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Determinants of Economic Growth:
Empirical Evidence from Russian Regions

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Abstract

A modification of Barro and Sala-i-Martin empirical framework of growth model is specified to examine determinants of per capita growth in 74 Russian regions during period of 1996-2005. We utilize both panel and cross-sectional data. Results imply that in general regional growth in 1996-2005 is explained by the initial level of region's economic development, the 1998 financial crisis, domestic investments, and exports. Growth convergence between poor and rich regions in Russia was not found for the period studied.

JEL Classification: E22, F21, P27

Keywords: Russian regions, economic growth

1. Introduction

Empirical growth analysis was pioneered by Barro (1991) and Mankiw et al (1992). A large empirical literature on the determinants of economic growth in transition economies appeared in the 1990s and 2000s, including Fischer, Sahay and Vegh (1998), Havrylyshyn, Izvorski and van Rooden (1998), Berg et al. (1999), and Havrylyshyn and van Rooden (2000). The studies have identified a variety of microeconomic, structural, and institutional factors of economic growth in transition economies in general. A good description of empirical literature published in the 1990s is available in a survey by Havrylyshyn (2001).

For the Russian economy the question of determinants of economic growth during transition remains an open question. There are a lot of variables which could be included into the growth model specification taking into consideration the fact that the "traditional" growth regressions literature is quite different from the more recent literature explaining growth in transition economies. Papers aiming to shed light on this are few. Berkowitz and DeJong (2003) found that regional difference in reform policies and in the formation in new legal enterprises can help account for regional differences in growth rates in Russia. They estimate growth regression by Ordinary Least Squares (here and after OLS) and Two Stage Least Squares (2SLS) using cross-sectional data for 48 Russian regions. Note that regional growth differences for such economies as USA and China are comparable. Both countries occupy quite large territories which consist of many regions: states in USA and provinces in China.

Papyrakis and Gerlagh (2007) analyze empirically determinants of economic growth in the United States using cross-sectional data on 49 states. Their dependent

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variable is growth rate of Gross State Product (GRP). The regressors are initial income, natural resources, investment, schooling, openness and corruption. They found that empirical data seem to support the absolute convergence hypothesis for US states, but the data also show that natural resource abundance is a significant negative determinant of growth.

Cai, Wang and Du (2002) analyze empirically determinants of economic growth in Chinese provinces during the period 1978-1998. They estimate specification using panel data by OLS and FGLS. The finding is that (1) there is an evidence of conditional convergence in China's growth, namely, per capita GDP in the initiative year is negatively related to growth rates in following years, (2) labor market distortion negatively impacts regional growth rates, and (3) many other variables used in previous studies impact growth performance.

Dermurger (2000) utilizes the same empirical panel data framework as Cai, Wang and Du (2002) to analyze panel data from a sample of 24 Chinese provinces (excluding municipalities) throughout the 1985 to 1998 period. The estimation of a growth model shows that, besides differences in terms of reforms and openness, geographical location and infrastructure endowment did account significantly for observed differences in growth performance across provinces. The significant and negative coefficient associated to the logarithm of lagged GDP per capita indicates a catch-up phenomenon among Chinese provinces.

This paper attempts to find some evidence on the determinants of economic growth across Russian regions. As the background of empirical analysis of regional determinants of economic growth in Russia is very small, our focus is on the traditional factors of economic growth. Special emphasize is put on dynamic panel data methods to control for endogeneity problems found in growth empirics. We use also the Oaxaca-Blinder decomposition method to examine the extent to which differences in growth rates between sub-samples of relatively poor and rich Russian regions can be explained by differences in specified factors of economic growth. According to neoclassical theory lower-income countries tend to grow faster than higher-income countries. The Oaxaca-Blinder decomposition helped us to find further evidence on the factors of convergence between lower-income and higher-income regions in present day Russia.

The main results of our paper are the following. We found that conditional convergence is relevant across the Russian regions during the transition period. Domestic investment and export can be considered as important factors of economic growth in Russia. The Oaxaca-Blinder analysis produced some evidence on the relative magnitudes of different factors of convergence across Russian regions, e.g. that initial GRP per capita plays an important role here along with domestic investments.

The reminder of the paper is constructed as follows. Section 2 describes the background theory for the empirical model. Section 3 describes the data and variables. Section 4 gives the estimation methods. Section 5 reports the results with some discussion. Some additional results are given Section 6, and Section 7 concludes.

2. Empirical model

Growth regression studies have been used to explain differences in economic performance across nations and regions. Assuming diminishing returns to capital, neoclassical growth theory predicts a convergent growth trend among nations or regions, i.e. poor countries or regions tend to grow faster than rich ones (Mankiw, Romer, & Weil, 1992). Islam (1995) was first to propose a dynamic panel data approach to modifying the Mankiw-Romer-Weil model.

