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von

Vadim Kufenko

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Empirical Analysis of Regional Economic Performance in Russia: Human Capital Perspective[1]

Vadim Kufenko
Universität Hohenheim, Stuttgart
vkufenk@uni-hohenheim.de

Abstract

Having shown the important role of the Russian economy in the ex-USSR region by causality tests, we proceed to empirical analysis of growth and performance of the Russian regions. A dynamic panel data approach enabled us to obtain elasticity coefficients on proxies for convergence, physical capital, labour and innovation. After including human capital in the reformulated model we resolve endogeneity and reverse causality by introducing two instrumental variable approaches. Taking advantage of the Unified State Exam data we managed to successfully endogenize human capital by number (and share) of outperforming students and by the education index. The second approach helped to improve causality between instruments and human capital: the dates of first university foundation and distance to Moscow successfully explains human capital variations due to historical and spatial characteristics of a given region.

Keywords: growth regressions, regional analysis, human capital, system GMM, instrumental variables

JEL classification: C01, E24, O40, O47

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1. Introduction – Russian economy and its regional heterogeneity

It is important not to underestimate the impact of the fall of the Soviet Union, as a part of a complex transition process, on the economies of the region: the well established interregional and international links shaped by the Gosplan for decades and sustained by the political regime and system faced a severe shock when in 1991 the USSR started to deteriorate which resulted into 15 new independent states, the former Soviet Republics. The abolishment of Gosplan in April 1991 marked a start for the transition from a planned economy to market economic relations. Let us empirically consider the role of the dissolution of the Soviet Union for the economies of the ex-USSR republics – this can be performed by statistical tests on stationary of a selected economic performance proxies. The idea behind the stationary tests is based on a neo-classical concept of a growth path: in case if the series are stationary, the dissolution of the Soviet Union as a shock had caused only a temporal distortion, which could not cause the series to significantly diverge from the growth path. However, in case of non-stationary series, the economic performance may follow a random walk or a similar pattern and is subject to structural brakes and shocks which may cause a permanent divergence from a previous path. In the latter case, the dissolution of the Soviet Union, as well as other shocks, could have caused structural changes and the economic performance would now follow a different pattern.

Table 1. Stationarity of economic performance of the ex-USSR countries

Period: 1989-2010*	Dickey-Fuller		
	I (0)	I (0), trend	I (2)
Russia_GNI	0.9967	0.9288	0
Ukraine_GNI	0.7707	0.7734	0
Belarus_GNI	1	0.9187	0
Georgia_GNI	0.6518	0.0301	0.0006
Armenia_GNI	0.9821	0.2738	0
Azerbaijan_GNI	1	0.9873	0.2827
Estonia_GNI	0.9945	0.3402	0
Latvia_GNI	0.9817	0.2353	0.0005
Lithuania_GNI	0.9859	0.2108	0
Moldova_GNI	0.7525	0.7244	0
Kyrgyz_GNI	0.9879	0.8650	0.0150
Turkmenistan_GNI	1	0.2030	0
Tajikistan_GNI	0.9816	0.9520	0
Uzbekistan_GNI	1	1	0
Kazakhstan_GNI	1	0.0279	0.0002

*for Armenia, Belarus, Lithuania the period is 1990-2010; for Turkmenistan and Kazakhstan the period is 1993-2010; for Uzbekistan the period is 1992-2010

The augmented Dickey-Fuller unit-root test is a sufficient tool to make a statistical inference on whether the series are stationary. The proxy for economic performance is the GNI per capita in PPP USD obtained from the World Bank database – the selection of this particular proxy is due to specific theoretical assumptions of the Granger causality test, which will be applied in the further part of the research. The results for the non-differences data or iterated of order 0 suggest that all the countries of the former Soviet Union exhibit non-stationary economic performance which allows us to conclude that these economies are subject to permanent shocks including structural breaks and do not follow a stationary growth path. The inclusion of a trend variable in the test regressions yields similar results with an exception of Kazakhstan and Georgia, which appear to have a trend-stationary GNI per capita series. This could hint on a stationary growth path in these countries. However, the reason to such result may be a smaller sample for Kazakhstan, which starts at 1993, excluding the 'valley of tears' during 1990-1992 which is clearly mapped in the series with a longer span. Only after iteration of order 2, or second differencing, on the 5 percent level we can reject the null hypothesis of the test that the data have a unit root and are not stationary. In other words, after second differencing the GNI per capita series become stationary with an exception to Azerbaijan, which exhibits non-stationarity even after the second differencing.

