DETERMINANTS OF ECONOMIC GROWTH OF RUSSIAN REGIONS[1]

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Paper submitted to the EcoMod International Conference on Regional and Urban Modeling, Brussels, June 1-3, 2006

ABSTRACT

The paper has two general objectives. First, to consider the determinants of economic growth of Russian regions. Here, we test the role of geography, infrastructure and some other 'deep determinants' of regional growth and regional disparities. For this purpose, we develop econometric simultaneous equations model of regional growth. Our empirical results claim climate and physical geography as an important factor of regional growth and regional disparities. Climate and physical geography affect growth via migration and investment. In addition, such factors as quality of infrastructure and agglomeration seem to be significant.

Second, we investigate convergence process across Russian regions using spatial econometrics methods. The supplementary objective of the study was to test whether models that take account of geographical connectivity of different locations are adequate for determination of growth factors in Russian regions. Our results suggest weak sigma convergence and weak unconditional beta convergence, and strong, about two percent a year, conditional beta convergence across 77 Russian regions. Spatial correlation between regions seems to be statistically significant but it is not as substantial as, for instance, in Europe (as shown in Fingleton, 2004).

[1] The paper presents preliminary findings of collaborative work of IET (Institute for the Economy in Transition) and the World Bank team on regional development and growth. The research is supported by CEPRA (The Consortium for Economic Policy Research and Advice) and the World Bank.

1. Introduction

Two main questions of the growth theory "Why do growth rates differ across countries?" and "Is there convergence of economic development of countries in long run?" can be addressed to the regions as well. Differences in development of regions within one country are comparable to disparities between countries. The paper considers the empirical determinants of economic growth of Russian regions and convergence across Russian regions.

The discussion about disparities in development of countries has a long story. Traditional neoclassical theory assigns the leading role to the factor endowments, investment in R&D and productivity growth. Institutional theory considers the factor endowments, education and innovations as the growth itself (North and Thomas, 1973), and institutions predetermine all the other factors.

Recent literature considers institutions also as endogenous or "partly endogenous". With respect to income differences D. Acemoglu, S. Johnson, J. Robinson (2005) point to three "Fundamental Causes": economic institutions, geography and culture. Thus, factors affecting economic growth exceed the bounds of neoclassical theory. R. Barro (1997) in his famous empirical work terms them as 'determinants of economic growth'. Rodrik (2003) divides all the factors into 'proximate' and 'deep' determinants of growth. Proximate determinants - factor endowments and productivity - are endogenous. They are affected by partly endogenous or exogenous factors: trade, institutions and geography (see fig. 1).

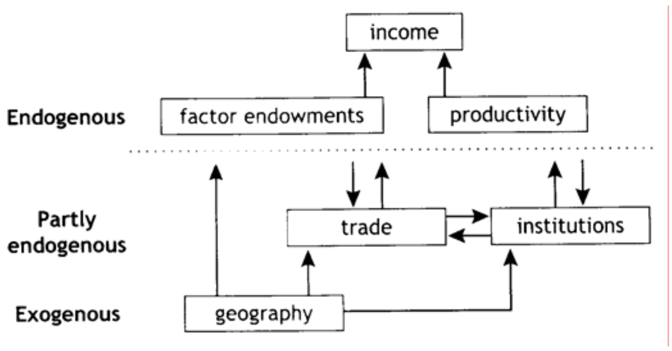

Figure 1. Determinants of growth according to Rodrik.
Source: D. Rodrik (2003), p. 5, Figure 1.3.

This paper has two objectives. First, according to the Rodrik's outline we consider the deep determinants of economic growth of Russian regions. Taking into account indirect influence of deep determinants on income we construct a simultaneous equation model, where we try to avoid the problem of endogenity and describe indirect relations.

Second, we investigate the hypothesis of convergence across Russian regions. In addition, we try to take into account possible spatial correlations of some economic variables.

2. Simultaneous equations model

We start the analysis with the commonly employed form of the production function with the additional factor for natural resources:

$$Y = AK^{\alpha}(HL)^{1-\alpha}(1+R), \qquad (1)$$

where

A – total factor productivity;

L – labor input;

K – capital input;

H – human capital;

R – input of natural resources.

We've included *R* into the production function because regions that exploit natural resources have an advantage over the others. They are able to produce more output given the same labor and capital input.

Taking logarithm of (1) and dividing by the labor we get the following equation:

$$y = a + r + \alpha k + (1-\alpha)h, \qquad (2)$$

where small letters denote the variables in logarithms, y and k - per worker.

According to our purpose, to estimate the impact of geography and institutions, there is no trade, institutions and geography in the equation except rent (*R*). As we've already discussed it is more likely that geography and trade affect output indirectly via factor endowments (see Rodrik's diagram, fig. 1). In this setting the equation (2) could be treated as demand for inputs by given y. Supplies of the endowments is defined by additional equations for labor and capital.

Labor supply: migration

The supply of labor in regions depends on natural population growth (birth and death rates) and migration. The birth rates and death rates are rather persistent, especially on the short time interval. The main cause of population growth and especially labor supply growth should be the migration.

One can find the extensive empirical literature that suggests variables affecting migration process. The common variables are income per capita, climate and geography, and population density (Barro, 2003, p.483). The specific feature of Russian migration is transition and the soviet period impact – the forced development of northern and less-developed territories. The process required a huge migration to the regions. After collapse of the USSR, the development of new territories suspended and the pattern of migration reversed.

The other two variables – the number of inhabitants in the largest city of the region and rail-passenger km per capita in the region - define an agglomeration effect and characterize the infrastructure.

The last variable (*cpol*) describes the quality of institutions in the regions.

$$m_{it} = c_0 + c_1 \cdot y_{it} + c_2 \cdot tjan_i + c_3 \cdot gpop_i + c_4 \cdot lcity_i + c_5 \cdot rpass_i + c_6 \cdot cpol_i + \varepsilon m_{it} \qquad (3)$$

where

m_{it} - net migration to the region *i* in period *t*,

y_{it} - GRP per capita in region *i* in period *t*,

$gpop_i$ - population growth during 1926-1989 in *i*-th region,

$tjan_i$ - the average temperature of January in region *i* (average of the period),

$lcity_i$ - the population of the largest city of region *i* (average of the period),

$rpass_i$ - railway-passenger kilometer a year per capita in *i*-th region (average of the period, zero for regions do not have railway),

$cpol_i$ - corrupted police index for *i*-th region (source: “OPORA-VCIOM, 2005; greater value means less corruption),

εm_{it} - error term.

Capital supply: investment

The supply of capital in regions depends on current stock of the capital and new investments. Investments, in turn, depend on variables characterizing risk and expected return on new investment, the opportunity for new business start-up.

$$inv_{it} = d_0 + d_1 \cdot y_{it} + c_2 \cdot tjan_i + c_3 \cdot pm_i + c_4 \cdot fuel_{it} + c_5 \cdot phone_i + c_6 \cdot coff_i + \nu_{it}, \qquad (4)$$

where

inv_{it} - investments per capita in region *i* and period *t*,

pm_i - dummy variable to permafrost in region *i*,

$fuel_{it}$ - output per capita of the fuel industry in region *i*,

$phone_i$ - telephone penetration, phones per capita in region *i*,

$coff_i$ - corrupted officials index for *i*-th region (source: “OPORA-VCIOM[2], 2005; greater value indicates less corruption),

ν_{it} - error term.