Assume each region *i* has a following production function:

$$Y_t = F(K_t, L_t, \boldsymbol{X}_t) \quad [1]$$

where *Yt* is the total production at time *t*, *F(.)* is a concave production function with homogeneity degree of one, *Kt* is the stock of physical capital, *Lt* is the labour force, and *Xt* is a vector of all other relevant production inputs. The properties of production function allow us to write it in the labour intensive form, i.e.

$$\mathrm{Y_t / L_t = F(K_t / L_t, I, X_t / L_t) \Rightarrow y_t = f(k_t, x_t)}. \quad [2]$$

Time differentiation of Eq. 2) gives

$$\frac{dy_t}{dt} = f_1 \frac{dk_t}{dt} + \sum_{j=2}^{N} f_j \frac{dx_{j,t}}{dt} \quad [3]$$

Let y_t^* denote the steady-state level of income per effective worker, and let y_t be its actual value at any time *t*, where *t* is the period average as in Islam (1995). Approximating around the steady state the pace of convergence is given by

$$\frac{\partial \ln y_t}{\partial t} = \lambda(\ln y_t^* - \ln y_t) \quad [4]$$

where λ is the speed of convergence. This equation implies for given $\ln y_t^*$ and $\ln y_{t-1}$

$$\ln y_t = (1 - e^{-\lambda t}) \ln y_t^* + e^{-\lambda t} \ln y_{t-1} \quad [5]$$

hjkj

Because equation (5) holds at any time, it can be rewritten by subtracting one-period lag, $\ln y_{t-1}$, from both sides:

$$\Delta \ln y_t = (1 - e^{-\lambda t}) \ln y_t^* + (e^{-\lambda t} - 1) \ln y_{t-1} \quad [6]$$

Equation (3) expresses the convergence process of growth rate over time. It implies convergence in growth rates, conditional on the steady-state growth rate. Equation (6) is a general feature of the neoclassical growth model, without relying on the Mankiw-Romer-Weil approximation. That is, if the steady-state growth rates are identical across countries, the actual growth rates must convergence.

In order to estimate the described scheme in panel data regressions we use the empirical framework suggested by Barro and Sala-I-Martin (1995) adopted for panel data (see, e.g., Soto 2000, Carcovic and Levine 2002, Laureti and Postiglione 2005). This framework relates real per capita growth rate to initial levels of state variables, such as the stock of physical capital and the stock of human capital, and to control variables. Following the idea of Barro and Sala-I-Martin (1995), we assume that a higher level of initial per capita GRP reflects a greater stock of physical capital per capita. Following

Soto (2000), we also assume that the initial stock of human capital is reflected in the lagged value of per capita output in the short-run. The neoclassical growth model predicts that, for given values of the control variables, an equiproportionate increase in initial levels of state variables reduces the growth rate. Thus we can approximate equation (6) with reference to Eq. 2) and Eq. 3)[1]

$$\Delta \ln y_{it} = \alpha_1 \ln y_{i,t-1} + \alpha_2 \ln k_{i,t} + \boldsymbol{\beta}' \ln \boldsymbol{x}_{it} \qquad [7]$$

where $y_{i,t}$ is per capita GRP in region *i* (*i=1,…,74*)[2] in period *t* (*t=1996,…,2005*), $y_{i,t-1}$ is (initial) per capita GRP in region *i* in period *t-1,* α_1 is a negative parameter reflecting the convergence speed, α_2 is a positive parameter giving the impact of capital-labour ratio to per capita GRP growth rate, $\boldsymbol{x}_{i,t}$ together with $k_{i,t}$ is a row vector of control variables in region *i* during period *t* with associated parameters $\boldsymbol{\beta}$.

3. Data and variable choice

We use five control variables which can be viewed as important factors in the Russian economy's regional development in the analyzed period. They are represented in Table 1.

Table 1. Control variables*

Variable	Description
Dummy_1998	Dummy variable for the year 1998 of major financial crisis in Russia
$ln(I/N)_{i,t}$	Natural logarithm of per capita domestic investment
$ln(Exp/N)_{i,t}$	Natural logarithm of per capita export
$ln(R/N)_{i,t}$	Natural logarithm of resource index
ln(FDI/N)i,t	Natural logarithm of per capita Foreign Direct Investment (here and after FDI)

**) all variables are for region i =1,…,74 in period t =1996,…,2005*

First we include a dummy variable for the year 1998, to control for the major financial crisis that occurred in Russia. The second variable is the natural logarithm of per capita domestic investment in physical capital, $ln(I/N)_{i,t}$, i.e. investment originated from Russia, in million dollar in year 2000 prices[3]. According to the existing theory and most empirical findings we expect this to be positively related to the dependent variable. Note that we do not use capital stock here as a variable. Instead we have the change of stock, i.e. investment per capita, as source of economic growth. The lagged stock effects operate via the lagged output per capita variable.

[1] Instead we could have assumed that production function in Eq. 2) is Cobb/Douglas type and log-linearize it.

[2] Actually there are 89 regions in Russia. We exclude from the analysis the autonomous territories, which are included in other regions. These are Neneckij, Komi-Permyatckij, Hanty-Mansijskij, Yamalo-Neneckij, Dolgano-Neneckij, Evenkijskij, Ust-Ordynskij and Aginskij Buryatskij, and Koryakskij. Regions for which most data are missing, namely Ingushetiya, Chechnya, Kalmykiya, Alaniya, Mari-el and Chukotka, are also excluded.

[3] The transformation was done using the USA deflator, which is 100 for the year of 2000.

The third variable is the natural logarithm of per capita export (from region *i* to abroad), $ln(Exp/N)_{i,t}$, in million dollars at year-2000 prices. This variable was included to predict the positive contribution of the degree of openness of the regional economy to economic growth. We add this variable to test the hypothesis of export-led economic growth in Russia during transition. This proposition is also based on recent finding of Awokuse (2007) that trade stimulates economic growth in three transition economies, namely Bulgaria, Czech Republic and Poland.