Relying on the stationarity of the I(2) or second differenced series we can also check whether the old economic links, which were formed in the times of the Soviet Union, are still functioning and whether economies of the post-Soviet region still actively interact with each other. This can be done by Granger causality testing between the GNI series of the given countries. Instead of forming a matrix of causal relations we estimate the impact of Russian economic performance with regards to economies of other former USSR republics. Azerbaijan had to be excluded due to non-stationarity. It is essential to note that the Granger causality test was carried out only after the VAR models of the following type were estimated:

$$y_t = \alpha_0 + \alpha_1 y_{t-1} + \alpha_2 y_{t-2} + \alpha_3 x_{t-1} + \alpha_4 x_{t-2} + u_t \quad 1)$$
$$x_t = \beta_0 + \beta_1 y_{t-1} + \beta_2 y_{t-2} + \beta_3 x_{t-1} + \beta_4 x_{t-2} + v_t$$

where:

y_t - GNI per capita in PPP USD of country A at time period t

x_t - GNI per capita in PPP USD of country B at time period t

y_{t-1}, y_{t-2} - lags of y_t

x_{t-1}, x_{t-2} - lags of x_t

α, β - coefficients

u_t, v_t - shocks at time period t

The selection of the GNI per capita series is based on the fundamental principles of the Granger causality test as in Granger (1988), which state that the cause occurs before the effect. This can be rephrased in the following manner: present variations determine the future ones and future variations cannot determine the present ones. This assumption leaves expectations out of consideration, which can be a serious bias for the testing due to the fact that expectations may drive growth or slow it down. Since GDP per capita series are often forecasted and their expected growth rates are often publiclly available, the GNI series are less frequently quoted which allows us to assume that the role of expectations in case of GNI series is less significant.

Table 2. Granger causalities

Period: 1989-2010*	Granger-causality test results		
	----->	<-----	
Ukraine_GNI	0.302	0.005	Russia_GNI
Belarus_GNI	0.989	0.026	
Georgia_GNI	0.294	0.087	
Armenia_GNI	0.022	0.001	
Estonia_GNI	0.003	0.000	
Latvia_GNI	0.140	0.936	
Lithuania_GNI	0.154	0.008	
Moldova_GNI	0.880	0.325	
Kyrgyz Rep_GNI	0.436	0.014	
Turkmenistan_GNI	0.482	0.059	
Tajikistan_GNI	0.874	0.125	
Uzbekistan_GNI	0.145	0.436	
Kazakhstan_GNI	0.238	0.016	

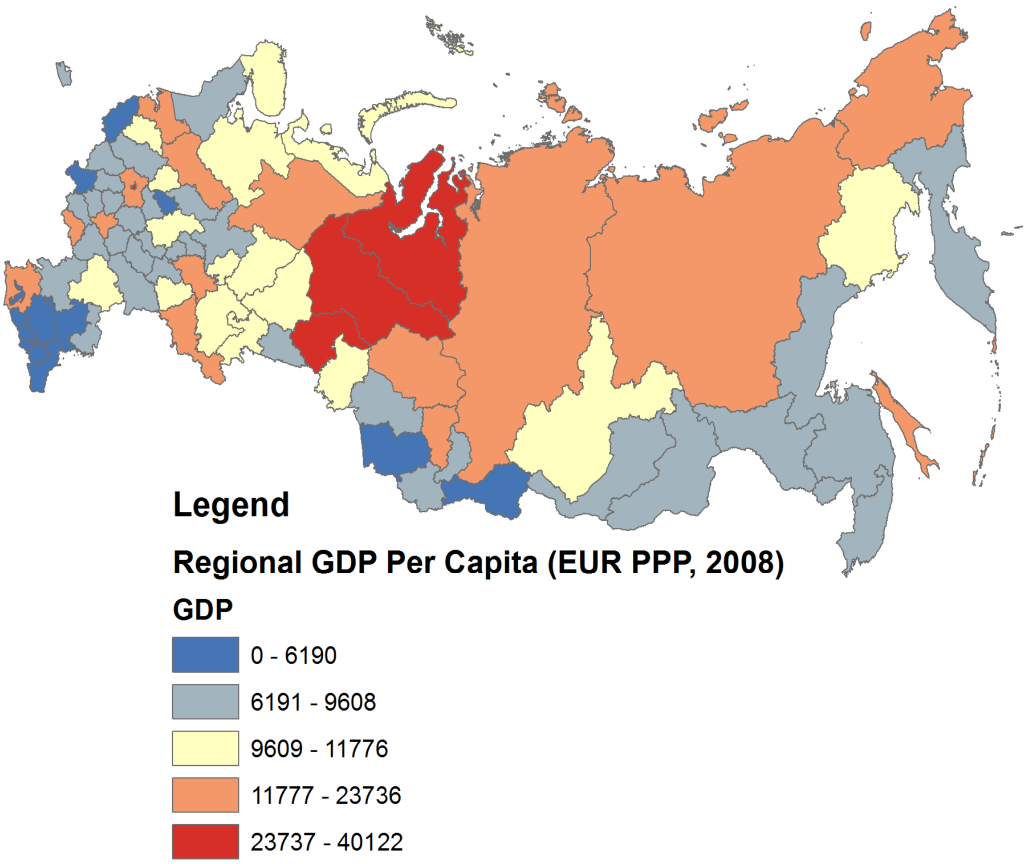
*for Armenia, Belarus, Lithuania the period is 1990-2010; for Turkmenistan and Kazakhstan the period is 1993-2010; for Uzbekistan the period is 1992-2010