The supply of capital in the region could depend on undeveloped reserves of natural resources, climate, the quality of the infrastructure, the potential demand, market capacity, and so on.

Mundlak specification of the SEM

To estimate the model one can apply the panel econometrics techniques. There are few possible ways of estimation: random effect (RE), fixed effect (FE), between estimates (BE) or polled data. The last one is the simplest way to evaluate regression, but ignores panel data, thus, it is less informative, and involves very strict assumptions.

BE and FE estimates could provide more information, but there appear another difficulties in estimation of SEM on panel data. The other feature of panel data techniques is that BE and FE have to be estimated separately.

The compromise can be found in Mundlak (1978, 1981) specification of panel data models. The feature of the specification is inclusion into the model variables that are constant in time but differ by regions, i.e. averages of respective variable by time.

Applying the Mundlak specification to our SEM we will estimate FE and BE simultaneously. The number of variables increases also. For each variable that varies across time and regions (x_{it}) we include mean-in-time variable ($\bar{x}_i$). For example, for the one-factor lineal regression model

$$y_{it} = a_0 + a_1 \cdot x_{it} + \varepsilon_{it}$$

Mundlak specification looks as follows:

$$y_{it} = a_0 + a_1 \cdot x_{it} + a_1^* \cdot \bar{x}_i + \mu_{it}$$

or

$$y_{it} = a_0 + \alpha_1 \cdot (x_{it} - x_i) + \alpha_1^* \cdot x_i + \mu_{it}$$

where

α_1 , α_1^* - coefficients for FE and RE respectively,

μ_{it} - error term (also includes random component).

[2] All-Russian Public Opinion Research Center

Basic hypothesis

Our specification contains the next main hypotheses on the role of climate, physical geography, agglomeration and infrastructure.

Mean temperature in January. This variable represents the severity of climate. According to Rodrik's logic, geography affects growth both directly (by shaping labor and capital supply via migration and investment behavior) and indirectly (by determining institutional differences and trade patterns). In Russian regions, temperature (together with dummy for permafrost) relates to the structure of economy. For example, in regions with severe climate the structure of manufacturing is shifted to extractive industries and capital-intensive production (for example, aluminum refining). Besides, it reflects pattern of settlement and such thing as 'institutional age' (for example, East-Siberian regions were explored and settled much later than the European core).

The basic hypothesis is that in post recession period (after-crisis migration from the Russian North) regions with harsh climate will tend to grow faster, because their structure of economy is resource-intensive and can be competitive on the global market.

Regions with coastal location possibly will grow faster than the others because of their stronger opportunities for trade. This hypothesis was already empirically tested for cross-country comparisons (Sachs, Mellinger, Gallup, 1999). Here we suppose that the same logic can be applied for regional analysis.

Agglomeration (effect of increasing returns) can also be important for growth (Krugman, Fujita, Venables). We measure agglomeration here as the population of the largest city in the region. The hypothesis is that growth will be faster in regions with larger urban centers (it is a serious disadvantage of Russia's national statistics that it doesn't represent data on metropolitan areas). It may be interesting to mention that because of high centralization of economy and governance in the Soviet Union, administrative centers are the largest urban centers in all but two regions – Kemerovskaya oblast (with Novokuznetsk – center of Kuzbass industrial region) and Vologodskaya Oblast (Cherepovets, where the largest steel factory Severstal is located). From here we can suppose that agglomeration for post-communist Russia is an *exogenous variable* that represents pattern of settlement, industrial location and governance in the Soviet era (all of these three categories are highly path-dependent, so here history matters).

Backward migration. In our research we suppose that territories, which experienced large inflow of immigrants during the Soviet period, will lose their population faster than the others. This prediction is based on the fact that vast areas with harsh climate were settled during the soviet period by means of selective incentives and coercive power of the state. The decrease of average temperature of Russian settled areas is well described in Hill & Gaddy (2003). It is obvious that with the removal of barriers for migration and higher wages in those regions (the latter were fixed before the collapse of the USSR) will trigger the opposite process – huge migration of people from the north.

3. Convergence across regions

The results of the analysis of per capita income convergence, measured as per capita gross regional product, are presented below.

It is important to stress that regional GRP per capita indicators need to be adjusted due to substantially varying among regions purchasing power of ruble. There is no PPP data, and therefore, we use results obtained by Granberg, Zaitseva (2003), who calculated composite regional indices of GRP correction in 1999 based on three main GRP components (household consumption, social consumption and savings). Then, we adjust GRP for all other years by implicit GRP deflator.

We use post-census 2002 population estimates made by Rosstat in our study.

Data for autonomous districts are included in larger geographic units which they are part of. Chechen Republic was excluded from the analysis.

3.1. Sigma-convergence (1996 – 2004)

First, we calculate measures of inequality and dispersion of GRP per capita over the period 1996 – 2004. Coefficient of variation indicates changing dispersion. In addition, we use the Gini coefficient, as in Fingleton (2004), to measure the level of inequality, inter-quartile range, which is the difference between the upper and lower quartiles of the ln GRP per capita and range, which is the difference between maximum and minimum of the ln GRP per capita. The values of these indicators for each year are presented in Table 1. All indicators provide no evidence of decreasing disparity of per capita regional income.

Table 1. Measures of dispersion for GDP per capita, adjusted data (GKS population data, post-census estimates): 79 regions

year	coeff.var.	Gini	IQR	range
1996	0.4869	0.2305	0.5255	2.6110
1997	0.4977	0.2368	0.5044	2.6247
1998	0.5036	0.2361	0.4825	2.7027
1999	0.4928	0.2356	0.4604	2.7269
2000	0.4910	0.2330	0.4710	2.6906
2001	0.4923	0.2328	0.4690	2.6302
2002	0.5028	0.2396	0.4918	2.8949
2003	0.5153	0.2442	0.5279	2.9314
2004	0.5038	0.2417	0.5475	2.9451

The dynamics of the coefficient of variation is shown in figure 1. The figure shows the increasing disparity of GRP per capita over the period under consideration, though there were two reductions of the variation coefficient in 1999-2000 and 2004. As for the latter, note that decrease in regional disparity in 2004 with respect to its value in previous year should be treated cautiously because of preliminary Rosstat's data on 2004 GRP values.

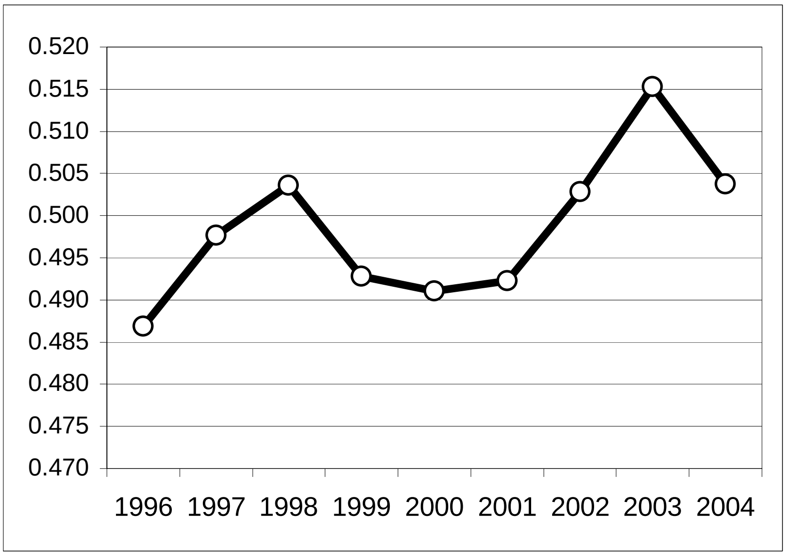

Figure 2. GRP per capita, adjusted data: Coefficient of variation, 79 regions.

