***	0.223***	0.109**	0.378***	0.285***	0.0003***	0.023***	0.004***
2007	0.19***	0.323***	0.232***	0.152***	0.377***	0.295***	0.002***	0.020***	0.003***
2008	0.145***	0.339***	0.223***	0.114**	0.372***	0.285***	0.005***	0.023***	0.005***
2009	0.101**	0.376***	0.176***	0.055	0.417***	0.206***	0.003***	0.026***	0.008***
2010	0.096**	0.337***	0.166***	0.06	0.370***	0.193***	0.005***	0.026***	0.007***
2011	0.085*	0.315***	0.155***	0.053	0.348***	0.175***	0.004***	0.024***	0.004***
2012	0.119**	0.320***	0.122**	0.068	0.351***	0.153***	0.006***	0.024***	0.003***
2013	0.146***	0.335***	0.150***	0.088*	0.372***	0.189***	0.005***	0.024***	0.003***
* p-value < 0,1 ** p-value < 0,05 *** p-value < 0,001									

2.3 Variables

The explanatory variables in this paper (population under the working age young, population over working age old, share of urban population urban share, density of population density, migration growth rate migrat, share of employed with a higher education higheduc, GRP per capita in 2005 prices grp) were selected in accordance with the findings of other studies on unemployment: (Partridge (1995), Semerikova (2014), Marelli and Vakulenko (2016), Demidova (2015), Kapelyushnikov and Oshchepkov (2014), Gimpelson et al. (2017)).

One of the most important factors determining unemployment is the demographic situation in the region. Typically, age structure indicators of the population are used to describe it, primarily the proportion of young (0-15 years) and post-retirement age people. As shown by Hofler and Murphy (1989), Elhorst (1995), Elhorst (2013), the increase in the proportion of young people increases the unemployment rate, a similar trend for Russia was noted in the work

(Kapelushnikov, 2014). The influence of the proportion of the elderly population is less obvious. This population may not enter the labour market, but, if it remains on the labour market, it is often more difficult to adapt to volatile working conditions and is less likely to move to areas with a more favorable labour market situation.

In the regions with a high proportion of urban unemployment should be lower, because the trade and services sectors are more developed in the city, creating jobs. Due to the diversified employment opportunities, the problem of the correspondence of labour supply and demand is weakened in the cities, which also reduces unemployment.

However, Russia is a country of single-industry towns: according to Maslova (2011), there are more than 500 of them, that is, about 46% of the total number. The main problem of single-industry towns is that due to the low competitiveness of products produced by the city-forming enterprise, a deterioration of its production capacities and fluctuations in demand, or other crises that arise at the enterprise cause severe and prolonged local unemployment.

Demographic characteristics population density and migration flows have an impact on the level of unemployment. If we consider population density as an indicator of the level of social and economic development of the region, then high values should identify a favorable economic situation with a low level of unemployment. However, with an increase in population density, there is a risk that at some point the demand for labour will cease to match its extremely high supply, which ultimately leads to an increase in unemployment.

It is not so simple to make an unambiguous conclusion about the direction of the effect of migration growth on the formation of unemployment. Migration reflects the economic well-being of the region: the richer and more developed it is, the more its migratory flows are (Andrienko and Guriev, 2004). Labour migration increases competition in the labour market and, in the absence of an increase in the demand for labour, leads to an increase in the number of unemployed. Taking into account the specifics of the statistical recording of migration growth, which includes only those who officially registered in their new location, workers who have changed their place of residence should be seen as competitors. Therefore, migration flows have a positive effect on the growth of unemployment. We used this variable as an endogenous.

An important indicator determining employment in the region is the level of education of its population. The more educated and skilled the worker, the higher the demand for him and the sooner his potential reemployment in the case of job loss. In addition, highly educated workers are more prone to interregional migration if other regions that can offer better economic opportunities (Aragon Y., 2003). The expected sign of the proportion of the employed population with higher education, chosen as an indicator of the educational level of the population, is negative.

Gross regional product per capita is also a significant factor reflecting the economic well-being of the region and affecting employment. The higher the regional GRP, the higher the incomes of producers and the population, the more resources for production, the higher demand for labour and the lower unemployment. Thus, the expected dependence of the unemployment rate on GRP per capita is negative.