The results obtained on the right side of the table point out that on a 5 percent level, the economic performance of Russia, measured by GNI per capita in PPP USD Granger causes the economic performance of Ukraine, Belarus, Armenia, Estonia, Lithuania, Kyrgyz Republic and Kazakhstan or 7 out of 13 ex-USSR republics considered. On a 10 percent level we can add Turkmenistan and Georgia to the list of 9 out of 13 countries. However, if we consider the left side of the table, economies of Armenia and Estonia may also Granger cause the developments of the Russian economy – in this case we observe a bi-directional causality. Keeping in mind that the Russian economy is one of the major economic actors in the region, the given Granger causalities reveal the fact that close interactions and economic connections between the former Soviet Union republics are still persistent.

Let us proceed from the aggregated empirics to a more detailed regional analysis of the Russian economy. Whereas macroeconomic empirical analysis is subject to certain measurement errors due to the fact that it disregards regional heterogeneity within a country, a regional empirical analysis would minimize the aggregated measurement error and yield a deeper understanding of determinants of economic growth with a specific focus on human capital or other factors.

Regional heterogeneity in the Russian Federation offers grounds for fruitful research on determinants of economic growth. Considering map 1 spatial distribution of GDP per capita can be displayed using 5 categories for simplicity. The last pre-crisis year of 2008 can be taken as a peak in economic growth which was followed by a severe contraction after 2009 when the global financial crisis had reached the real sector of the Russian economy.

Map 1. Regional economic heterogeneity



Data source: UNDP

An obvious leadership in economic performance, measured by GDP per capita as displayed in table 3, would most likely take place in two cases: extremely low population or extremely high GDP. Thus the leader in the GDP per capita list is Tyumen oblast rich in oil, gas and other resources, and having an extremely low population density of 2.3 people per sq. km[2]. A similar situation can be seen in Sakhalinskaya oblast, Republic of Komi and Chukotskij avt. okrug with the lowest population density of 0.069 people per sq. km. These regions are located in the Northern and North-Eastern parts of Russia.

The spatial heterogeneity of economic performance is obvious, however one may hesitate to state that raw resource extraction is the main determinant of regional wealth. There are numerous factors which could contribute: innovation and research, industrial output, human capital and knowledge, international and interregional trade and the last, but not the least, budget transfers and subsidies. In the framework of this research we will mainly focus on human capital, which we account as a decisive factor for growth and economic performance.

Table 3. Top-10 Regions (Euro PPP)

Rank	Region	UNDP_GDPpc in 2008
1	Tyumen oblast	40122
2	Moscow city	30832
3	Sakhalinskaya oblast	23735
4	Chukotksij avt. okrug	16620
5	Republic of Tatarstan	15767
6	Saint-Petersburg city	15392
7	Republic of Komi	14290
8	Lipetskaya oblast	13547
9	Belgorodskaya oblast	13323
10	Krasnoyarskij kraj	13177

Data source: UNDP

2. Research Background

Keeping in mind the scarcity of up to date empirical research on regional economic growth in Russia, we have considered the existing relevant literature in order to construct our proprietary approach avoiding such pitfalls as reverse causality and endogeneity and trying to capture the dynamics of growth.

