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The well-being of Russian cities: does location matter?

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The well-being of Russian cities: does location matter?

Preliminary draft, to be completed

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Abstract

Using the data covering the time period from 1996 till 2011, I estimate a spatial autoregressive model of wages' growth rates across Russian cities. I find that wages in Russian cities exhibit convergence. I also test whether city population (which is a proxy for city size) has positive impact on the speed of convergence. Using geographical location characteristics (longitude, latitude, average annual temperature, soil quality) and historical data (the first two censuses of the country) as instruments for population, I find a positive relationship between city size and city growth. In other words, cities converge in wages, but diverge in size.

Introduction

Empirical evidence shows that different regions grow at different speed, and their growth rates are probably spatially correlated. Russia is a large and heterogeneous country, so it is natural to conjecture that the role of geography should be essential. Are the differences between Russian regions due to more favorable geographic location? Is location a source of economic advantages for regions? Do spillovers across Russian regions impact substantially the regional growth rates? To this end, literature on spatial determinants of regional economic growth in Russian regions uses the subjects-of-Federation level data. The regions are highly heterogeneous, and moreover, their low number creates serious limitations of using subtle methods in order to estimate desirable effects. To avoid this problem, I consider spatial interaction in a **city level**.

The objective of the project is: 1) to measure the impact of geographical location on city wages and to find spatial factors of wages growth; 2) to measure the role of the market size and social capital in convergence of Russian cities.

Literature review

Baumol (1986) found that poorer countries like Japan and Italy substantially closed the per capita income gap with richer countries like the United States and Canada in the years from 1870 to 1979. Growth rates are positively correlated with the starting gap between the initial per capita income of a region and the steady-state per capita income level, which is the same for all regions. Regions on the steady growth trajectory are characterized by constant growth rates of per capita income. According to the model, poor regions should grow at higher pace than wealthy regions, so that the long-run perspective should tend to smooth regional differences in economic development.

Empirical works on data sets for different countries show different rates of convergence. As a possible explanation of the slow rate of convergence, Barro et al. (1992) suggest that the level of the technology can be different in different states or countries and try to model its dynamics.

Starting from Romer (1990), theoretical models of endogenous growth predict that long-term growth rates are positively related to the market size. Jones (2000) challenges these models for generating scale effects for which he could not find any evidence based on U.S. time series.

The problem of identifying spatial determinants of regional economic growth in Russia has already been addressed in the literature. Spatial autocorrelations of Russian regions are shown by means of Moran's tests (Zverev, Kolomak, 2010, Lugovoy et al., 2007). Moran's tests are also used for revealing spatial convergence clubs. Lugovoy et al. don't find any convergence clubs in the scatterplot for logarithm of GRP per capita in 1998 (using traveling time geographical weight matrix).

Strong σ -divergence simultaneously with β -convergence is found by Solanko (2003). The results indicate that per capita income in Russian regions may be converging towards two separate steady states. The poorest regions seem to be converging among themselves, while growth experiences among other regions have been highly heterogeneous. The role of geography is tested by means of the variable "distance from the capital Moscow" in one of the conditional convergence regressions. This variable results as completely insignificant. The time period of used data is 1992–2001.

Using a panel of 77 Russian regions from 1990–1998, R. Ahrend (2005) analyzes possible determinants affecting Russian regional economic growth. He finds that such factors as capital endowment, human capital and natural resources as well as urbanization can be positively correlated with growth.

Carluer (2005) examines the evolution of Russian regional disparities in the light of the theory of convergence clubs. The key conclusion is the strong diversity of regional evolutions, which are characterized by both inertia (rich regions remain rich, poor regions remain poor) and mobility (some rich regions become poor and vice versa). The value of an analysis of downward mobility relative to upward mobility (34 regions to 11), as well as of economic geography through specific spatial dynamics, are demonstrated. The main results based on the per-capita regional income of the Russian data over period 1985–1999.

Buccellato (2007) analyzes the process of convergence across the regions of Russia using spatial econometrics tools in addition to the traditional β -convergence techniques as derived from the neoclassical theoretical settings.

Lugovoy et al. (2007) explore disparity in regional growth in Russia and investigate the role of geographic, economic, and institutional factors in economic growth over rather short time period 1996–2004. They find out significance of the sectoral specialization for Russia, particularly, the share of fuel industry in industrial output are significant in the equation of conditional regression.

Kholodilin et al. (2009) investigate the income convergence among Russian regions in the period 1998–2006. They identify spatial regimes using the exploratory spatial data analysis. Also they examine the impact of spatial effects on the convergence process. Their results show that the overall speed of regional convergence in Russia, being low by international standards, becomes even lower after controlling for spatial effects. However, when accounting for the spatial regimes, they find a strong regional convergence among high-income regions located near other high-income regions. Their results indicate that estimation of speed of convergence using aggregate data may result in misleading conclusions regarding the nature of convergence process among Russia’s regions.