The purchasing power varies greatly by region. Therefore, per capita GRP, was adjusted for the cost of a fixed basket of consumer goods and services used by Rosstat for the corresponding region in 2005.

Since unemployment is determined by long term factors, there is a certain stability in its development. This relation on the Russian labour market has been repeatedly observed in many empirical studies. Oschepkov and Kapelyushnikov (2015) note that the correlation between the level of unemployment in 2000 and its level in 2014 is 0.79. That confirms the strong dependence of the unemployment rate on its past values. To take into account this dependence, the lag of the dependent variable is included in the model.

A complete list of explanatory variables and their descriptive statistics are given in Table A3 in Appendix.

3. Model and Results of estimation

3.1. Model

In the present study I used SAR model proposed by Demidova (2015) was used. In that study, to identify possible differences in the spatial effects for the eastern and western regions and to identify the mutual influence of the two groups of regions on one another, all the explanatory variables were doubled by having one each for rich and poor regions. The weighting matrices were divided into four parts, with an explanation provided below. It revealed the asymmetric impact of the western and eastern areas of Russia on each other.

This approach is applicable when considering any two groups of regions with mutual influence. In this paper, all regions of Russia were divided into resource-rich and resource-deficient.

The following dynamic model is proposed:

$$\begin{pmatrix} Y^r_{i_\kappa t} \\ Y^p_{i_p t} \end{pmatrix} = \sigma \begin{pmatrix} Y^r_{i_r t-1} \\ Y^p_{i_p t-1} \end{pmatrix} + \begin{pmatrix} \rho_l^{rr} W_l^{rr} & \rho_l^{rp} W_l^{rp} \\ \rho_l^{pr} W_l^{pr} & \rho_l^{pp} W_l^{pp} \end{pmatrix} \begin{pmatrix} Y^r_{i_r t} \\ Y^p_{i_p t} \end{pmatrix} + \begin{pmatrix} X^r \beta^r \\ X^p \beta^p \end{pmatrix} + \sum_{k=7}^{13} \gamma_k d_{200k} + \alpha_i + \varepsilon_{it}, \qquad (1)$$

where Y^{r} and Y^{p} are the rich (resource-rich) and poor (resource-deficient) parts of the corresponding dependent variable Y (level of unemployment), respectively, $i_{\mathrm{r}} = 1,\ldots,8,\ i_{\mathrm{p}} = 9,\ldots,80,\ i = 1,\ldots,80,\ t = 2005,\ldots,2013$, *l = b(boundary) or id(inverted distance) or end(endogenous)*, X^r and X^p are rich (resource-rich) and poor (resource-deficient) parts of the matrix X of explanatory variables, $d_{2007} - d_{2013}$ are dummy variables for the corresponding year, $\alpha_i, i = 1,...,80$ are individual regional effects, and $\varepsilon_{it} \sim iid(0, \sigma_\varepsilon^2)$ are disturbances.

The weighting matrices (normalised by rows) are divided into four parts in the following manner:

$$\underbrace{W_l}_{(80\times80)} = \begin{pmatrix} \underbrace{W_l^{\text{rr}}}_{(8\times8)} & 0 \\ 0 & 0 \end{pmatrix} + \begin{pmatrix} 0 & W_l^{\text{rp}} \\ 0 & 0 \end{pmatrix} + \begin{pmatrix} 0 & 0 \\ W_l^{\text{pr}} & 0 \end{pmatrix} + \begin{pmatrix} 0 & 0 \\ 0 & \underbrace{W_l^{\text{pp}}}_{(72\times72)} \end{pmatrix},$$

l = b(boundary) or id(inverted distance) or end(endogenous).

The matrices W_b^{rr}, W_{id}^{rr}, and W_{end}^{rr} reflect the influence of the resource-rich regions on one another, the matrices W_b^{pp}, W_{id}^{pp}, and W_{end}^{pp} reflect the impact of the resource-deficient regions on one another, W_b^{rp}, W_{id}^{rp}, and W_{end}^{rp} reflect the impact of the resource-deficient regions on the resource-rich regions, W_b^{pr}, W_{id}^{pr}, and W_{end}^{pr} reflect the influence of resource-rich regions on the resource-deficient regions.