In regard to Russian researchers, one of the most recent empirical paper on human capital as a determinant of regional growth is the work of A.V.Koritzky (2007, p. 180-187) and its more detailed version of 2010. The latter version includes various regional cross-section regressions based on the following neo-classical model:

[2] The density is derrived from 2010 Population census and 2010 spatial data from Rosstat.

$$\ln Y_i = \ln A + \alpha \ln K_i + \beta \ln L_i + \gamma \ln H_i + aX_i + \varepsilon_i \qquad 2)$$

where:
Y_i - is an income or income per capita proxy
A - is a constant
K_i - physical capital proxy
L_i - number of people employed
H_i - educational level of the employed
X_i - various controls including regional dummies

The author considers quantitative and qualitative characteristics of human capital in one regression model, treating human capital proxies as exogenous. From the cross-section regressions from 2000-2008, A.V.Koritzky (2010) concludes that the educational level of the employed is one of the main determinants of the regional income variations. A similar framework was used in an earlier work of Lugovoy, E. Astafyeva, D. Polevoy, A. Kozlovskaya, P. Trunin, L. Lederman (2005) where the authors restricted the empirical analysis to the neo-classical growth model. Acknowledging the contribution of the above mentioned authors, we will refrain from this approach due to development reverse causality and endogeneity of human capital proxies in this model. Nevertheless the neo-classical growth model has become widely used in regional analysis which is evident from L. Pelkonen & S. Ylonen (1998) where regional growth and education levels in Finland are considered, S. Coulombe and & J. Tremblay (2001) where regional growth and human capital accumulation in the Canadian regions is analyzed and C. Cardoso & E. J. Pentecost (2011) focusing on regional growth and human capital represented by schooling in Portugal on a NUTS III level.

Another approach for regional empirical analysis is known as a ‘Mincer wage equation’ (Mincer, 1974), where the dependent variable is not economic performance but rather income or regional income and wage income. In this strategy income is used as a dependent variable and human capital proxies as exogenous ones. This approach was also used by A.V.Koritzky (2010, pp. 207-217) in order to show that human capital represented by education levels significantly impacts regional income variations.

It appears that in most empirical literature on regional growth, human capital is treated as a positive exogenous variable and its various quantitative and qualitative characteristics are used as proxies. The choice of these proxies is rather limited and includes years of schooling, enrolment or proxies for education levels. We detect four major issues arising from the traditional approach. Firstly, it is essential to consider dynamic models which capture variations in time and across regions. Secondly, the reverse causality: naturally human capital can determine economic performance. However, economic performance can also stimulate human capital by inducing investments into human capital and thus causing a reverse causality bias for empirical estimations. In addition, reverse causality between growth and education has been broadly mentioned in specific literature including Aghion and Howitt (2009, p 288) as a serious challenge to empirical analysis. Thirdly, human capital may not only be treated as an exogenous variable, but as an endogenous one. Indeed, one cannot aggregate human capital in one single variable or select a proxy without loosing the precision of estimation or encountering a severe econometric bias. Fourthly, the only true causal instruments for human capital should be the ones which not only explain a certain share of endogenous variations, but also cause or predetermine human capital, for example, historical instruments.

3. Empirical Strategy

For the framework of our research, we have selected the neo-classical model which we have tailored in a special manner to avoid problems related to empirical analysis. This does not mean that the empirical analysis was carried out strictly according to the growth theory - the specification of the models were rather based on preliminary empirical findings and the usage of instrumental variables such as school graduation results or dates of foundation of the first universities can be considered as a necessary deviation from the canonical growth regressions in order to circumvent empirical issues and improve the quality of results.

In the beginning, we formulate a dynamic panel data model based on economic growth theory. The idea is simple: to check for convergence by using lagged growth and to obtain the elasticity coefficients for growth factors using two-step system GMM (General Method of Moments) ensuring most efficient results. The dynamic elasticity coefficients will help us to establish the role of labour as a determinant for regional growth. Focusing on quantitative variables such as labour will not be sufficient for our paper so we will proceed to the next model in order to use endogeneous human capital as an explanatory variable for economic performance.