If we exclude Chukotka AD and Ingush Republic (obvious outliers by GRP per capita average growth rates, see below) from the sample, we find the presence of sigma-convergence: all indicators except IQR tend to reduce over time during the whole period.

Table 2. Measures of dispersion for GDP per capita, adjusted data (GKS population data, post-census estimates): 77 regions (except Chukotka AD and Ingush Republic)

year	coeff.var.	Gini	IQR	Range
1996	0.4859	0.2276	0.4764	2.6110
1997	0.4977	0.2348	0.4734	2.6247
1998	0.5020	0.2336	0.4432	2.7027
1999	0.4890	0.2322	0.4465	2.7269
2000	0.4862	0.2288	0.4503	2.6906
2001	0.4877	0.2273	0.4614	2.6302
2002	0.4879	0.2277	0.4712	2.5849
2003	0.4891	0.2283	0.4822	2.5371
2004	0.4855	0.2285	0.5140	2.4558

Figure 2 depicts CV dynamics for this case. We can see highly increasing disparity till 1998 and discover sigma-convergence over the post-crisis period from 1999 to 2004, though slight increase of inequality was observed over the sub-period from 2001 to 2003.

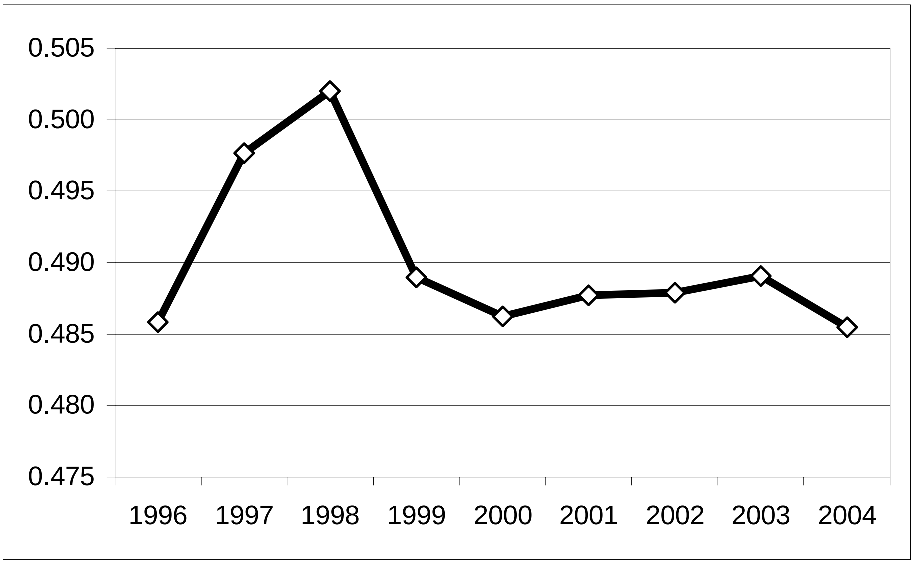

Figure 3. GRP per capita, adjusted data: Coefficient of variation, 77 regions (except Chukotka AD and Ingush Republic).

3.2. Beta convergence (1998 – 2004)

In this section we test the hypothesis of beta-convergence. The analysis is based on three types of beta-convergence models: unconditional, minimal conditional and conditional.

Unconditional model tests the hypothesis of negative correlation between average growth rates and initial per capita income in accordance with the prediction of neoclassical growth theory. At the same time, it is assumed that regions tend to the same equilibrium steady state, which does not seem realistic due to presence of economic, geographical and institutional differences among the regions.

In the context of minimal conditional convergence models regions may have different steady states because economic performance of a particular region may be conditioned on its neighbors. These models test two main spatial hypotheses:

- Spatial clustering by average growth rates through the endogenous spatial lag on average growth rates of GRP per capita,
- Spatial clustering by initial conditions through the exogenous spatial lag on the initial value of per capita GRP.

In general, the conditional convergence model can be formalized as follows:

$$Growth\ rates = f\,(Initial\ condition,\ Factors,\ Spatial\ lags)\,,$$

so that average growth rates depend not only on initial per capita income, but also on spatial dependence and various additional factors such as indicators of infrastructure or resource endowment.

Estimation of unconditional beta-convergence on the full sample of 79 regions does not provide statistically significant estimate of the convergence coefficient. We can confirm neither presence nor absence of convergence of economic growth.

This result is conditioned to the outliers in our sample. Chukotka (87) has extremely high average growth rates and Ingush Republic (6) on the contrary is the only region with negative average growth rate of GRP per capita (see fig. 3). That is why we exclude these regions from further analysis.

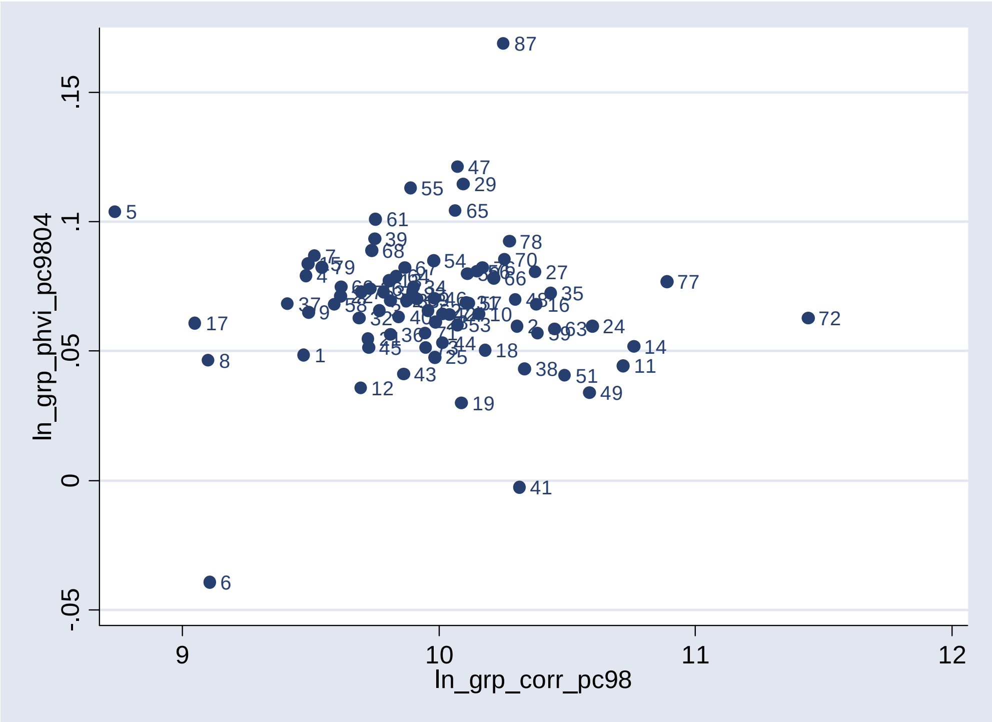

Figure 4. Log average growth rates of GRP per capita over 1998-2004 versus Log initial GRP per capita 1998: 79 regions.