Kolomak (2010) tests a model where the spatial externalities generated by regional growths are considered as a source for development of neighboring territories. Such externalities do affect the other regions’ growth rates. She finds that the character of such influence depends on location of the region.

Guriev and Vakulenko (2012) provide a very good review on convergence of Russian regions. They find there was no convergence in 1990s, but the situation changed dramatically in 2000s. While interregional GDP per capita gaps still persist, the differentials in incomes and wages decreased substantially. They investigate the phenomenon of recent convergence using panel data on the interregional reallocation of capital and labor and show that economic growth and financial development has substantially decreased the barriers to labor mobility.

So, existing empirical works on growth of Russian regions mostly cover a short time period and consider regional-level data; they do not concern city-level data.

Dataset

The main economic indicator that I consider is an average monthly wage in Russian cities provided in Multistat database. The database contains 1090 observations on Russian cities and towns. I drop settlements of Chechen republic, Ingushetia republic and observations with missing values on wages. So, the number of observations of the main dataset is 1004, they cover 78 regions of Russia.

The country is not homogenous by the city distribution, so it’s reasonable to compare whether the growth in denser regions is the same as in the other part. I separate the dataset into two in a following way. Due to natural resources and being underpopulated, a very big territory Tyumen region is a well-known outlier in major of empirical papers on Russian regions, so I construct the

first dataset (Western, 810 obs.) of the cities which are situated to the west from the Tyumen region. The second dataset (Eastern, 194 obs.) includes the rest of the cities.

I use regional prices of the fixed set of goods and services for adjusting wages by PPP as follows. The nominal values of wages are deflated by the cost of a fixed basket of goods and services in regions to arrive at real wages measured in 2010 roubles. Data for the cost of a fixed basket of goods and services in regions is available since 2002, so I use regional consumer price index (CPI) for the earliest years.

I geo-coded the dataset with geographical latitudes and longitudes for each observation. Spatially comparable wages in cities are shown in Fig.1. The yellow curve in the map is a part of the border of the composite region – Tyumen oblast, this curve separates the dataset into the Western and Eastern parts. One can see that some dark points (i.e. cities with high wages) correspond to cities with big population: Moscow, Saint-Petersburg, Ekaterinburg, and the mentioned cities seem to generate clots of cities with big wages. It is worth to mention that not only big cities are rich ones. Cities in oil and gas regions are also display high values of wages: Tyumen oblast, Saha (Yakutia) republic etc.