The first attempt to use human capital as a determinant of economic performance in the context of this paper is to instrument human capital with ability and schooling proxies. Due to certain specifications of the model the first approach has several drawbacks among which are: absence of time-constant variables due to within, or fixed-effects transformation, usage of lags (which is a common practice, however, in theory can violate the exogeneity assumption) and the fact that graduation test results may not solely determine human capital levels. In order to circumvent these issues, another regression was made to include time-constant variables such as GDP level at the start of the series and to use historical/spatial instruments for human capital such as a date when the first university in the region was established and the distance to Moscow. These instruments are supposed to have a stronger causal relationship to human capital.

4. Data

In order to estimate the dynamic panel data model we use a panel of 80 Russian regions for a time period of 1995-2007. However, due to differencing and specifications of the final version of the dynamic panel data model only 405 observations from 65 regions were used for the system GMM estimation. All the data for the dynamic model were taken from Goskomstat database.

For the first instrumental approach with educational instruments we have used a panel data on 80 Russian regions for 2007-2008. The data were acquired from UNDP, Goskomstat and EGE (Unified State Exam data) which allowed us to consider endogenous variations of human capital.

The second approach with historical and spatial instruments required the usage of the federal web-based database of higher education entities and various geographical references including the matrix of distances created by A. Abramov (1965). The usage of time-constant variables limited the dimensions of the estimation to 2007 keeping the same number of regions as in the first instrumental approach, 80.

5. Empirical analysis

5.1 Dynamic panel data approach

Since economic growth is a dynamic process, we require a dynamic model which exploits both: regional heterogeneity and time-series. By using a panel data structure we face severe limitations such as strict or weak exogeneity which would not allow us to use the lagged dependent variables as explanatory ones. A simple fixed effects or a first difference model would comply with exogeneity assumption but would not fully capture the dynamics or, as in case of first differencing, causalities. The most appropriate approach would be the Arellano-Bond estimator or the more asymptotically efficient version of it – the Blundell and Bond system GMM estimator. The statistical package used for the system GMM estimation was created by Roodman (2005).

The given estimator performs a first-differencing transformation and creates a system of two equations: the level equation (original one) and the difference equation. The variables in these equations are then instrumented by their lagged levels and differences depending on the settings: for example, for the difference equation the differences of exogenous variables instrument themselves whereas the levels of predetermined variables serve as instrument for the variables which are assumed to be endogenous; for the level equation the levels of the exogenous variables are used as instruments for themselves whereas the differences of the endogenous ones are used to instrument the levels of the variables assumed to be endogenous.

$$\log\_gdppc_{i,t} = C + \beta_1 \log\_\overset{*}{gdppc}_{i,t-1} + \beta_2 \log\_privratio_{i,t} + \beta_3 \log\_\overset{*}{privratio}_{i,t-1} + \beta_4 \log\_fixinvpc_{i,t} + \beta_5 \log\_created\_tech_{i,t} + \beta_6 X_{i,t} + e_{i,t} \quad 3)$$

where:

$\log\_gdppc_{i,t}$ - real GDP per capita at time period t

$\log\_\overset{*}{gdppc}_{i,t-1}$ - lag of real GDP per capita, treated as predetermined

$\log\_privratio_{i,t}$ - ratio of privately employed to total employed at time period t

$\log\_\overset{*}{privratio}_{i,t-1}$ - lag of the ratio of privately employed to total employed, , treated as predetermined

$\log\_fixinvpc_{i,t}$ - real fixed investments per capita

$\log\_created\_tech_{i,t}$ - created technologies

$X_{i,t}$ - vector of time period controls (time period dummies)

$e_{i,t}$ - composite error term (idiosyncratic error and unobserved effects)

In order to exercise due diligence we run a two step robust estimation with a Windmeijer (2005) correction of standard errors – the two step estimation is asymptotically efficient and robust to whatever patterns of heteroskedasticity and cross-correlation as in Roodman (2009), however since the standard errors after the two step procedure are downward biased and thus the significance of our variables boosts up, we have to use robust standard errors as suggested by Windmeijer (2005) which can make the robust two step results modestly superior to the results of a robust one step estimation as per Roodman (2009).