The fourth variable, the natural logarithm of the resource index, $ln(R/N)_{i,t}$ (for calculation details, see Appendix 1), was included because of the high dependence of Russian economy on natural resources. In accordance with the aggregate production function approach in the short run, the natural resources stock is positively related to economic growth and is treated as an additional input. As we operate with a short period of only 10 years (1996-2005) of the present transitory phase of the Russian economy, we expect this variable to have some importance for the Russian regional growth process. However historic experience across countries provides support to the hypothesis that resource scarce economies often outperform resource-abundant countries in terms of economic growth. A number of recent studies has described and analysed the resource curse hypothesis (Gylfason, 2000, 2001ab, Leite and Weidmann 1999, Papyrakis and Gerlagh 2004, Rodriguez and Sachs 1999, Sachs and Warner 1995, 1997, 1999a). The conclusion is widely accepted: natural riches tend to frustrate rather than promote economic growth. Thus it is important to investigate if the resource abundance (in particular oil and gas abundance) retards or stimulates regional growth in Russia.

The last variable included in our specification is natural logarithm of FDI per capita in million dollars in year-2000 prices. Most theoretical and empirical findings imply that FDI has a strong positive growth impact on the recipient economy (see, e.g., theoretical studies of Dunning and Narula 1996, Borenstein, Gregorio and Lee 1998, Markusen and Venables 1999, and empirical studies of Balasubramanyam, Salisu and Sapsford 1996, Bende-Nabende and Ford 1998, Soto 2000, Li and Liu 2005). For the Russian economy the question of aggregate FDI impact on economic growth remains an open question.

The source of all data used is Russia's regions yearbooks published yearly by Goskomstat (Russian State Statistical Agency). We are aware that Russian statistics suffer from a bad data problem. However Goskomstat is the only public source of Russian statistics. We are also aware that the estimated period is a transition period in Russia characterized for macro instability. This also may cloud the estimation results. We carefully examined the data and found that the main source of instability in it is financial crisis of 1998. Before and after this year the dynamics of variables is more or less stable. Thus by introducing a dummy variable for the year of 1998 we partly solve this problem.

Empirical panel data studies on growth are generally carried out for periods of around 30 years, with five-year or three-year average observations (see e.g. Barro and Lee 1994, Caselli, Esquivel and Lefort 1996, Carcovic and Levine 2002). Our estimation time period is limited to 10 years (1996-2005) since 1) relatively short transition period of the Russian economy (15 years), 2) capital inflows into Russia have been registered by the state statistical authorities only since 1995, and 3) the data for all the other variables are available only since 1996. Thus we follow Soto (2000) and Laureti and Postiglione

(2005) and utilize yearly data in our estimations. The summary statistics of all the variables involved in baseline estimation is represented in Appendix 2.

4. Econometric Methods

The specified growth adjustment model (Eq. 7, above), is estimated with panel data allowing for region and time specific components. That is

$$\Delta \ln y_{it} = \alpha_1 \ln y_{i,t\text{-}1} + \alpha_2 \ln (I/N)_{it} + \beta_1 \ln (Exp / N)_{it} + \beta_2 \ln (R / N)_{it} + \beta_3 \ln (FDI / N)_{it} + \beta_4 D1998 + \nu_i + \tau_t + \varepsilon_{it} \quad [8]$$

where v_i is a region-specific effect, τ_t is a period-specific effect common to all regions, and ε_{it} is the error term.

The fixed effect (FE) and random effect (RE) estimators of the panel data model with lagged dependent variable in the set of regressors produces biased coefficient estimates with small samples. The basic problem of using least square methods is that the lagged dependent variable is correlated with the error term, as the dependent variable lny_{it} is a function of v_i, and it immediately follows that $lny_{i,t-1}$ is also a function of v_i (for details, see e.g. Baltagi, 2002, pp. 129-131)[4].

In order to cope with the above mentioned problems estimators based on the General Method of Moments (GMM) are employed, which are consistent for $N \to \infty$ with fixed T. We exploit the GMM-DIFF (GMM based on differenced variables) procedure of Arellano and Bond (1991). This calls for first differencing and using lags of the dependent and explanatory variables as instruments for the lagged dependent and endogenous right hand side variables.

In general, the GMM estimator can be viewed as simultaneous estimation of a system of equations, one for each year, using different instruments in each equation and restricting the parameters to be equal across equations. First-differencing the equations removes the individual effects v_i, thus eliminating a potential source of omitted variables bias estimation, and removes the problems of series non-stationary. Note also that one of the advantages of using a dynamic model is that both short-run and long-run elasticities can be obtained.

As linear GMM estimators, the Arellano-Bond estimators have one- and two-step variants. Bond (2002, p.9-10) pointed out that: "…a lot of applied work using these GMM estimators has focused on results for the one-step estimator than the two-step estimator. This is partly because simulation studies have suggested very modest efficiency gains from using the two-step version, even in the presence of considerable heteroskedasticity…. Simulation studies have shown that the asymptotic standard errors tend to be much too small, or the asymptotic t-ratios much too big, for the two-step estimator, in sample size where the equivalent tests based on the one-step estimator are quite accurate. Windmeijer (2000) provides a formal analysis of this issue, and proposes a finite-sample correction for the asymptotic variance of the two-step GMM estimator which is potentially very useful in this class of models." In our study we report two-step variants of the estimators (we also did one-step estimation, but as the results are quite

[4] However we estimated fixed effects and random effects models for robust-checking purposes (for detail section 5).

similar we report only the two-step robust estimations). They are obtained using a finite-sample correction to the two-step covariance matrix derived by Windmeijer (2005).