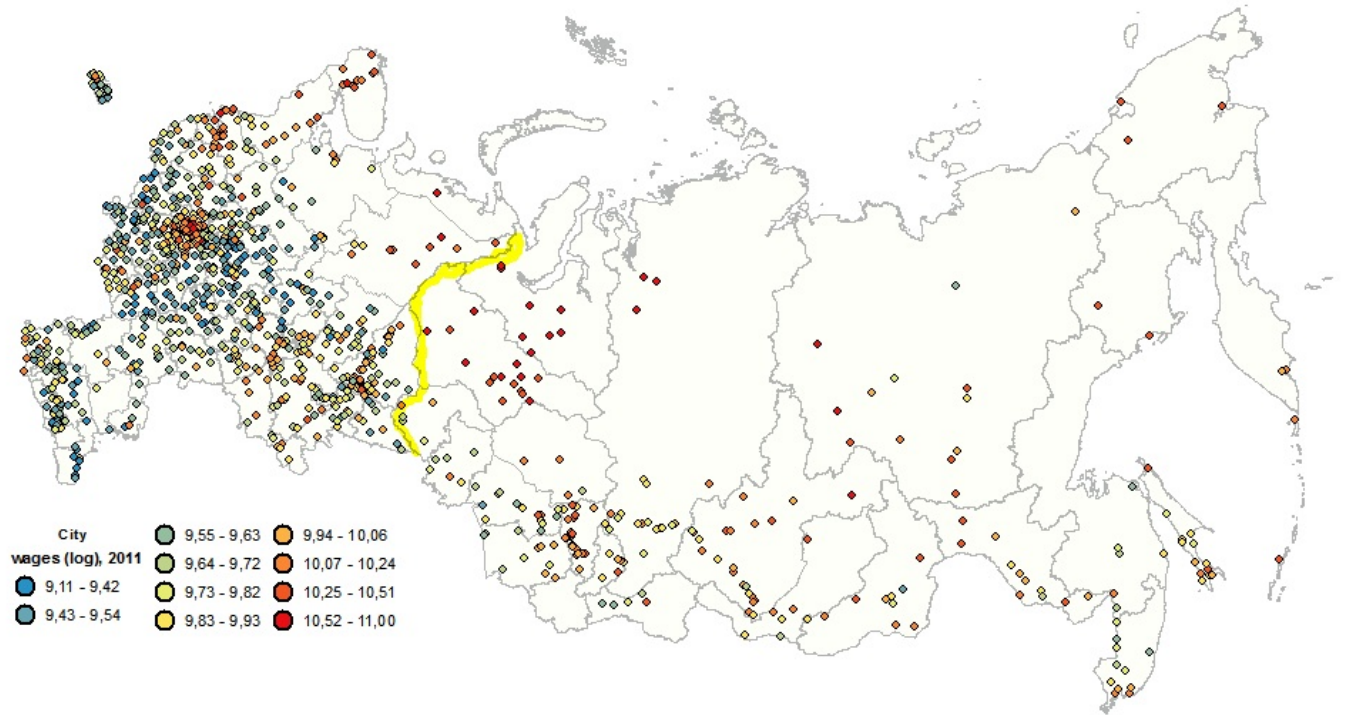


Figure 1: Real wages, 2011 (in 2010 roubles, log).

Differences between means of real wages of the two datasets are significant, according to t-tests. I calculate pairwise great-circle distances (km) between cities, histograms are shown below (Fig. 2). The left histogram corresponds to pairwise distances between all the cities, the central one –

to pairwise distances between cities of the Eastern part of the country, and the right one – to the Western part.

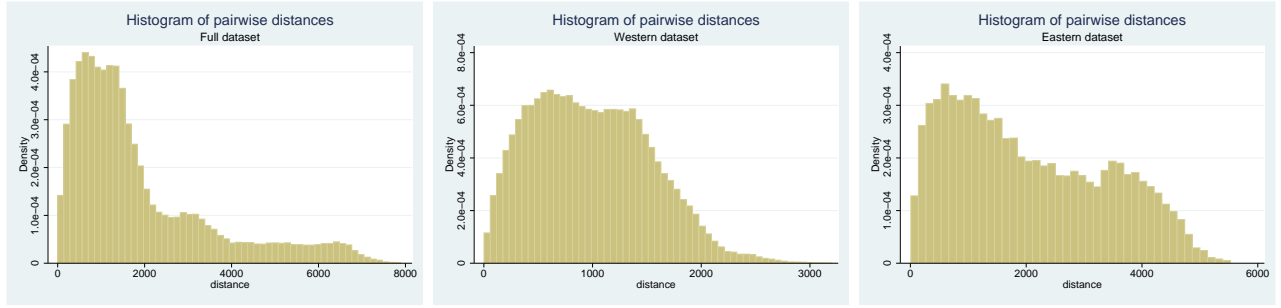


Figure 2: Histograms of pairwise distances

Descriptive statistics for bilateral distances are as follows (Table 1):

Table 1: **Descriptive statistics of pairwise distances**

Dataset	Mean	St. deviation	Median
Full	1894.143	1649.539	1342.153
Western	990.339	543.267	949.347
Eastern	2048.831	1341.455	1788.217

Differences in means of pairwise distances are also significant, so it makes sense to consider the two datasets and then to compare results.

Research questions

Does the space matter for regional convergence in Russia? How to describe the spatial interaction of cities?

I test whether spatial interaction of the cities takes place. Many researchers studying Russian regions in their empirical papers, use several main types of spatial matrices in their estimation. As a rule, such matrices are contiguity and distance ones. Distance between regions is measured as a distance between regional central cities, i.e. such type of spatial matrix in the case of regions is a rather rough measure of the spatial distribution, and this is more suitable for cities. Moreover, in such papers distance matrices are based on highway or railway distances, so these spatial matrices cannot be considered as exogenous.

Furthermore, because of very huge and irregularly populated territory one should be careful in adopting standard spatial matrices to spatial models.

In this paper there will be an attempt to construct different spatial matrices for different parts of the country.

Does the size of the city display positive impact on growth of the Russian cities?

One of the conclusions of endogenous growth models is that the market size impacts on growth. In my study I use total city population as a starting point for a measure of market size. Preliminary study shows that the larger the regional population, the higher the growth rates, and the results are robust to measure. Market size is likely to be endogenous. Therefore, in the estimation of regression I instrument the variable, I use data on city population during the Soviet period and the Russian Empire. Also I use geographical variables that may affect city distribution across the country: longitude, latitude, and soil quality.

Methodology and estimation results

There is a dynamics of the coefficient variation of real wages (in logs) in Fig. 2. Variation of real city wages is decreasing, this implies that sigma-convergence of cities holds.