One serious issue which is encountered by many researchers when applying the system GMM estimation is the usage of an extremely large number of instruments which weakens the Hansen test statistics and may cause the two step covariance matrix to become singular. The latter leads to the use of generalized inverse to calculate the optimal weighting matrix which can make the difference-in-Sargan/Hansen statistics negative. While the dataset is itself large, the model specification slightly reduces the number of observations, as well as differencing. As a result, in the first column we present the estimations with a limited number of lags for the instruments, used to explain the predetermined variables. In the first case the estimation was carried out on 405 observations from 65 regions and using 61 instruments. The number of instruments turned out to be over-proportionate and the logical decision was to selectively reduce them or collapse them to use less moment conditions as instruments and thus dramatically decrease the width of the instrument matrix: ‘collapse’ option divides the GMM moment conditions into groups and sums the conditions in each group to form a smaller set of conditions as in Roodman (2005). Once collapsed the number of instruments used decreases from 61 to 17 which appears to be plausible and does not create any notable issues in estimation or for the difference-in-Sargan/Hansen statistics. Collapsing the instrument matrix is a common practice: for example, it was implemented in Cassimon & Van Campenhout (2007). The statistical package xtabond2 used in this paper is also implemented for our research.

Another note which is essential to make: for the un-collapsed estimation the lag limits from 2 to 4 were set (in order to limit the number of instruments used), whereas the ‘collapse’ option enabled us to broaden the lag limits from 2 to 7. In addition, to eliminate the autocorrelation in first differences, which arises from the dynamic structure of the model, we have included the time period dummies as performed in Bond, Hoeffler, Temple (2001). With regard to the instruments used, the predetermined variables were instrumented by levels in the difference equation and by differences in the level equation. Other variables, considered as exogenous were instrumented according to the equation: with differences in difference equations and with levels in the level equation.

Considering the endogenous and predetermined variables, the first astonishing empirical finding is the absence of convergence among regions. As it was noted in Arnold, Bassanini, Scarpetta (2010), the lagged GDP per capita coefficient can be a proxy for convergence – the negative sign in that case would show that the GDP per capita growth decreases after reaching higher levels of the growth path. The absence of convergence may hint at two things: either the regions find themselves at the beginning of the growth path where the convergence effect may be absent or the lagged GDP per capita is simply a proxy of expectations which play a positive role for the dynamics – in the latter case the convergence hypothesis is irrelevant.

Table 4. Dynamic panel data model

VARIABLES	(3, uncollapsed) logrealgdp	(3, collapsed) logrealgdp
L.logrealgdp	0.861***	0.717***
SE	*(0.0432)*	*(0.0948)*
Z-stat	*19.92*	*7.562*
log_fixinvpc	0.0999***	0.191***
SE	*(0.0259)*	*(0.0638)*
Z-stat	*3.856*	*2.991*
log_privratio	14.04***	13.21*
SE	*(4.799)*	*(7.156)*
Z-stat	*2.925*	*1.846*
L.log_privratio	-13.33**	-14.50*
SE	*(5.381)*	*(7.972)*
Z-stat	*-2.478*	*-1.819*
log_created_tech	0.0122**	0.0228***
SE	*(0.00564)*	*(0.00818)*
Z-stat	*2.157*	*2.794*
Constant	0.830***	1.461***
SE	*(0.257)*	*(0.460)*
Z-stat	*3.235*	*3.174*
Time controls	Yes	Yes
Observations	405	405
Number of code	65	65
Number of instruments	61	17
Arellano-Bond test for AR(2)		
Z stat.	-1	-1.12
Pr > Z	0.318	0.262
Sargan test of overid. restrictions		
Chi2 stat.	61.41	5.38
Pr > chi2	0.174	0.716
Hansen test of overid. restrictions		
Chi2 stat.	47.28	4.22
Pr > chi2	0.660	0.837
Difference-in-Hansen tests of exogeneity of instrument subsets		
GMM instruments for levels		
Hansen test excluding group		
Chi2 stat.	32.07	2.33
Pr > chi2	0.656	0.887
Difference (null H = exogenous)		
Chi2 stat.	15.21	1.89
Pr > chi2	0.509	0.389
Standard instruments		
Hansen test excluding group		
Chi2 stat.	45.63	2.91
Pr > chi2	0.649	0.820
Difference (null H = exogenous)		
Chi2 stat.	1.66	1.31
Pr > chi2	0.437	0.518