In model (1), we estimated the following coefficients characterising the spatial effects: $\rho_l^{rr}, \rho_l^{\text{rp}}, \rho_l^{\text{pr}}, \rho_l^{\text{pp}}$, *l = b(boundary) or id(inverted distance) or end(endogenous).*

The dynamic form of model (1) is not accidental due to the Arellano– Bond (1991) method of estimating which provides estimates for the required parameters "with good properties" because of the use of instrumental variables.

The set of independent variables in model (1) is doubled; for example:

$$shurbanr = \begin{cases} shurban, if\ i = 1,\dots,8\,(rich\ \ regions) \\ \quad 0, if\ i = 9,\dots,80\,(poor\,regions) \end{cases}$$

$$shurbanp = \begin{cases} \qquad 0, if\ i = 1,\dots,8\,(rich\ \ regions) \\ shurban, if\ i = 9,\dots,80\,(poor\ \ regions) \end{cases}$$

In models with an endogenous weighting matrix, we used the algorithm proposed by Kelejian and Piras (2014). First we instrumented all nonzero elements of weighting matrix $w_{ij}, i, j = 1,\dots,80, i \neq j$ (for each year). As instruments we used distances between capitals of regions *i* and *j*, ratio of populations in regions *i* and *j* and their second and third powers.

Second, as is the case with exogenous weighting matrix, we used the Arellano - Bond (1991) approach and GMM as an estimation method.

3.2 The results of estimation

Table 3 shows the final results of the estimation of model (1) with a boundary or an inverse distance or endogenous weighting matrix.

Table 3. The results of estimation

Variables	Wb	Wid	Wend		Variables	Wb	Wid	Wend
Time lag	0.47***	0.575***	0.564***		youngr	-1.294	-3.865*	-2.617*
WYrr	0.411**	0.289***	-20.285*		youngp	-0.1	-0.233	0.126
WYpp	0.139*	0.037	-0.08		oldr	0.885	1.782	1.548*
WYrp	0.435***	0.323***	1.101		oldp	-0.047	-0.371	-0.465*
WYpr	0.691***	0.176	-0.405		higheducr	0.292	0.212*	-0.188
grpr	-0.000	-0.000*	-0.00***		higheducp	0.01	-0.019	-0.015
grpp	-0.000	-0.000	-0.000		migrat(-1)r	-0.002	-0.000	-0.000
densityr	-7.99	2.898	7.951		migrate(-1)p	-0.01***	-0.007***	0.001
densityp	0.004*	-0.001	-0.000		Time effects	Yes	Yes	Yes
urban sharer	-1.308	-2.89***	-1.997**		Sargan stat.	25.326	32.427	19.402
urban sharep	0.225**	0.148**	0.031		N	80	80	80

We offer our interpretation only for spatial effects. Interpretations of the other results are deliberately omitted to avoid obscuring the main research question about spatial effects.

For boundary weighting matrix all coefficients $\rho_b^{rr}, \rho_b^{rp}, \rho_b^{pr}, \rho_b^{pp}$ were positive and significant. For inverted distance weighting matrix only coefficients ρ_{id}^{rr} *and* ρ_b^{rp} were significant and positive. Thus, rich regions receive positive spillovers from all regions. At the same time poor regions receive spillovers only from neighbouring regions. This is consistent with Oschepkov and Kapelyushnikov (2015) on the weak connection of regional markets in Russia.

Spillovers from regions with a similar economic structure are received by only the rich regions, and these spillovers were negative. However, in this case we used the Euclidean distance between the industrial structures of regions (not the inverted distance as in the case of geographical distance). That is, increasing unemployment in one of the resource-rich regions leads to its growth in others.

4. Conclusions and policy implications

The results obtained are briefly summarized below.

- The existence of "geographic" spillovers was confirmed

- Positive "geographic" spillovers from resource-rich regions spread only to neighboring regions (i.e. if unemployment in resource-rich regions decreases, a similar change will occur in neighboring regions)
- “Structural-sectoral" spillovers were identified only for resource-rich regions
- The estimated models revealed differences in economic development and the mutual influence of resource-rich and resource-deficient Russian regions. These results can be used for determining regional policies.