Measures of global spatial autocorrelation

Implementing spatial econometrics methods we first test for global spatial autocorrelation in logarithm average growth rates of GRP per capita (ln_grp_phvi_pc9804) and in logarithm initial per capita GRP (ln_grp_corr_pc98). We use Moran's I statistic, which is the most widely known measure of spatial clustering, and two types of exogenous spatial weight matrices. The first one is pure geographical distance-based matrix, calculated as inverse square shortest distance by auto roads between regional centers. The second matrix we use is market potential distance-based matrix, where the spatial weights for particular region are calculated as inverse square distance times GRP of each neighbor in 1998.

Tables 3 and 4 present the estimates of Moran's I statistic and p-values for the average growth rates and the initial GRP per capita.

Table 3. Moran's I (distance).

Variables	I	E(I)	sd(I)	z	p-value*
ln_grp_phvi_pc9804	0.096	-0.013	0.064	1.713	0.043
ln_grp_corr_pc98	0.112	-0.013	0.064	1.97	0.024

*1-tail test

Table 4. Moran's I (market potential).

Variables	I	E(I)	sd(I)	z	p-value*
ln_grp_phvi_pc9804	0.112	-0.013	0.06	2.074	0.019
ln_grp_corr_pc98	0.096	-0.013	0.06	1.806	0.035

*1-tail test

These results show that the null hypothesis of no spatial autocorrelation should be rejected for both variables at 5% significance level. Therefore the average growth rates of GRP per capita are positively spatially clustered, though the spatial clustering is rather weak as it follows from the estimated values of Moran's I statistic.

This can also be seen from the Moran scatter plot, which is usually used for investigation of spatial instability in the form of spatial regimes. This plot displays the spatial lag of a variable against the same variable and the regression line obtained by regressing lag on its variable with the slope equal to the estimated Moran's I.

Figures 4 and 5 depicts Moran scatter plot for average growth rates of GRP per capita and initial GRP per capita in 1998, respectively. In fact, these figures show moderate spatial clustering: as we can see, the slope of the regression line is rather small. Besides, there are enough regions located in upper-left and lower-right quadrants which correspond to atypical spatial clustering. These quadrants represent spatial clustering of high values around low-value locations and low values around high-value locations, respectively. These locations are associated with negative local spatial autocorrelation.

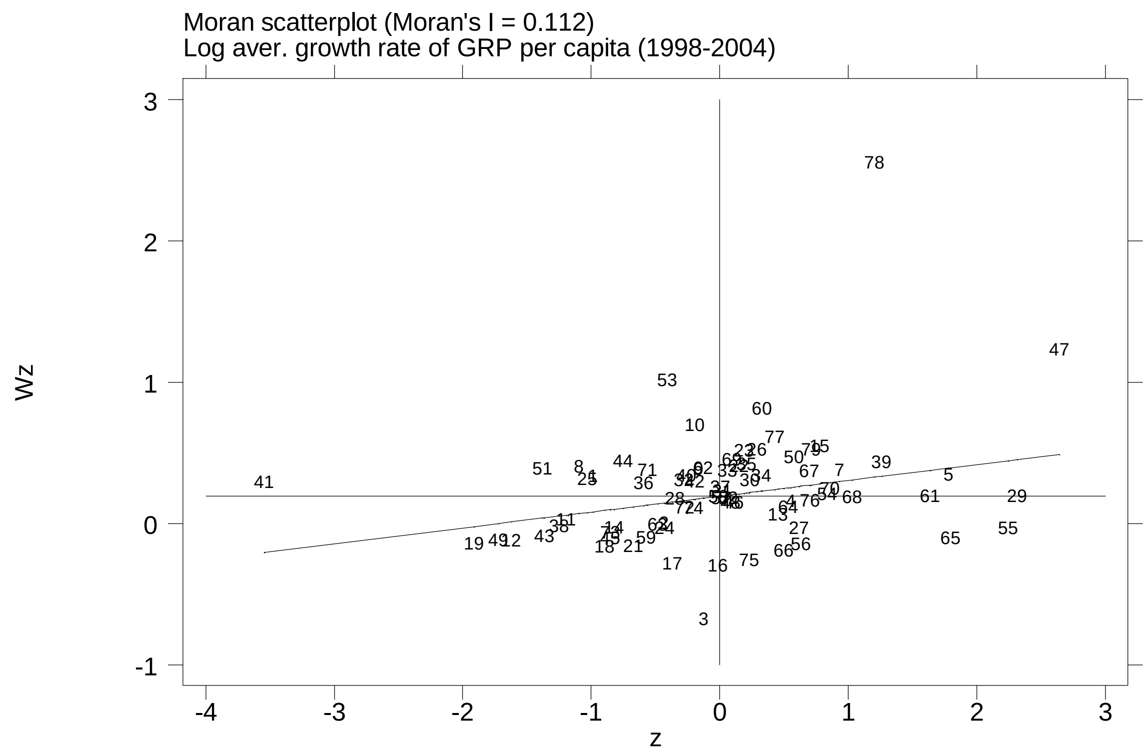

Figure 5 Moran scatter plot: Log average growth rates of GRP per capita over 1998 – 2004, adjusted data.

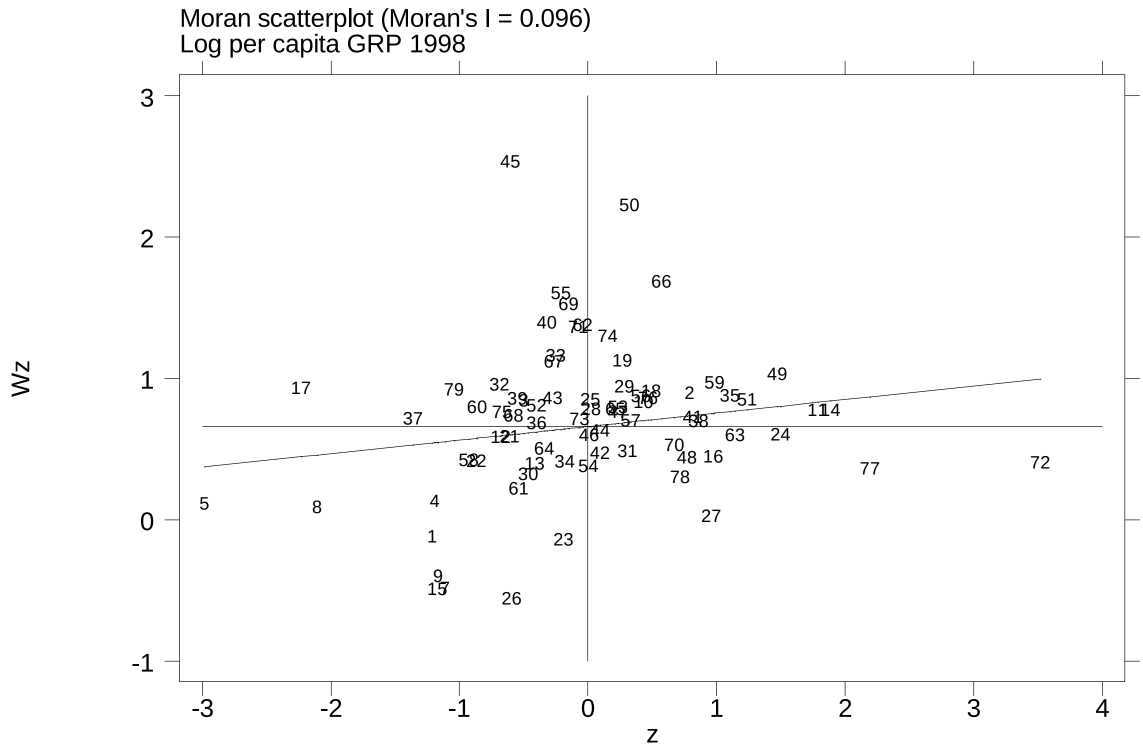

Figure 6. Moran scatter plot: Log per capita GRP 1998, adjusted data.