Standard instruments

*** p<0.01, ** p<0.05, * p<0.1

A more exact measure of convergence could be the GDP per capita levels dated back to the 1950s or even to the beginning of the 20th century as can be found in empirical regional analysis of convergence in Sala-i-Martin (1996). However this approach is not valid for system GMM due to the fact that such levels would be time-constant variables. Moreover due to reallocation of regional borders and several monetary reforms obtaining such levels at high precision would be problematic. Another relevant research on the topic can be found in Drobyshevsky, O. Lugovoy, E. Astafyeva, D. Polevoy, A. Kozlovskaya, P. Trunin, L. Lederman (2005). Whereas the authors do not find the σ-convergence and state that regional disparities only increase over time, they were able to find β-convergence using the time frames 1994-2002 and GRP series, known as the physical output index, instead of GDP per capita. They were able to get a negative coefficient on the 1994 GRP levels. However we would like to note that using GRP index which denotes physical output may not precisely hint on β-convergence, because in this case the theoretical formulation of the growth model, which is based on GDP per capita, would be violated. We consider these findings rather debatable from the empirical and theoretical points of view, however, for the sake of objectivity we needed to additionally discuss alternative findings.

The ‘privratio’ is an assumed proxy for the employed labour. We will further proceed to deepen the analysis of human capital as a determinant for economic performance. However, at this point it is important to note that the given proxy of labour has a significant and positive impact on GDP per capita growth. The ratio provides additional information – the increase of the share of privately employed to total number of employed (including state run corporations) has a positive effect. This effect captures the importance of the private sector in the regional economies.

Regarding the exogenous variables, the coefficient of fixed investments per capita is positive and significant on all levels which suggests that capital and fixed investments are decisive for regional economic growth. Another interesting observation is a significant positive role of innovation or its proxy, the number of created technologies. Both results are intuitive, nevertheless we have to highlight the important role of physical capital and innovation as growth determinants for the Russian regions.

We have established the fact that fixed investments, privately employed labour and created technologies are positive determinants of growth. Let us note that both privately employed labour and created technologies are indirectly related to human capital: for example, obviously for creation of new technologies, knowledge and education are needed; productivity of privately employed workers can be a result of better skills and education. On the other hand, we have insufficient information to make such statements from the given model: created technologies may be a result of a complex innovation process which cannot be solely attributed to human capital, and privately employed workers productivity may be explained simply by the fact that private companies can in general be more profit oriented in contrast to state owned companies which can be restricted by certain objectives from the government. Without further speculations let us proceed to a different approach and focus on human capital and its endogeneity which was not sufficiently considered in the dynamic panel model.

The broadest definition of human capital was formulated by Becker as ‘expenditures on education, training, medical care, [...] produce human, not physical or financial, capital because you cannot separate a person from his or her knowledge, skills, health, or values the way it is possible to move financial and physical assets while the owner stays put’ (Becker | 1993, p. 16). Another conventional definition may sound more precise: ‘human capital is defined […] as the knowledge, skills, competencies and attributes embodied in individuals that facilitate the creation of personal, social and economic well-being’ as per Keeley (2007, p. 29).

According to Barro (2001), human capital can sustain growth and convergence due to an assumption that human capital facilitates generation and absorption of new technologies which can improve the efficiency of physical capital. Moreover, Barro mentions quantitative and qualitative characteristics of schooling to serve as significant determinants of economic growth across countries.

Acknowledging a significant role of human capital on a cross-country level, we would like to focus on the role of human capital and its aspects for the regional growth in Russia.

5.2 Endogenous human capital – ability to outperform and schooling approach

The first attempt to endogenize human capital requires a short introduction in order to explain the idea of the approach. We suggest considering both aspects of human capital: ability and schooling. Thus, the instrumental approach will allow us to elegantly deal with reverse causality and endogeneity: by endogenizing human capital for our growth model we will use only the variation of human capital which is explained by ability and schooling to avoid reverse causality.

The proxies of schooling can be selected without hesitations – these could be education levels, years of education, number of students, graduates or other variables such as education indexes. However, measuring ability is a more sophisticated task. For the latter, we have decided to use the data on the Unified State Exam, which, in our opinion, reflects an ability to outperform – a certain positive qualitative characteristic of human capital. The data on the Unified State Exam are a crucial part of our empirical strategy, and therefore it is necessary to examine the details of this evaluation procedure, which is also claimed to be one of the key elements of educational reforms in modern Russia.