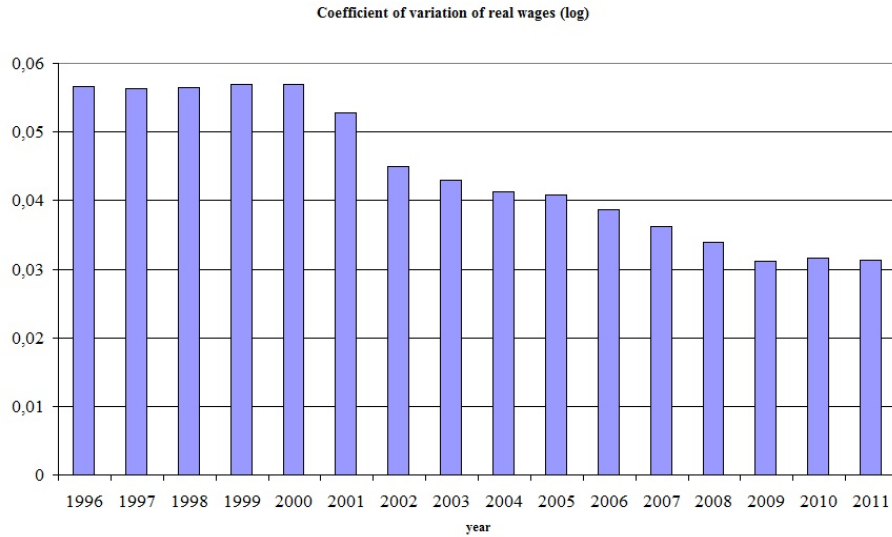


Figure 3: Coefficient of variation for log of real wages .

There is a scatterplot for real wages in 1996 and average annual growth of wages between 1996 and 2011 in Fig. 2.



Figure 4: Scatterplot for real wages in 1996 and average annual growth of wages between 1996 and 2011.

The slope of the line in Fig. 4 is negative. The fitted values correspond to the Barro regression:

$$\frac{1}{T} \ln \frac{y_{T,i}}{y_{0,i}} = a + b \ln y_{0,i} + \varepsilon_i, \quad (1)$$

i – city, $i = 1, 2, \dots, n$,

T – time (years),

y_{0i} – initial wages adjusted by PPP,

y_{Ti} – wages adjusted by PPP in the year T ,

$\frac{1}{T} \ln \frac{y_{Ti}}{y_{0i}}$ – average annual growth of wages between years $t = 0$ and $t = T$,

ε_i – errors, $\varepsilon_i \sim iid$ with 0 mean and finite 2nd moment.

In order to test which factors explain the convergence, I use the equation of conditional convergence as follows:

$$\frac{1}{T} \ln \frac{y_{T,i}}{y_{0,i}} = a + b \ln y_{0,i} + c' X_{0,i} + \varepsilon_i, \quad (2)$$

where X_i – a vector of control variables chosen in accordance with the hypotheses.

The OLS estimates of (1) for different datasets are presented in Table 2, columns 1, 3, 5. All the coefficients for the initial wages are significant and negative, so there is β -convergence of Russian cities by wages. The absolute value of the coefficient is higher for the Western dataset, so the speed of city convergence by wages in this part of Russia is higher than in the Eastern part.

Also I estimate equation (2) with geographical control variables: longitude and latitude of each city. I get significant negative effect of longitude for the Western dataset (Table 2, column

4). Mikhailova (2004) notices that the average population-weighted temperature becomes lower when longitude becomes greater, because the isotherms on the Eurasian continent resemble lines of longitude, not latitude. Decreasing temperature leads to decreasing growth, so the result in the 4th column is consistent with this. Eastern dataset does not reveal this pattern, because the share of settlements with natural resources is higher.

Table 2: **OLS estimates of equation (2)**

Variables	Dependent: Average annual growth of wages, 1996–2011, log					
	(1)	(2)	(3)	(4)	(5)	(6)
Wages in 1996, log	-0.0263*** (0.0012)	-0.0292*** (0.0014)	-0.0307*** (0.0016)	-0.0304*** (0.0017)	-0.0225*** (0.0021)	-0.0243*** (0.0026)
Longitude		0.0000** (0.0000)		-0.0003*** (0.0001)		0.0000 (0.0000)
Latitude		0.0003** (0.0001)		0.0003** (0.0001)		0.0002 (0.0002)
Constant	0.1152*** (0.0164)	0.1340*** (0.0172)	0.1727*** (0.0208)	0.1655*** (0.0206)	0.0670* (0.0282)	0.0750* (0.0307)
R-squared	0.3163	0.3241	0.3226	0.3548	0.3799	0.3786
Dataset	Full	Full	West	West	East	East
Observations	1004	1004	810	810	194	194

Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

The key indicator needs to be considered more carefully. I draw annual scatterplots with fitted lines for real wages and their annual growth since 1996 till 2011 (Fig. 4). A horizontal axis in each plot displays values of real wages of initial year t in logarithms: $\ln y_{t,i}$, and a vertical axis is used for values of annual growth of wages: $\ln y_{t+1,i} - \ln y_{t,i}$; $t = 1996, \dots, 2010$. Only 2 of 15 plots contain positive slope of the regression line, they correspond to 1999 and 2010 years; which in terms of the Barro regression mean not convergence, but divergence. The other 13 plots display negative slope which supports the hypothesis of convergence of Russian cities by wages.