GMM estimation has the further advantage that it can treat the explanatory variables as strictly exogenous, predetermined or endogenous. If we assume that explanatory variables (X_{nt}) are strictly exogenous (i.e. that $E(X_{nt}\xi_{ns}) = 0$ for all t, s = 1, 2, …, T) then the current and all lagged X_{it} are valid instruments for the lagged dependent variable as a regressor. If X_{nt} are assumed to be predetermined ($E(X_{nt}\xi_{nt}) = 0$ for all $t \le s$), then only $\left[X_{i1}, X_{i2}, \ldots X_{i,s-1}\right]$ are valid instruments. And, finally, if X_{it} are allowed to be endogenous $(E(X_{nt}\xi_{nt}) = 0$ for $t < s)$ then only $\left[X_{i1}, X_{i2}, \ldots X_{i,s-2}\right]$ are valid instruments. For further details, see e.g. Bond (2002) and Baltagi (2002, p. 129-136).

5. Results

5.1. Base-line results

Estimation results for panel data are presented in Table 2 and 3. Note that we estimated model in Eq. 8 first in pooled OLS and in regional FE/RE effect forms. GMM-DIFF is first-differencing version of the model. The descriptive statistics of the dependent and explanatory variables is represented in Appendix 2. In accordance with descriptive statistics of the dependent variable several extreme outliers have been detected and trimmed away from the sample. However in order to control for possibly remaining outliers we also perform pooled Least Absolute Deviation (LAD) estimation. BP –stands for Breusch-Pagan test for pooled of data, i.e. ignoring the regional effects. For panel estimation we perform fixed effects model as Hausman test firmly favours fixed effects model against random effects model. The correlation matrix of the variables is represented in Appendix 3.

Table 2. Panel data estimation for regional growth. Yearly observations 1996 - 2005. Dependent variable: GRP per capita growth rate (t-values in parenthesis)

Variable	Pooled OLS	Pooled LAD3)	Fixed effects
Constant	0.053 (0.40)	-0.07 (-0.42)	
Initial income	-0.55 (-22.40)*	-0.38 (-11.30)*	-0.70 (-25.00)*
ln(I/N)	0.43 (21.80)*	0.27 (10.10)*	0.60 (27.40)*
ln(Exp/N)	0.04 (4.50)*	0.034 (3.40)*	-0.006 (-0.38)
ln(R/N)	-0.0003 (-0.88)	-0.0005 (-1.15)	0.001 (0.82)
ln(FDI/N)	-0.0002 (-0.24)	-0.0004 (-0.32)	-0.0005 (-0.48)
D1998	-0.22 (-6.70)*	-0.36 (-8.30)*	-0.14 (-4.60)*
Number of obs.	583	583	583
Adjusted R2	0.64		0.73
BP test 1)	45.70* (p-value: 0.0)		
Hausman test 2)	1695.70* (p-value: 0.0)		

1) The null hypothesis: the pooled OLS model is adequate against the random effects alternative.
2) The null hypothesis: the random effects model is consistent against the fixed effects model.
*3) LAD – Least Absolute Deviation estimation. *) Statistically significant at 5% level*

We report here the GMM-DIFF results under assumptions that all explanatory variables are endogenous. We use the levels of explanatory variables as instruments and utilize standard expanding instruments starting with two year lags. Two statistics evaluate the validity of the instruments used. The Sargan statistic of over-identifying restrictions tests the hypothesis that the instruments are not correlated with the residuals. The hypothesis is essential for the consistency of the estimators. The Arellano-Bond methodology assumes also that there is no second order autocorrelation in the first difference errors. However first order autocorrelation is acceptable. Arellano and Bond (1991) suggest tests for this.

Table 3. GMM panel data estimation for regional growth. Yearly observations 1998 -2005. Dependant variable: GRP growth rate (asympt. t-values in parenthesis)

Variable	GMM two-step	GMM two-step with time dummies
Constant	0.067 (23.90)*	0.14 (13.90)*
Initial income	-0.71 (27.10)*	-1.05 (-4.20)*
ln(I/N)	0.34 (19.70)*	0.06 (5.72)*
ln(Exp/N)	0.044 (4.68)*	0.001 (0.22)
ln(R/N)	0.003 (6.02)*	-0.001 (-1.12)
ln(FDI/N)	0.001 (1.59)	-0.001 (-1.61)
D1998	-0.56 (-28.64)*	-0.53 (-36.62)*
D1999		-0.59 (-38.03)*
D2000		0.017 (1.30)
D2001		-0.012 (-1.13)
D2002		0.038 (3.82)*
D2003		0.076 (7.72)*
D2004		0.12 (9.51)*
D2005		0.14 (13.88)*
Number of obs.	499	499
Test for residual AR(1)	-5.57* (p-value: 0.00)	0.58 (p-value: 0.56)
Test for residual AR(2)	0.01 (p-value: 0.99)	-2.75* (p-value: 0.01)
Sargan test for instrument validity	60.10* (p-value: 0.01)	39.10 (p-value: 0.33)

**) Statistically significant at 5% level*

From the results we conclude that they do not differ much between panel and GMM-DIFF estimations. The magnitude of coefficient for domestic investment variable is considerably lower with time dummies. The convergence parameter is larger (in module terms) for the results with time dummies. However the coefficient of export variable is positive and significant for the results without regional effects and time dummies.

Though time dummies are highly significant in GMM-DIFF regressions we will focus on the results without time dummies. We still control for the year of 1998 when the major financial crisis during transition happened in Russia. Note also that the misspecification test for residual AR(2) structure in the first difference errors indicate that GMM-DIFF results are more reliable for the case without time dummies.