Measures of global spatial autocorrelation show that the values of the variable of interest at the different locations are more spatially clustered than those under a random assignment, but they do not explain why such clustering occurs (Anselin). To answer this question one can apply spatial econometrics models.

Unconditional beta-convergence

First, we estimate unconditional beta-convergence model by means of OLS on the sample of 77 regions (except Chukotka and Ingush republic) and test the model for the residual's spatial autocorrelation. Estimation results are presented in Table 5.

Table 5. Unconditional beta-convergence model. OLS estimation

ln_grp_phvi_pc9804	**Coef.**	**Std. Err.**	**t**	**P>|t|**
ln_grp_corr_pc98	-0.0098	0.0054	-1.8	0.075
constant	0.1660	0.0543	3.06	0.003
conv. Speed, %	1.02		LIK	194.16
Half-life, years	68		AIC	-4.991
Number of obs	77		BIC	-714.104
F(1, 75)	3.25		White	0.32
Prob > F	0.0754			(0.854)
R-squared	0.0416		Moran's I	1.762
Adj R-squared	0.0288		**distance**	(0.078)
Root MSE	0.0197		Moran's I	2.008
			MP	(0.045)

This table shows that *the convergence parameter* (for **ln_grp_corr_pc98)** *is negative and statistically significant* (at 10% significance level)*, which points to the existence* of beta-convergence in the period under consideration. At the same time, the speed of the convergence is low. It will take 68 years for the regions to clear a half of their distances to the steady state of the GRP per capita. The unconditional model may be misspecified due to the spatial autocorrelation of the errors. Moran's I statistic computed with the market potential weight matrix is significant at the 5% significance level and with the pure geographical weight matrix – at the 10% level.

Table 6. Spatial diagnostics.

Weights matrix			
Name: grpwd_687			
Type: Imported (non-binary)			
Row-standardized: Yes			
Diagnostics			
Test	Statistic	df	p-value

Spatial error:			
Moran's I	2.008	1	**0.045**
Lagrange multiplier	2.519	1	0.112
Robust Lagrange multiplier	0.115	1	**0.734**
Spatial lag:			
Lagrange multiplier	2.813	1	0.094
Robust Lagrange multiplier	0.409	1	**0.522**

Then we estimate minimal convergence model, considering spatial dependence with the use of the market potential weights. Spatial diagnostics (see table 6) of the OLS residuals provides some more evidence in favor of the spatial lag model[3].

Minimal conditional beta-convergence

Table 7 represents estimation results of the spatial lag model. In this model, spatial autocorrelation is handled by the endogenous spatial lag on the dependent variable. This model has to be estimated by maximum likelihood procedure because OLS produces inconsistent estimators due to the presence of stochastic regressor (Anselin 1988).

Table 7. Minimal conditional beta-convergence model. Spatial Lag model: ML estimation

ln_grp_phvi_pc9804	**Coef.**	**Std. Err.**	**z**	**P>|z|**
ln_grp_corr_pc98	-0.0095	0.0052	-1.83	0.067
Constant	0.1359	0.0541	2.51	0.012
Rho	0.3766	0.1921	1.96	**0.050**
conv. Speed, %	0.98			
Half-life, years	70			
Number of obs	77			
Variance ratio	0.064			
Squared corr.	0.106			
Sigma	0.02			
Log likelihood	195.884			

We can see that adding endogenous spatial lag improves the significance of the convergence coefficient, but it is still at 10% significance level. Moreover, OLS estimates that ignore spatial dependency overestimate the convergence speed. Econometric results suggest that the average growth rate of a region is positively correlated (at the 5% significance level)

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[3] Florax et all, 2003; Anselin, An introduction to spatial regression analysis in R, 2003

with the average growth rate of neighboring regions, through the endogenous spatial lag variable.

Note that the initial GRP per capita and endogenous spatial lag considered in the model explain up to 10.6 % GRP per capita average growth rates variation. To increase the descriptive quality of the model we put some additional factors, reflecting the nature of the Russian regional growth in the next section.

To conclude, the models show some evidence of beta-convergence but its significance level and goodness of fit are low. Therefore, we should investigate distinct growth regimes (steady states) for regions with different characteristics. Another important result of the minimum convergence regression is the evidence of the strength of the spatial spillover effect. The spatial lag coefficient of 0.3766 means that about one-third of regional growth can be explained by spatial growth spillover, which constitutes a very significant share.

Conditional beta-convergence

The following specification imitates the analysis of regional convergence in the EU by Fingleton 2004.

First, we test the hypothesis of resource oriented economic growth that took place in Russia over the period under consideration. For that purpose, we use share of the fuel industry in 1998 (sh_fuel98).

Second, in order to find out whether Central Government spending has been facilitating regional equalization (which however wasn't the stated goal of such spending[4]) we include a variable of financial aid of the Central Government to the regional budgets in 1998 (fapc98), calculated on per capita basis[5].

Next, we represent the geographical openness to external markets by the dummy characterizing the availability of a seaport.

In addition, we construct special dummy variable on poor and depressed regions to capture underdeveloped economic performance (t12).

The estimation results of the model are presented in the Table 8.

Table 8. Conditional convergence model. OLS estimation

[4] The main objective of these funds was to provide territorial justice in public spending.

[5] We calculated Central Government assistance to the regions as the sum of five elements: The Fund of the Financial Support of the Regions (FFPR), mutual settlements, subsidies, subventions, and budgetary loans.

ln_grp_phvi_pc9804	Coef.	Std. Err.	t	P>|t|
ln_grp_corr_pc98	-0.0275	0.0061	-4.53	0.000
fapc98	-0.0173	0.0040	-4.37	0.000
sh_fuel98	0.0002	0.0001	1.77	0.082
Port	0.0196	0.0055	3.59	0.001
t12	-0.0099	0.0052	-1.91	0.060
Constant	0.3507	0.0619	5.67	0.000
conv. Speed, %	3.05		LIK	213.749
Half-life, years	23		AIC	-5.396
Number of obs	77		BIC	-735.909
F(5, 71)	10.44		White	12.46
Prob > F	0			(0.822)
R-squared	0.4238		Moran's I	2.14
Adj R-squared	0.3832		**distance**	(0.032)
Root MSE	0.0157		Moran's I	1.472
			MP	(0.141)

Estimated coefficients reflect differences in equilibrium steady states levels of the regions. Convergence speed is much higher now; it reduces half-life to 23 years.