Formally, the panel version of the growth equation (2) can be expressed in the following way:

$$\ln \frac{y_{(t+1),i}}{y_{t,i}} = a + b \ln y_{t,i} + c' X_{t,i} + a_i + \tau_t + \varepsilon_{t,i}, \quad (3)$$

where $t = 1, \dots, T$. I estimate fixed effects panel data model, because the analysis is limited to a precise set of cities, whilst random effects are usually estimated when a dataset is constructed as a certain number of observations drawn randomly from the whole set. I consider individual city-level fixed effects in order to remove individual-level differences of cities. And I include year fixed effects into regression for taking into account crisis years.

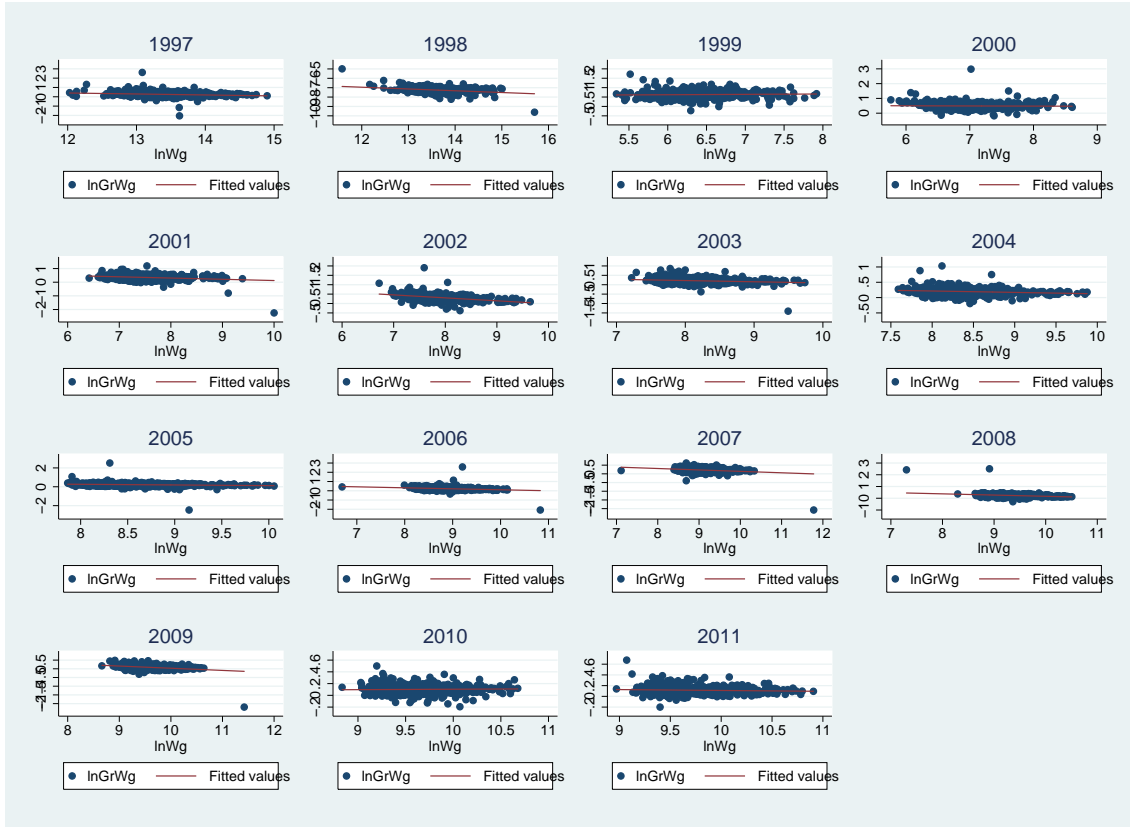


Figure 5: Scatterplots for real wages and their annual growth, 1996–2011.

Does space matter for convergence?

In order to reveal if there is spatial autocorrelation of wages I calculate Moran's index using inversed distance matrices with different thresholds (Fig.6). All the indexes are significant at $p < 0.05$ and positive, hence, city wages are spatially autocorrelated, and I include a spatial component into the regression to be estimated.

A spatial version of the growth equation that I estimate is a spatial autoregressive model (SAR):

$$\ln \frac{y_{(t+1),i}}{y_{t,i}} = b \ln y_{t,i} + \rho W \ln \frac{y_{(t+1),i}}{y_{t,i}} + c' X_{t,i} + a_i + \tau_t + \varepsilon_{t,i}, \quad (4)$$

here W – a matrix of spatial weights, ρ – a spatial autoregressive parameter, ε – a vector of homoscedastic and uncorrelated errors (Anselin, Hudak, 1992). The spatially lagged term $W \ln \frac{y_{(t+1),i}}{y_{t,i}}$ of the dependent variable captures the spatial interaction effect indicating the degree to which the growth rate of real wage in one city is determined by the growth rates of its neighbouring cities, after conditioning on the effect of initial level of wages $\ln y_{t,i}$.