The calculated parameter estimates for α_1 are negative which indicates conditional conver-gence, i.e. higher growth in response to lower starting GRP per capita when the other explanatory variables are held constant. In particular the result predicts that a 1% increase in the initial level of GRP per capita leads to 0. 71% decrease in GRP per capita growth.

Using equation (6), i.e. $\alpha_1 = e^{-\lambda t} - 1$ (for our case $t = 1$), we can calculate the speed of convergence. For $\alpha_1 = -0.71$ it equals to 1.24%. Thus 1.24% of the GRP per capita gap is closed every year. This is smaller than "2% rule". In general the conclusion is that conditional convergence in Russian regions is slower than that expected from growth theory. Dummy variable for financial crisis in 1998 is negatively related to economic growth in Russian regions. In particular, if the other explanatory variables are held constant the financial crisis of 1998 decreases GRP per capita growth in Russia by 0. 56%.

The results imply that the most important factor of economic growth in Russian regions during 1996-2005 was domestic investment, $ln(I / N)$. This is a typical result in the theoretical and empirical literature. 1% increase in the level of domestic investment leads to 0. 34% increase in GRP per capita growth.

No other variables show any evident statistical relationship with the dependent variable. There is some small evidence that export is positively related to economic growth (however the magnitude of the coefficient is very small). However the result is not stable.

Foreign direct investment seems not to be important for Russian economic development in the analysed period. The result may be due to their small amounts, and to the problem of "bad" statistics and/or the impossibility to use FDI variable with considerable time lags (4-5 years). The latter fact arises due to theoretical proposition that FDI effects economic growth with considerable time lag. We included FDI variable with lags of 1 and 2 in the model but the estimated coefficients were not statistically significant (not reported). The insignificance of foreign direct investment may be explained also by its disadvantageous industrial distribution across industries and regions. FDI in Russia are mostly concentrated in Moscow region, and in market oriented industries (food industry. trade and catering).

Natural resources themselves do not necessarily enhance economic growth in the short-run. But still domestic investment in resource industries may be quite productive, especially if it is associated with exports. Thus resources may positively influence economic growth through investment variable. However further research is needed to prove this proposition.

5.2. Sensitivity analysis of baseline results

First we construct a dataset with 5 years intervals (averages of period 1996-2000 and 2001-2005), i.e. there are only two observations along the time dimension. The panel data results are presented in Table 4. In general the results confirm our base-line findings.

However the convergence parameter is considerably smaller now. This is quite expected as in our baseline estimation it reflects the dependence of GRP per capita growth rate in current year on GRP per capita level in previous year. Here the convergence parameter reflects the dependence of average GRP per capita growth rate in five-year period on GRP per capita in the year that precede this period. In general we conclude that a 1% increase in the initial per capita income leads to 0.20-0.22 % decrease in the average GRP per capita growth in the coming five years.

Table 4. Panel data estimation for regional growth. Data in 5 years intervals (1996-2000 and 2001-2005). Dependant variable: GRP growth rate. Initial incomes: years 1995 and 2000

Variable	Pooled OLS	Pooled LAD1)
Constant	-0.43 (-2.09)*	-0.68 (-2.91)*
Initial income	-0.20 (-11.26)*	-0.22 (-9.51)*
ln(I/N)	0.10 (3.50)*	0.09 (2.62)*
ln(Exp/N)	0.07 (5.60)*	0.05 (3.97)*
ln(R/N)	-0.00 (-0.05)	0.0005 (0.85)
ln(FDI/N)	0.001 (0.45)	0.003 (0.97)
Dummy for 2nd period	0.20 (8.77)*	0.20 (7.53)*
Number of obs.	116	116
Adjusted R2	0.78	
BP test [2)]	8.28* (0.004)	

1) LAD – Least Absolute Deviation estimation.
2) The null hypothesis: the pooled OLS model is adequate against the random effects alternative.
** Statistically significant at 5% level*

As next step we estimate cross-section regressions for two sub-periods: averages of periods 1996-1999 and 2000-2005. Here our question is whether the growth determinants have changed from the "low growth years" to "the high growth years". The results are presented in Table 5.

Table 5. Cross-sectional results. The dependent variable is GRP per capita growth as average of period 1996-1999 and 2000-2005

Variable	Period 1996-1999 Initial income: year 1996		Period 2000-2005 Initial income: year 2000	
	OLS	LAD	OLS	LAD
Constant	-0.35 (-2.40)*	-0.50 (-2.80)*	0.33 (0.90)	0.46 (0.80)
Initial income	-0.23(-20.80)*	-0.22(-15.00)*	0.05 (0.62)	0.08 (0.65)
ln(I/N)	0.14 (6.40)*	0.11 (4.30)*	-0.045 (-0.85)	-0.053 (-0.61)
ln(Exp/N)	0.03 (4.80)*	0.038 (3.40)*	0.04 (2.22)*	0.035 (0.96)
ln(R/N)	-0.00 (0.05)	0.001 (0.84)	-0.00 (-0.10)	-0.003 (-0.22)
ln(FDI/N)	0.002 (1.80)*	0.003 (0.90)	0.005 (1.40)	0.005 (0.50)
Number of obs.	59	59	55	55
Adjusted R2	0.94		0.20	
Bera-Jarque Normality test for residuals	6.70 (p-value:0.04)		0.11 (p-value:0.95)	
Heterogeneity test for residuals	37.50 (p-value:0.01)		30.00 (p-value:0.07)	

**) Statistically significant at 5% level*

The results imply that in recent years there has been a significant structural break in Russian economic development. Our specification works very poorly in the second period – "the high growth years". Adjusted R2 decreases from 0.94 to 0.20 in the second period. Among the variables considered only export has a positive influence, albeit quite small, on economic growth in Russia. This effect is statistically significant at

5% level. In particular, a 1% growth in export per capita increases GRP per capita economic growth by 0.05-0.07 %. All the other variables are not statistically significant.