While the results of the unconditional convergence model hold (the GRP per capita growth rate is negatively correlated with either the base year GRP per capita), lower spending of the Central Government in 1998 on assistance to the regions, higher share of fuel industry in 1998, openness to external markets and better economic performance raise regional growth rates.

The table includes diagnostics on spatial correlation of the regression errors (Moran's *I* statistics), carried out with two different geographic weight matrices – inverted squared distance and market potential (MP). Distance-based Moran's I statistic points to the presence of spatial correlation of regression errors. The subsequent spatial error model is estimated with maximum likelihood method (see Table 9).

Table9. Spatial Error Model (Distance-based weights matrix). ML estimation

ln_grp_phvi_pc9804	Coef.	Std. Err.	z	P>|z|
ln_grp_corr_pc98	-0.0286	0.0058	-4.90	0.000
fapc98	-0.0176	0.0039	-4.53	0.000
sh_fuel98	0.0003	0.0001	2.32	0.021
port	0.0175	0.0056	3.12	0.002
t12	-0.0096	0.0048	-1.98	0.047
constant	0.3605	0.0592	6.09	0.000
lambda	**0.3142**	**0.1761**	**1.78**	**0.074**
conv. Speed, %	3.19			

Half-life, years	22			
Number of obs	77			
Variance ratio	0.423			
Squared corr.	0.42			
Sigma	0.01			
Log likelihood	215.17383			

Estimated spatial coefficient (lambda) represents the spatial spillover effect, reflecting spatial dependence for average GRP per capita growth rates. The endogenous spatial lag in GRP growth can be explained by the interregional flows and market potential argument, that is, a region located close to higher growing regions benefits from fast growing demand for its goods and services in those regions.

In some specifications, to control infrastructure variables, we include passenger departures by railway per capita. This variable reflects the geographical connectivity of the region with the rest of the country (and the configuration of existing infrastructure) and, hence, the mobility of region's population.

As well, we use migration rate over 1998-2004 to test the hypothesis whether labor supply dynamics affects average growth rates of GRP per capita.

The estimation results are presented below.

Table 10. Conditional convergence model. OLS estimation.

ln_grp_phvi_pc9804	**Coef.**	**Std. Err.**	**t**	**P>|t|**
ln_grp_corr_pc98	-0.0297	0.0059	-5.00	0.000
fapc98	-0.0136	0.0041	-3.30	0.002
sh_fuel98	0.0003	0.0001	2.26	0.027
port	0.0176	0.0053	3.29	0.002
t12	-0.0103	0.0050	-2.06	0.044
mprpc9804	0.0008	0.0003	2.47	0.016
constant	0.3655	0.0600	6.09	0.000
conv. Speed, %	3.33		LIK	216.961
Half-life, years	21		AIC	-5.454
Number of obs	77		BIC	-737.988
F(6, 70)	10.34		White	16.5
Prob > F	0			(0.899)
R-squared	0.4699		Moran's I	1.092
Adj R-squared	0.4245		**distance**	(0.275)
Root MSE	0.01516		Moran's I	0.486
			MP	(0.627)

Table 11. Conditional convergence model. OLS Estimation.

ln_grp_phvi_pc9804	**Coef.**	**Std. Err.**	**t**	**P>|t|**
ln_grp_corr_pc98	-0.0238	0.0062	-3.81	0.000

fapc98	-0.0111	0.0050	-2.22	0.030
sh_fuel98	0.0002	0.0001	1.87	0.066
port	0.0206	0.0054	3.83	0.000
t12	-0.0091	0.0051	-1.79	0.079
migrrate9804	0.1080	0.0543	1.99	0.051
constant	0.3103	0.0639	4.86	0.000
conv. Speed, %	2.60		LIK	215.865
Half-life, years	27		AIC	-5.425
Number of obs	77		BIC	-735.797
F(6, 70)	9.72		White	26.36
Prob > F	0			(0.389)
R-squared	0.4546		Moran's I	1.702
Adj R-squared	0.4078		**distance**	(0.089)
Root MSE	0.01538		Moran's I	1.264
			MP	(0.206)

These tables show that infrastructure development leading to greater geographical connectivity as well as positive dynamics in labor supply are positively correlated with regional growth rates.

At the same time, spatial coefficients in the Spatial Error and Spatial Lag models were *insignificant*. The lack of spatial correlation of regression errors (boundary significance or insignificance of Moran's I statistic) is probably caused by the passenger departures and migration rate variables, which both incorporate in themselves the spatial structure of the model. In addition, the infrastructure system and population mobility absorb the spatial structure, and demonstrate the ability to alleviate spatial barriers to growth.

4. Results and Conclusions

We have considered the following questions of economic growth and development: "Why do growth rates differ across Russian regions?" and "Does the convergence exist and if it does, what is the rate of convergence?"

To analyze the first question we have developed the simultaneous equation model. The model consists of four equations. The first equation represents the level of economic development – GRP per capita. The second equation describes the growth rates of GRP per capita. The third and fourth equations are for migration and investment. We interpret them as labor and capital supply respectively.

All four equations were estimated simultaneously using 3SLS and Mundlak's specification to derive 'between' and 'within' estimates.

Our aim was to estimate the importance of 'deep determinants' (geography, infrastructure and institutions) in regional economic growth and disparities.

According to our results, geography and climate matter for migration flows and investment. Infrastructure also seems to be important for the capital accumulation and migration processes. We don't have a proper measure for institutions quality by regions. The only measure we had was data based on survey 2005 (OPORA-VCIOM), the data exceeds our period of estimation. This keeps on the problem of endogenity, and some relations might be interpreted in vice-versa direction.

These conclusions are based on the estimated relationships, presented below:

Relatively more wealthy regions (GRP per capita) are characterized by:

- Relatively higher level of per capita investment;
- Higher share of raw materials in industrial output (including fuel, ferrous, non-ferrous and timber industries);
- Higher share of economically active population;
- Increase in share of economically active population;
- Higher share of the employed in economically active population;
- Increase in share of the employed in economically active population;
- Higher number of post-graduate students (per 10 thousand inhabitants);
- Higher agglomeration (population in the largest city).

The faster growing regions are characterized by:

- Relatively higher level of per capita investment;
- Increase in per capita investment;
- Relatively higher migrants' inflows;
- Increase in share of raw materials' industries in industrial output;
- Availability of a sea-port (non-freezing ports, Arkhangelskaya oblast, Khabarovsk Krai);
- Lower per capita output level (conditional convergence).

Larger inflow of immigrants is observed at:

- Relatively wealthy regions (per capita output, mean over the period);
- Regions with higher density of rural population;
- Highly assimilated regions (those with the smallest population growth rates during the soviet period);
- Regions with relatively warmer climate (higher mean January temperature);

- Regions with more developed infrastructure;
- Regions with higher passenger departures by railway per capita;
- Regions with higher agglomeration (population in the largest city).

Unemployment level tends to be statistically insignificant.

Regions with higher migrants' inflows during the period 1997-2004 are characterized by higher level of the police corruption in 2005 (in accordance with the research of OPORA-VCIOM).