As I mentioned above, I calculate real wages using consumer price indexes. There is criticism of consumer price indexes (Gluschenko K., 2006) provided by the Russian statistical agency. In order to remove a possible bias in time, I include year fixed effects τ_t into both (3) and (4).

At the first stage I consider an inverse spatial matrix based on great circle distances. On the

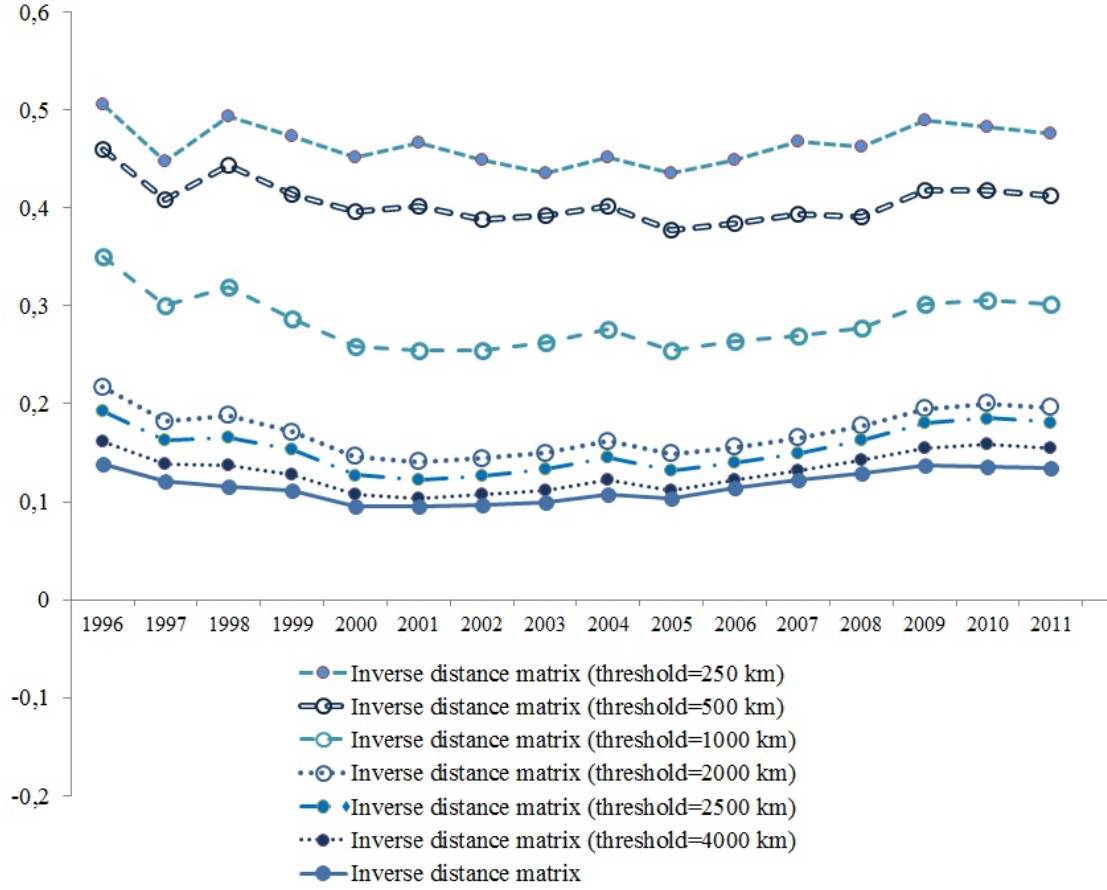


Figure 6: Dynamics of Moran's I for real wages (log).

further steps of study I modify the matrix with a threshold distance which is different for the Western and Eastern parts ($w_{ij} = 0$ if $d_{ij} > d_{threshold}$ km).

The estimates of equations (3) and (4) are presented in Table 3, spatial matrix is an inverse distance one.

Table 3: **Estimates of equations (3) and (4)**

Model	equation (3)	equation (4)
$\ln y_{t,i}$	-0.484*** (0.007)	-0.485*** (0.007)
Constant	4.814*** (0.067)	
Year fixed effects	yes	yes
Spatial ρ		0.002**
Variance σ_ε^2		0.013***
Direct effect: $\ln y_{t,i}$		-0.485***
Indirect effect: $\ln y_{t,i}$		-0.001*
Total effect: $\ln y_{t,i}$		-0.486***
Method	OLS	ML
R-squared	0.996	
N	15060	15060
Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1		

But the last column estimates show that the direct effect from wages is negative and highly significant: -0.485 , and indirect effect is very small: -0.001 . This suggests that we would see decreased growth of wages in cities experiencing increasing wages. The indirect effect in the case of year fixed effects is very small, so one can conclude a negligible spillover effect from wages, and changes in wages are almost completely explained by variation year by year out.