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Appendix

Table A1. List of Russian regions

Number	Name	Number	Name
	Resource-rich regions	40	Volgograd region
1	Republic of Tatarstan	41	Rostov region
2	Orenburg region	42	Republic of Dagestan
3	Khanty-Mansi Autonomous Area - Yugra	43	Republic of Ingushetia
4	Yamal-Nenets autonomous region	44	Republic of Kabardino-Balkaria
5	Krasnoyarsk Territory	45	Republic of Karachaevo-Cherkessia
6	Kemerovo region	46	Republic of Northen Osetia – Alania
7	Republic of Sakha (Yakutia)	47	Stavropol Territory
8	Sakhalin region	48	Republic of Bashkortostan
	Resource-deficient regions	49	Republic of Marii El
9	Belgorod region	50	Republic of Mordovia
10	Bryansk region	51	Republic of Udmurtia
11	Vladimir region	52	Republic of Chuvashia
12	Voronezh region	53	Perm territory
13	Ivanovo region	54	Kirov region
14	Kaluga region	55	Nizhny Novgorod region
15	Kostroma region	56	Penza region
16	Kursk region	57	Samara region
17	Lipetsk region	58	Saratov region
18	Orel region	59	Ulyanovsk region
19	Ryazan region	60	Kurgan region
20	Smolensk region	61	Sverdlovsk region
21	Tambov region	62	Tumen region
22	Tver region	63	Chelyabinsk region
23	Tula region	64	Republic of Altay
24	Yaroslavl region	65	Republic of Buryatia
25	Moscow	66	Republic of Tyva
26	Republic of Karelia	67	Republic of Khakassia
27	Republic of Komi	68	Altay Territory

28	Arkhangelsk region	69	Zabaykalsky Territory
29	Nenets Autonomous Okrug	70	Irkutsk region
30	Vologda region	71	Novosibirsk region
31	Leningrad region	72	Omsk region
32	Murmansk region	73	Tomsk region
33	Novgorod region	74	Kamchatka territory
34	Pskov region	75	Primorsky Territory
35	Saint-Petersburg	76	Khabarovsk Territory
36	Republic of Adygea	77	Amur region
37	Republic of Kalmykia	78	Magadan region
38	Krasnodar Territory	79	Jewish autonomous area
39	Astrakhan region	80	Chukotka Autonomous Okrug

Table A2. United subjects of the Russian Federation

Data	Merging regions	Incorporated as
01.01.2007	Taymyr Autonomous Okrug	Krasnoyarsk Territory
	Evenk Autonomous Okrug	
	Krasnoyarsk territory	
01.07.2007	Kamchatka oblast	Kamchatka territory
	Koryak Autonomous Okrug	
01.01.2008	Ust-Orda Buryat Autonomous Okrug	Irkutsk region
	Irkutsk region	
01.03.2008	Chita region	Zabaykalsky Territory
	Aginsky Buryatsky Autonomous Okrug	
01.07.2012	Moscow	Moscow
	Moscow region	

Table A3. Gross value added by economic activity

agriculture, forestry
fishing
mining and quarrying
manufacturing
production and distribution of electricity, gas and water
construction
wholesale and retail trade; repair of motor vehicles and motorcycles
accommodation and food service activities
information and communication
financial and insurance activities
real estate, rent and services activities
public administration and defense; compulsory social security
education
human health and social work activities
provision of other communal, social and personal services

Table A4. Explanatory variables and their descriptive statistics

	Variables	Mean	St.Dev	Min	Max
Population under the working age	Share in the total population, in %	17.373	3.567	12.1	33.4
Population over working age	Share in total population, in %	20.731	4.861	5.5	29.1
Share of urban population	Share in total population, in %	69.411	12.616	26.1	100
Density of population	People per km2	122.3043	611.742	.071	4671.604
Migration growth rate	Per 10 000 people	-9.384	51.619	-201	197

Share of employed with a higher education	Share in the total number of employed, in%	25.357	5.189	12.5	46
GRP per capita in 2005 prices	adjusted for the cost of the consumer basket, in rubles	166317.3	303597.1	18092.14	6217504