The largest per capita investment is observed at:

- Relatively wealthy regions (per capita output, mean over the period);
- Regions with relatively warmer climate (higher mean January temperature) on the one side, and regions with permafrost on the other (probably those with field development of natural resources);
- Regions with higher per capita fuel industry output;
- Regions with increase in per capita fuel industry output;
- Regions with more developed infrastructure (per capita phones);
- Regions with the smallest level of legislative risk (risk_zakon_min, dammy on 10 regions with the minimal values of risk)
- Regions included in Standard-and-Poor's index
- Regions with higher per capita investment during the period 1997-2004 are characterized by better officials' corruption figures concerning small-scale business in 2005.

In the next part of the paper, we discover the presence of GRP per capita sigma-convergence (on the sample of 77 regions except Chukotka and Ingush Republic) over the post-crisis period from 1998 to 2004, though slight growth of disparity was observed over the sub-period from 2001 to 2003. Nevertheless, on the whole sample of 79 regions we find no evidence of decreasing regional disparities over the whole period from 1996 to 2004. Note, that 2003-2004 dynamics of the coefficient of variation should be treated cautiously because of preliminary Rosstat's data on 2004 GRP values.

We also find that we can not reject the hypothesis of unconditional beta-convergence of GRP per capita on the sample of 77 regions. Next, we discover spatial autocorrelation in the errors and estimate spatial lag model, which can be interpreted as a minimal conditional beta-convergence model. Estimated spatial coefficient means that about one-third of regional growth can be explained by spatial growth spillover. However, the initial GRP per capita and endogenous spatial lag explain up to 10.6 % of GRP per capita average growth rates variation. To increase the descriptive quality of the model we put some additional factors, reflecting the nature of the Russian regional growth as well as differences in regions' equilibrium steady states.

Our conditional convergence tests show that higher average growth rates of GRP per capita over the 1998 – 2004 period are correlated with:

- lower initial GRP per capita in 1998;
- lower financial aid to the regions from on the Federal budget in 1998;
- higher share of fuel industry in industrial output in 1998;
- access to the sea coastline and persistence of a seaport;
- higher passenger departures by railway per capita;
- higher migration rates over 1998-2004;
- higher average growth rates of GRP per capita in neighboring regions

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Appendix 1.

Table A1.The result of SEM estimation, 3SLS, 1997-2004, 77 regions.

Equation	Obs	Parms	RMSE	R-sq	chi2	P
ln_grp_p0_pc	616	10	0.1986	0.8331	2920.32	0.0000
ln_grp_phvi_pc	616	8	0.0612	0.2338	257.87	0.0000
ln_migr_new	616	7	0.0055	0.4535	702.26	0.0000
ln_inv_p0_pc	616	12	0.4440	0.5850	1157.44	0.0000

ln_grp_p0_pc	Coef.	Std. Err.	z	P>|z|
ln_inv_p0_pc_be	0.4380	0.0327	13.39	0.000
ln_inv_p0_pc_fe	0.0661	0.2953	0.22	0.823
ln_sh_ind_rawwide_be	0.4005	0.0687	5.83	0.000
ln_sh_ind_rawwide_fe	0.2713	0.3420	0.79	0.428
ln_sh_econact_pop_be	1.8576	0.2193	8.47	0.000
ln_sh_econact_pop_fe	3.3464	1.2889	2.60	0.009
ln_sh_ebmp_econactiv_be	1.1483	0.1244	9.23	0.000
ln_sh_ebmp_econactiv_fe	3.8457	1.4805	2.60	0.009
ln_postgrad_students_pc_be	0.0407	0.0120	3.40	0.001
ln_city	0.0602	0.0103	5.85	0.000
Constant	6.8300	0.3357	20.34	0.000
ln_grp_phvi_pc				
ln_inv_p0_pc_be	0.0257	0.0138	1.86	0.063
ln_inv_p0_pc_fe	0.1298	0.0118	11.03	0.000
ln_migr_new_be	1.6119	0.4571	3.53	0.000
ln_sh_ind_rawwide_be	0.0174	0.0192	0.90	0.366
ln_sh_ind_rawwide_fe	0.3390	0.0699	4.85	0.000
Port	0.0152	0.0074	2.07	0.038
ln_postgrad_students_pc_be	0.0053	0.0041	1.29	0.199
ln_grp_pc_p0_be	-0.0374	0.0165	-2.27	0.023
Constant	0.1949	0.0750	2.60	0.009
ln_migr_new				
ln_grp_phvi_pc_be	0.1485	0.0213	6.97	0.000
ln_ruralpop_dens_be	0.0020	0.0007	3.02	0.003
avertemp_jan_cs	0.0001	0.0000	3.40	0.001
ln_pop_gr_89_26	-0.0022	0.0002	-9.38	0.000
ln_pass_railway_percap_be	0.0029	0.0009	3.19	0.001
ln_city	0.0017	0.0003	5.35	0.000
ln_ins3_corrupted_police	-0.0024	0.0008	-3.03	0.002
Constant	-0.0074	0.0039	-1.88	0.060
ln_inv_p0_pc				
ln_grp_pc_p0_be	0.9555	0.0653	14.63	0.000
avertemp_jan_cs	0.0131	0.0033	3.94	0.000
permafrost1	0.1574	0.0528	2.98	0.003
permafrost2	0.4423	0.0771	5.74	0.000
permafrost3	0.4500	0.1087	4.14	0.000
ln_indusoutput_fuel_p0_pc_be	0.0731	0.0129	5.66	0.000

ln_indusoutput_fuel_p0_pc_fe	0.3505	0.0578	6.06	0.000
ln_phone1995	0.2781	0.0669	4.16	0.000
ln_ins3_corrupted_officials	0.2573	0.0576	4.47	0.000
risk_zakon_max	0.0126	0.0415	0.30	0.762
risk_zakon_min	0.0951	0.0386	2.47	0.014
standard_and_poors	0.1476	0.0399	3.70	0.000
Constant	-3.5927	0.5860	-6.13	0.000

List of variables:

ln_grp_p0_pc – log of GRP per capita in constant prices;

ln_grp_phvi_pc – log of real GRP per capita growth (annual growth of physical value of GRP, Rosstat data)

ln_migr_new – log of population growth (in the region) caused by migration (estimates based on births, deaths and official data on population, census 2002 corrected).

ln_inv_p0_pc – log of real investments per capita in the region;

ln_sh_ind_rawwide – log of share of raw materials industries output in the industrial output;

ln_indusoutput_fuel_p0_pc - log of share of fuel industry output in the industrial output;

ln_sh_econact_pop – log of share of economic active population in the whole population;

ln_sh_ebmp_econactiv - log of share of employed population in the economic active population;

ln_postgrad_students_pc – log of number of postgraduate students per 10000 of population;

ln_ruralpop_dens – log of rural population density

ln_city – log of the population of the largest city of the region;

port – dummy variable to the availability of sea port;

avertemp_jan – average temperature of January;

ln_pop_gr_89_26 – log of the population growth during 1926-1989 in the region;

ln_pass_railway_percap - railway-passenger kilometer a year per capita;

permafrost1- permafrost3 - dummy variable to permafrost (three different types) in the region;

ln_phone1995 - telephone penetration, phones per capita in the region;

ln_ins3_corrupted_police - corrupted police index for *i*-th region (source: "OPORA-VCIOM, 2005; greater value means less corruption);

ln_ins3_corrupted - corrupted officials index for *i*-th region (source: "OPORA-VCIOM, 2005; greater value means less corruption).

risk_zakon_max – dummy on 10 regions, those with highest legislative risk

risk_zakon_min – dummy on 10 regions, those with lowest legislative risk

standard_and_poors – regions with Standard-and-Poor's rate

Appendix 2.