6. Convergence between Russian regions. High-income regions versus low-income regions

6.1. Regressions results

In order to find evidence for convergence between Russian regions we divide Russian regions into two sub-samples on the basis of the average GRP per capita for the regions in the period of 1996-2005. The first sub-sample consists of regions with above-average GRP per capita value, and second sub-sample corresponds to lower-income regions. By splitting the sample into rich and poor regions enables us to see if the convergence speed differs between rich and poor Russian regions. Moreover Oaxaca – Blinder decomposition presented below helps to shed light on the factors that retard convergence between these two groups of regions.

Taking into account the fact that the Russian economy relies significantly on natural resources, the division into rich and poor regions may be highly influenced by resource availability in the regions, and so the main factor in absorptive capacity may be resource availability. To check this we calculated the average resource index for both groups and found that it does not differ significantly between the groups. However we note that our dataset is not complete, i.e. we removed outliers and the data is not available for some regions.

The estimation results for different regions are represented in Table 6.

Table 6. Pooled OLS and GMM-DIFF estimation results for the sub-samples of high income and low income regions. Yearly observations 1996-2005 and 1998-2005.Dependant variable: GRP growth rate.

	High-income regions		Low-income regions	
	Pooled OLS	GMM-DIFF	Pooled OLS	GMM-DIFF
Constant	0.23 (0.90)	0.087 (11.69)*	-0.22 (-1.2)	-0.06 (30.7)*
Initial income	-0.48 (-10.00)*	-0.69 (21.85)*	-0.62 (-20.00)*	-0.73 (34.08)*
ln(I/N)	0.41 (10.00)*	0.24 (6.61)*	0.45 (20.50)*	0.36 (45.25)*
ln(Exp/N)	0.03 (1.40)	0.09 (4.81)*	0.04 (3.80)*	0.028 (4.03)*
ln(R/N)	-0.001 (-1.30)	0.0005 (0.49)	-0.001 (-0.50)	0.002 (12.23)*
ln(FDI/N)	-0.03 (-2.60)*	-0.017 (-1.61)	0.001 (0.20)	0.001 (6.38)*
D1998	-0.25 (-3.70)*	-0.61 (-18.42)*	-0.19 (-5.20)*	-0.54 (-37.68)*
Number of obs.	176	152	401	341
Adjusted R2	0.55		0.69	
BP test 1)	5.80* (p-value 0.02)		35.40* (p-value: 0.00)	
Test for residual AR 1		-3.27* (p-value:0.00)		-4.63* (p-value:0.00)
Test for residual AR 2		-0.60 (p-value:0.55)		0.31 (p-value:0.75)
Sargan test for instrument validity		19.74 (p-value: 0.99)		45.77 (p-value: 0.13)

1) The null hypothesis: the pooled OLS model is adequate against the random effects alternative.
**) Statistically significant at 5% level*

The results confirm the importance of domestic investment for economic growth and conditional convergence in Russian regions. In general the results do not differ much between low income and high income regions. The main difference is that in low income regions FDI has positive effect on economic growth while in high income regions it has negative effect. The some evidence is found that convergence among the low income regions is faster than in high income regions. The initial income variable coefficients estimates are larger is absolute terms for the low income group compared to the high income group.

6.2. Oaxaca-Blinder decomposition of economic growth difference

We use the Oaxaca-Blinder decomposition approach (see e.g. Wei 2005, Blinder 1973, Oaxaca 1973) to examine the contribution of control factors to the difference in GRP per capita growth between the two sub-samples. Originally Oaxaca-Blinder decomposition was proposed to analyze the contribution of factors to the wage gender difference. Here we adopt it for the macroeconomic analysis, i.e. in our study GRP per capita difference substitutes wage difference. By estimating a growth regression for the whole sample we cannot see the contribution of control variables to the regional specific convergence processes.

As predicted by neoclassical growth theory, the poor countries (here regions) tend to grow faster than richer ones. However in Russian regions for the analysed period this proposition is not true (see Table 7). The result also motivates use of the Oaxaca–Blinder method in analysing the factors that retard convergence across Russia.

Table 7. Growth rate difference between low income and high income regions

Mean of lower-income regions growth rates in the period of 1997-2005 (1)	0.056
Mean of higher-income regions growth rates in the period of 1997-2005 (2)	0.081
Difference (1-2)	-0.025

As long as the expected means of the error terms in the regressions for high and low income regions are both zeros, the total estimated difference in average GRP per capita growth between the sub-samples can be represented by

$$\overline{ln(y_{it}/y_{i,t-1})_{li}} - \overline{ln(y_{it}/y_{i,t-1})_{hi}} = \hat{\beta}`_l \overline{lnX_{li}} - \hat{\beta}`_h \overline{lnX_{hi}} \,. \qquad [9]$$

where $\hat{\beta}`_h$ and $\hat{\beta}`_l$ represent, respectively the estimated on pooled OLS[5] - estimation coefficients of regressions for higher-income and lower-income regions sub-samples (including constant). $\overline{lnX_{hi}}$ and $\overline{lnX_{li}}$ represent the averages of modeled factors of economic growth for the two sub-samples. The total estimated difference or gap can be further decomposed into the following three components:

$$\overline{ln(y_{it}/y_{i,t-1})_{li}} - \overline{ln(y_{it}/y_{i,t-1})_{hi}} = \hat{\beta}`_h(\overline{lnX_{li}} - \overline{lnX_{hi}}) + (\hat{\beta}`_l - \hat{\beta}`_h)\overline{lnX_{hi}} + (\hat{\beta}`_l - \hat{\beta}`_h)(\overline{lnX_{li}} - \overline{lnX_{hi}})$$
$$= E + C + CE \qquad [10]$$

[5] Oaxaca-Blinder decomposition was originally derived for classical OLS regression (see eg Yun, 2004). The GMM approach allows in theory for decomposition but some practical problems remain.