I will estimate equations (3) and (4) for Western and Eastern datasets and will use modified spatial matrix. *[To be completed]*

Does city size matter for convergence?

1. Non-spatial case.

To study the impact of the market size on the growth, one should estimate the equation (2) with a variable for the market size of the city, or the spatial version of (2). Using the population of the city as a proxy for the market size generates a problem of endogeneity. So, in the estimation of the equation (5) I instrument the variable by means of historical data. Following Mikhailova (2011), who investigates long-term dynamics urban population and city growth, according to the population census in Russian Empire, USSR and Russian Federation. Available census data covers years: 1897, 1926, 1937, 1939, 1959, 1970, 1979, 1989, 2002. So, I estimate cross-sectional version of the conditional convergence equation

$$\frac{1}{T} \ln \frac{y_{T,i}}{y_{0,i}} = a + b \ln y_{0,i} + c' \ln Population_{ti} + \varepsilon_i. \quad (5)$$

Estimates of (5) are presented in Table 4. I have to restrict the full dataset to the number of observations for the appropriate census year because of missing values. Columns 2 and 5 contain estimates of the equation with endogenous variable – population in the initial year 1996. In columns 3 and 6 estimates with instrumental variables are provided. Comparison coefficients for wages in 1996 reveals that using endogenous variable leads to a bias – this enhances the speed of convergence.

Table 4: **Estimates of equation (5)**

Variables	Dependent: Average annual growth of wages, 1996–2011, log					
	(1)	(2)	(3)	(4)	(5)	(6)
Wages in 1996, log	-0.0281*** (0.0019)	-0.0380*** (0.0019)	-0.0336*** (0.0021)	-0.0280*** (0.0017)	-0.0365*** (0.0018)	-0.0332*** (0.0020)
Popul. in 1996, log		0.0047*** (0.0004)	0.0026*** (0.0006)		0.0045*** (0.0004)	0.0027*** (0.0006)
Constant	0.1367*** (0.0257)	0.2190*** (0.0239)	0.1828*** (0.0254)	0.1369*** (0.0233)	0.2024*** (0.0223)	0.1766*** (0.0232)
Method	OLS	OLS	IV, 2SLS	OLS	OLS	IV, 2SLS
Instrument			Popul. in 1897			Popul. in 1926
R-squared	0.3095	0.4592	0.4300	0.2866	0.3959	0.3788
N	471	471	471	641	641	641
Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1						

2. Spatial case.

I use longitude and latitude for cities in order to take into account for city location and data of the first two censuses for the first stage of the estimation in order to instrument population in 1996 (Table 3).

Table 5: **Estimates of the first stage**

Variables	Dependent: $\ln Pop_{1996}$	
	year=1897	year=1926
$\ln Pop_{year}$	0.949*** (20.98)	0.832*** (25.53)
$\ln Lon$	2.392 (1.15)	4.066* (2.45)
$\ln Lat$	-158.9*** (-4.69)	-67.69** (-2.71)
$\ln Lon^2$	-0.171 (-0.67)	-0.427* (-2.10)
$\ln Lat^2$	20.02*** (4.68)	8.524** (2.71)
<i>Constant</i>	310.6*** (4.65)	128.0** (2.60)
<i>N</i>	472	643
<i>R</i> ²	0.532	0.541

t-statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

SAR estimates are in Table 4.

Table 6: **Estimates of the first stage**

Variables	Dependent: annual growth of wages	
$\ln y_{1996}$	-0.576*** (-19.20)	-0.564*** (-20.90)
$\ln Pop_{1996}$	0.0551*** (7.74)	0.0531*** (7.56)
Constant	3.636*** (9.79)	3.519*** (10.56)
λ	0.0334*** (3.56)	0.0186*** (3.37)
ρ	3.239*** (4.80)	1.696*** (5.90)
<i>N</i>	472	643

t-statistics in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

[To be completed]

Soil quality

In order to test whether soil quality explains the city size variation, I use data from the National Snow and Ice Data Center (Vladimir Stolbovoi. Description of Russian Soils. National Snow and Ice Data Center), the map is in Fig. 7.