Table A2. List of the Russian Regions

#	Name of Region	#	Name of Region
1	Adigeya Rep.	46	Kurskaya oblast
2	Bashkortostan Rep.	47	Leningradskaya oblast
3	Buryatiya Rep.	48	Lipetskaya oblast
4	Altai Rep.	49	Magadanskaya oblast
5	Dagestan Rep.	50	Moskovskaya oblast
6	Ingushetitya Rep.	51	Murmanskaya oblast
7	Rep. Kabardino-Balkariya	52	Nizhegorodskaya oblast
8	Kalmikiya Rep.	53	Novgorodskaya oblast
9	Karachaevo-Cherkesia Rep.	54	Novosibirskaya oblast
10	Karelia Rep.	55	Omskaya oblast
11	Komi Rep.	56	Orenburgskaya oblast
12	Maryi-El Rep.	57	Orlovskaya oblast
13	Mordovia Rep.	58	Penzenskaya oblast
14	Sakha (Yakutia) Rep.	59	Permskaya oblast
15	North Osetia Rep.	60	Pskovskaya oblast
16	Tatarstan Rep.	61	Rostovskaya oblast
17	Tuva Rep.	62	Ryazanskaya oblast
18	Udmurtiya Rep.	63	Samarskaya oblast
19	Khakassia Rep.	64	Saratovskaya oblast
20	Chechen Rep.	65	Sakhalinskaya oblast
21	Chuvash Rep.	66	Sverdlovskaya oblast
22	Altai Krai	67	Smolenskaya oblast
23	Krasnodar krai	68	Tambovskaya oblast
24	Krasnoyarsk krai	69	Tverskaya oblast
25	Primorskiy Krai	70	Tomskaya oblast
26	Stavropol Krai	71	Tulskaya oblast
27	Khabarovsk Krai	72	Tumenskaya oblast
28	Amurskaya oblast	73	Ulyanovskaya oblast
29	Arkhangelskaya oblast	74	Chelyabinskaya oblast
30	Astrakhanskaya oblast	75	Chitinskaya oblast
31	Belgorodskaya oblast	76	Yaroslavskaya oblast
32	Bryanskaya oblast	77	Moscow City
33	Vladimirskaya oblast	78	St-Petersburg City
34	Volgogradskaya oblast	79	Yevreiskaya Autonomus Obl.
35	Vologodskaya oblast	80	Aginskiy Buryatskiy AO*
36	Voronezhskaya oblast	81	Komi-Permyatskiy AO
37	Ivanovskaya oblast	82	Koryakskiy AO
38	Irkutskaya oblast	83	Nenetskiy AO
39	Kaliningradskaya oblast	84	Ddlgano-Nenetskiy AO
40	Kaluzhskaya oblast	85	Ust-Ordinskiy Buryatskiy AO
41	Kamchatskaya oblast	86	Khanti-Mansiyskiy AO
42	Kemeroskaya oblast	87	Chukotskiy AO
43	Kirovskaya oblast	88	Evenkiyskiy AO
44	Kostromskaya oblast	89	Yamalo-Nenetskiy AO
45	Kurganskaya oblast		

*AO = autonomous okrug (district).

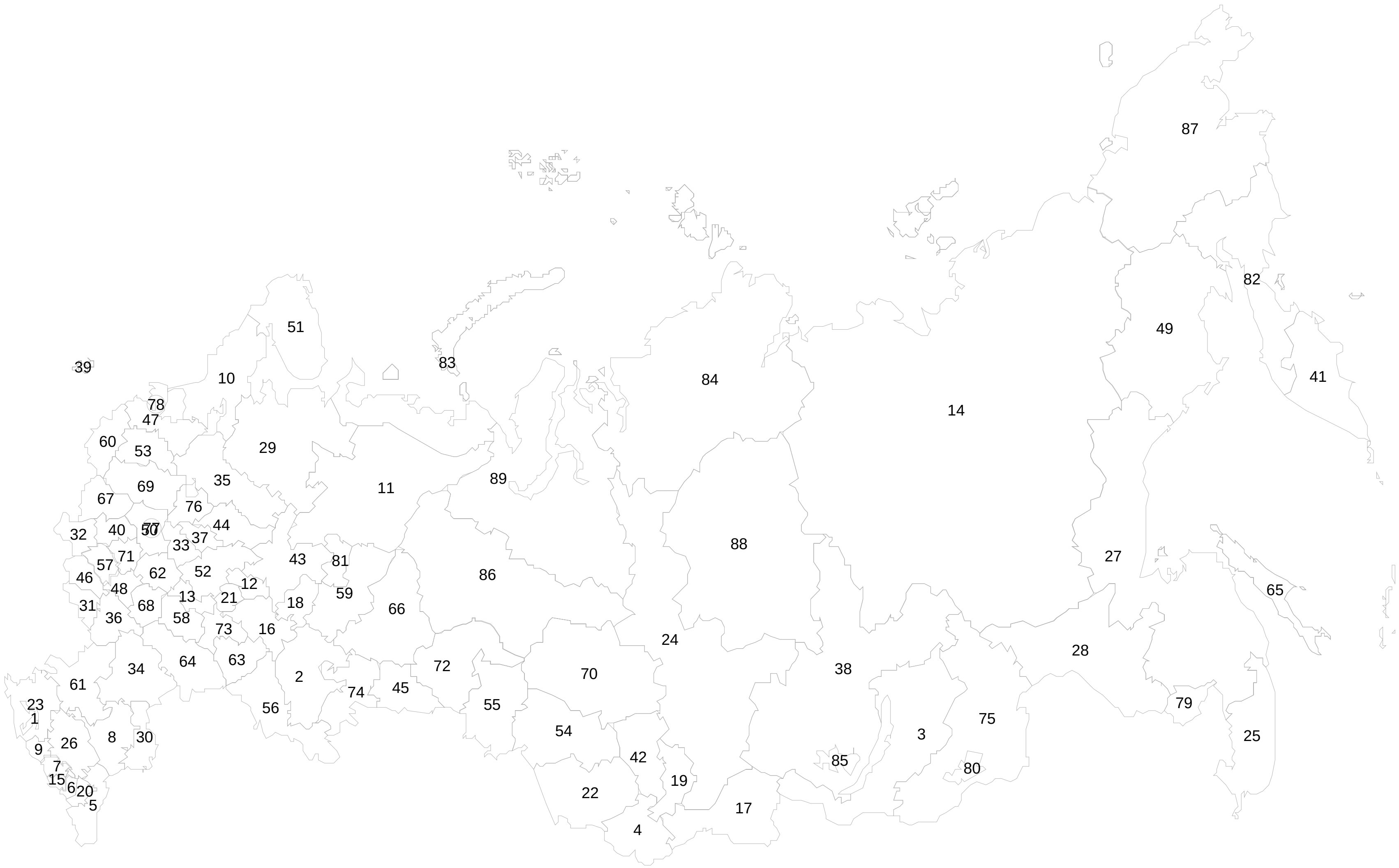

Figure A2. Map of the Russian Regions.