The first component on the right-hand side (E) is the portion of the gap due to the difference in structural and control factors. The coefficient component C is attributable to differences unexplained by these factors. CE is the interaction factor between these two components. Note that method also generates detailed decomposition results for individual regressors, i.e. specified factors of economic growth.

6.3. Difference in growth rates between high income and low income Russian regions: Factors of convergence

Table 8 reports the (predicted) difference decomposition of growth rates between lower-income and higher-income regions derived from estimations. As the results are based on pooled panel OLS estimation, the conclusions are preliminary and approximate. However since the relative importance of specified factors is similar in all estimations in Table 6. the inferences drawn can be useful.

Table 8. Predicted growth rates and decomposition of growth rates differences between lower-income and higher-income regions. 1997-2004

Mean predictions and predicted gap

Mean prediction for lower-income regions	0.065
Mean prediction for higher-income regions	0.080
Predicted gap	-0.015

Detailed linear decompositions

	Total	Factors	Coefficients	Interaction
Constant	-0.30		-0.30 (-0.90)	
$lny_{i,t-1}$	1.20	0.25 (7.00)*	0.85 (2.70)*	0.10 (2.60)*
$ln(I/N)_{i,t}$	-0.78	-0.25 (-6.70)*	-0.48 (-1.30)	-0.05 (-1.30)
$ln(Exp/N)_{i,t}$	-0.038	-0.04 (-1.20)	0.001 (0.10)	0.002 (0.06)
$ln(R/N)_{i,t}$	-0.01	0.001 (0.70)	-0.01 (-0.60)	-0.001 (-0.40)
ln(FDI/N)i.t	-0.13	0.13 (2.30)*	-0.13 (-2.50)*	-0.13 (-2.30)*
D_{1998}	0.012	0.002 (0.90)	0.01 (1.2)	-0.001(-0.12)

*Note: z - statistics in parentheses; * denote 5% significance level.*
Variances/standard errors of components are computed as in Jann (2005).

Although the mean predictions do not differ significantly across the sub-samples there is no evidence of the convergence process between high income and low income Russian regions. On the contrary higher-income regions tend to grow faster than lower-income regions. Nonetheless, the results in Table 8 are of some interest as they may help to shed light on the factors that retard convergence of poor regions to rich regions in Russia.

The difference in structural and control factors reveal that lower initial GRP per capita in poor regions stimulates convergence of poor regions to rich regions, i.e. the initial GRP per capita difference $(\overline{lny_{li,t-1}} - \overline{lny_{hi,t-1}})$, which is obviously negative in the analyzed period, decreases the gap of GRP per capita growth between rich and poor regions by 0.25. The result accords with the convergence proposition of neoclassical growth theory.

Smaller amounts of domestic investment in poor regions in comparison with rich regions retard convergence as expected, i.e. the decreasing domestic investment difference $(\overline{ln(I/N)_{li,t}} - \overline{ln(I/N)_{hi,t}})$, decreases the gap of GRP per capita growth between rich and poor regions by 0.25. However, the result for FDI is opposite, i.e. smaller amounts of FDI in poor regions in comparison with rich regions enhance convergence. This means that the FDI difference $(\overline{ln(FDI/N)_{li,t}} - \overline{ln(FDI/N)_{hi,t}})$, which is negative, multiplied by negative coefficient for FDI variable for higher-income regions $\hat{\beta}`_h$ gives a positive contribution of 0.13 to the gap of GRP per capita growth between rich and poor regions.

Coefficients decomposition part shows the unexplained difference in growth effects. They operate mainly via the initial income variable, positively influencing convergence process, i.e. $(\hat{\beta}`_l - \hat{\beta}`_h)$ and $\overline{lnX_{hi}}$, which are negative, decreases the gap of GRP per capita growth between rich and poor regions by 0.85.[6] The opposite result is obtained for the FDI variable. However the result for FDI variable is not reliable as $\hat{\beta}_{FDI,l}$ is not significant. The interaction decomposition result shows that initial income variable is the only significant and reliable one. In general we conclude here that only initial income and domestic investment can be considered as important factors of convergence across Russian regions.

7. Conclusions and policy implications

We examined empirically determinants of short-run economic growth in Russian regions in the transition period (1996-2004). We used modified Barro Sala-I-Martin empirical framework for the neoclassical production function model. Advanced Arellano-Bond estimation method was applied for dynamic panel data. The results suggested that initial conditions (conditional convergence), domestic investment and exports are the most important ones for stimulating economic growth in Russia. Of the other specified control variables, natural resource availability surprisingly not contributed significantly to short-run economic growth in Russian regions, although the Russian economy is traditionally considered to rely heavily on natural resources. The same result was found when we replaced the natural resources variable with the oil variable. A possible explanation is that natural resources (especially oil resources) influence short-run economic growth, not directly, but through the domestic investment and export variables.