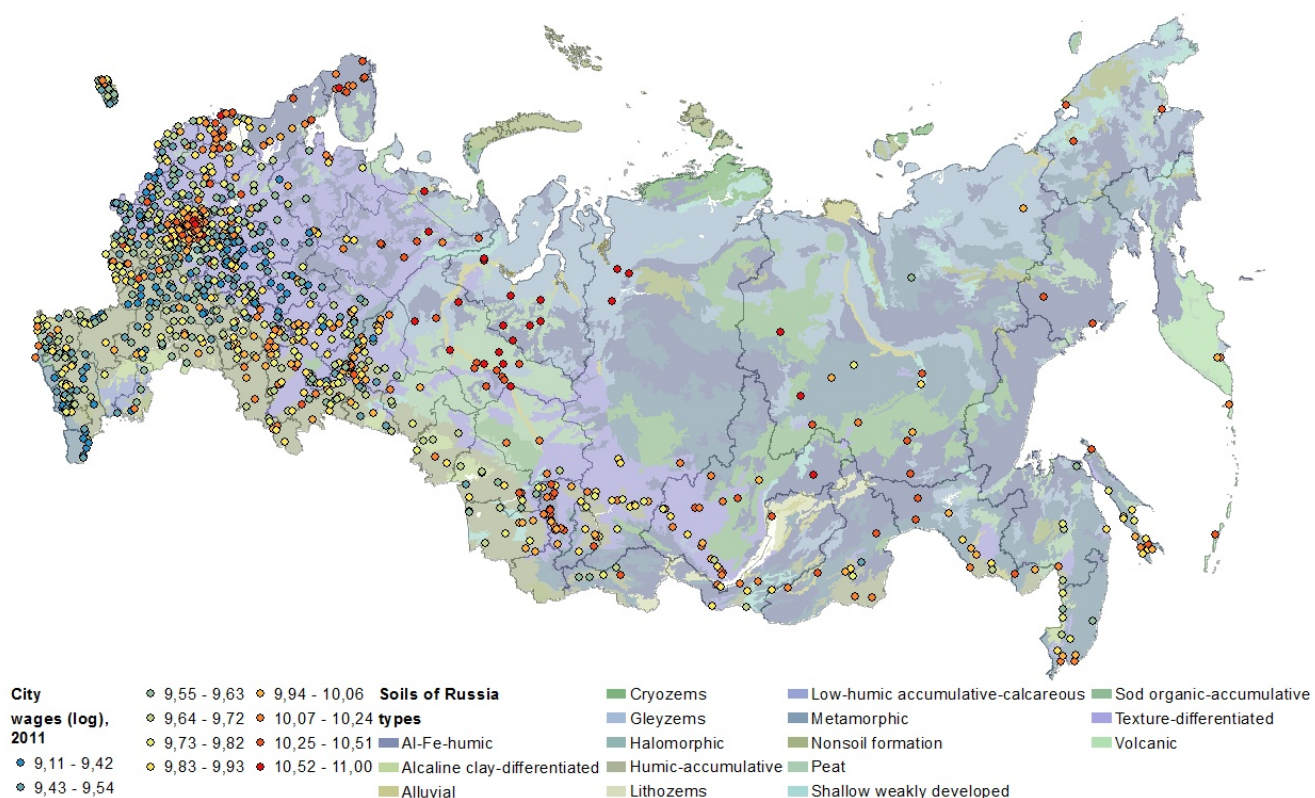


Figure 7: City wages 2011 and soil quality.

I run several regressions for the dependent variable city population for different years with dummies for the soil quality, estimates are in Table 7. As we can see, for the census of the Russian Empire in 1897, soil quality was highly significant, because the country was mostly agricultural. Nowadays soil quality has no big impact on city population, so these dummy variables don't capture city population variation, they should be used jointly with other variables.

Table 7: **Population and soil quality**

Type of soil	Population 1897	Population 1926	Population 1996
Al-Fe-humic	2.195* (1.052)	1.348 (1.109)	0.778 (0.597)
Alkaline clay-differentiated	2.865* (1.125)	1.877 (1.158)	0.965 (0.671)
Alluvial	2.747* (1.083)	2.029 (1.141)	1.176 (0.634)
Gleyzems	1.488 (1.258)	0.294 (1.338)	0.510 (0.671)
Halomorphic			0.406 (1.299)
Humic-accumulative	3.393** (1.031)	2.036 (1.095)	0.941 (0.585)
Lithozems			0.547 (1.299)
Low-humic accumulative-calcareous			-0.076 (1.299)
Metamorphic	2.514* (1.054)	1.522 (1.111)	0.424 (0.598)
Nonsoil formation	2.795* (1.258)	1.290 (1.338)	0.017 (1.006)
Peat	2.854** (1.098)	1.622 (1.145)	0.751 (0.639)
Shallow weakly developed	3.295** (1.186)	2.538* (1.221)	1.504* (0.750)
Sod organic-accumulative	3.260** (1.258)	1.001 (1.196)	0.134 (0.659)
Texture-differentiated	2.914** (1.029)	1.633 (1.094)	0.687 (0.584)
Constant	5.979***	7.433***	9.724***
R-squared	0.082	0.035	0.014
N	471	641	1004

Standard errors in parentheses, * p<0.05, ** p<0.01, *** p<0.001

[To be completed]

Concluding remarks

There is significant β -convergence of Russian cities by wages. Speed of convergence is different for the Western and Eastern parts of the country.

The role of spatial spillovers is almost eliminated while considering underaccounted price distribution accross regions. To get more exact estimates, it is necessary to construct different spatial

matrix for the Western and Eastern parts of the country

The impact of the market size on city-level convergence is positive.

[To be completed]

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