For robust checking purposes we split our sample in two parts along the time dimension, e.g. 1996-1999 and 2000-2005 to analyze empirically whether the growth determinants have changed from the "low growth years" to "the high growth years". We found that while our specification performs very well for the first period, it presents

[6] Note that $(\hat{\beta}`_l - \hat{\beta}`_h)\overline{lnX_{hi}}$ corresponds to growth differences unexplainable by structural factors, i.e difference due to (unobserved) group differences.

the second period poorly. In the first period initial income, domestic investment, and export variables related significantly to economic growth in Russia while for the second period only export variable was statistically significant and positive. The explanatory power of the specification falls significantly in the second period as well.

We also divided the sample into two sub-samples along cross-sectional dimension – high income regions and low income regions. The main difference between the sub samples' estimates is that in lower-income regions FDI has positive effect on economic growth while in high-income regions it has negative effect. Growth convergence between poor and rich regions in Russia was not found for the period studied. Some results for the Oaxaca-Blinder (OB) decomposition of growth rate differences between higher-income and lower-income regions were provided. OB analysis produced some evidence on the relative magnitudes of different factors of convergence across Russian regions, e.g. that initial GRP per capita plays a major role here along with domestic investments. In general we conclude that lower initial GRP per capita and faster convergence speed contributes positively to the gap of GRP per capita growth between rich and poor regions while smaller domestic investment in poor regions contribute negatively to this gap.

Our results in general go along with previous empirical studies on the determinants of economic growth. Findings of conditional convergence, positive influence of domestic investment and export are quite usual in the economic growth literature, both theoretical and empirical. However it is a interesting result that in recent years the traditional specification performs very poorly and only export remains statistically significant. This sheds light on possible source of economic growth in Russia in recent years – oil and gas export. There is already a hot discussion among economists and politicians that recent signs of economic growth in oil and gas abundant Russia are mostly due to favourable oil prices in the world market and therefore oil and gas export. Our results give some support for such a position.

Our results have some important policy implications. First, export-led growth seems to be important in Russia during transition. Thus enhancing export Russian authorities boost the economic growth in the country. However Russian export mostly consists of oil and gas. This is especially evident in recent years. This option must be only temporary, and Russian policy-makers must find other inner sources for economic growth in the country. Second, FDI seems not to be important as a growth determinant in Russia. This challenges policy makers to improve federal (as well as regional) strategy towards foreign investors. Finally, in order to enhance economic growth in poor Russian regions the authorities must stimulate domestic investment in these regions.

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Appendix 1

The Resource Index was calculated using the following formula of integrated coefficient:

$$Resource\ index_{it} = \frac{1}{m}\sum_{j=1}^{m}\left[100*\left(\frac{F_{j,it}}{\overline{F_{jt}}}\right)\right].$$

where *i=1…..74* in period *t=1997…..2003*. $F_{j,it}$ is the actual resource indicator *j* for a region i in period *t*. $\overline{F_{jt}}$ is the sample mean of the indicator in period *t* (in our case the mean value for Russian regions, which is $\overline{F_{jt}} = \frac{1}{n}\sum_{i=1}^{n} F_{ijt}$. where *n* is the number of Russian regions involved in the computation(74)). *m* is the number of indicators included in the index computation (adopted from Ndikumana. 2000). Indicators. included in the computation of the resource index are presented in Table A1.1.

Table A1.1. Indicators included in the Resource Index

Indicator
Electricity production per capita. kilowatt - hour
Oil digging including gas condensate ¨per capita. thousands of tones
Natural gas digging per capita. millions cubic meters
Coal digging per capita. thousands of tones
Black metals production per capita. thousands of tones

Appendix 2

Table A2.1. Summary statistics of the dependent and explanatory variables used in baseline estimation: unbalanced data set for 74 Russian regions along the time period of 1996-2005

Variable	Mean	Median	Minimum	Maximum
ln(GRP/N)	-6.482	-6.520	-8.609	-3.871
Δln(GRP/N)	0.063	0.151	-1.421	1.526
ln(I/N)	-8.244	-8.272	-10.341	-5.386
ln(FDI/N)	-7.987	-5.495	-55.262	1.854
ln(NR/N)	-21.407	-5.086	-48.354	3.553
ln(EXP/N)	-1.433	-1.274	-6.397	2.105
Variable	Std. Dev.	C.V.	Skewness	Ex. kurtosis
ln(GRP/N)	0.629	0.0971	0.472	1.038
Δln(GRP/N)	0.3689	5.812	0.161	2.339
ln(I/N)	0.7262	0.088	0.428	1.129
ln(FDI/N)	10.774	1.348	-3.948	14.448
ln(R/N)	22.844	1.067	-0.294	-1.852
ln(EXP/N)	1.372	0.957	-0.458	0.217

Appendix 3

Table A3.1. Correlation matrix of variables used in baseline estimation. Unbalanced data set for 74 Russian regions along the time period of 1996-2005

	Δln(GRP/N)	Ln(I/N)	ln(FDI/N)	Ln(NR/N)	Ln(EXP/N)	D1998
ln(GRP/N)	0.334*	0.888*	0.330*	0.073	0.662*	0.057
Δln(GRP/N)	1	0.333*	0.025	0.008	0.179*	0.490*
ln(I/N)		1	0.329*	0.092*	0.614*	0.106*
ln(FDI/N)			1	-0.035	0.313*	0.075
ln(R/N)				1	0.102*	0.027
ln(EXP/N)					1	0.082*

** The level of significance is 0.05.*

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