The introduction of the Unified State Exam in Russia can be considered as a bright illustration of institutional transplantation, which can be defined as adoption of institutions originating from a different environment (Polterovich V.M., 2001, p. 24). In addition, one may note that such transplantation is an integral part of economic and institutional transition which Russia is experiencing. The testing system itself is transplanted from the Western countries such as the USA, France and others. The Unified State Exam procedure combines both school graduation and enrolment exams – this similarity can be found in Germany, Finland, Estonia and other European countries with similar 'maturity exams'. Surprisingly in the USA, which is often claimed to be an example for the Russian Unified State Exam, tests for school graduation and tests for the University enrolment such as SAT and ACT are completely different exams. Another interesting fact is that the Unified State Exam reform has Soviet roots in the form of the Federal Test Center, founded in 1990. This institution did not play a significant role until it became the core of the Unified State Exam reform in 2001, when the first experimental exams were designed and conducted by its representatives.

Prior to the introduction of the given exam, school graduation examination was conducted and assessed at the school level. The type and content of exams were determined by the regional educational authority. However, the assessment scheme was not clearly defined. School graduation exams were followed by enrolment exams in secondary or higher education entities, which were organized locally as well without centralized assessment. The system allowed for subjective loopholes and a certain degree of flexibility of assessment and thus graduation and enrolment procedures. Considering the fact that out of total corruption in the sphere of education, 3.3 percent is attributed to primary education and 21.4 percent to higher education (A. Starodubzev, 2011, p. 9), the flexibility offered by the old system could endorse a certain degree of corruption, especially at the enrolment phase. In addition, enrolment examination varied from one university to another which created additional issues in preparation since a student had to prepare for both graduation and enrolment exams simultaneously. This could be problematic due to the fact that the geographical location of the school and the university could be completely different and thus the Unified State Exam could help to decrease geographical barriers for university applicants.

Keeping in mind the above described drawbacks of the old examination system, the initial objectives of the Unified State Exam can be summarized as follows:

1) to centralize school graduation exams and knowledge assessment

2) to synchronize graduation and enrollment procedures

3) to decrease the subjectivity in the assessment procedures and thus decrease corruption in education

4) to improve the distribution of human capital among education levels

5) to create a universal benchmark for analysis of education on regional, municipal and school levels

Whereas the first three objectives are reasonable improvements as quoted by A. Starodubzev (2011, P. 7-9), points 4 and 5 need clarification. Firstly, the distribution of human capital after the introduction of an objective evaluation system would be more optimal due to the fact that school graduates will be distributed among higher education entities according to a more objective evaluation of their knowledge and abilities, compared to the old system. In addition, the Unified State Exam could help to avoid educational ‘bubbles’, or over proportionate graduation of certain specialists which would result in oversupply of the latter on the labour market. Secondly, the Unified State Exam would help to analyze and compare education, knowledge and ability of school graduates in various parts of Russia.

The Unified State Exam is seen by many as an integral part of the education reform in Russia, in addition to the reform of school financing and management, merging under numbered schools and introduction of educational vouchers. The concept of the reform was shaped in 2000 making it one of the first reforms conducted by Putin’s government. Its experimental status allowed for continuous reshaping of exam formats and procedures. The starting point of the official reform was the state decree of 16th February 2001 ‘On the organization of the experiment of the introduction of the Unified State Exam’. Next year, on the 5th of April 2002, another decree followed: ‘On the participation of secondary education entities in the experiment of the introduction of the Unified State Exam’. These two steps formed the grounds for the organization of the school graduation exam and secondary and higher education matriculation procedures. The Unified State Exam was gradually introduced starting from 5 regions in 2001 and finishing with 83 regions in 2008. The number of universities, which accepted the Unified State Exam results for matriculation, increased dramatically from 16 in 2001 to 1650 in 2008. The corresponding amendments to the ‘Law on Education’ and the ‘Law on higher and post-graduate education’ became effective on the 1st of January 2009 making the Unified State Exam obligatory and the only legitimate school graduation exam. In addition, the amendments obliged secondary and higher education entities to use the results of the Unified State Exam for enrolment of new students.

Table 5. Introduction of the Unified State Exam

Year	Participants	
	Regions	Universities
2001	5	16
2002	16	123
2003	47	464
2004	65	950
2005	78	no data
2006	79	no data
2007	83	no data
2008	83	1650

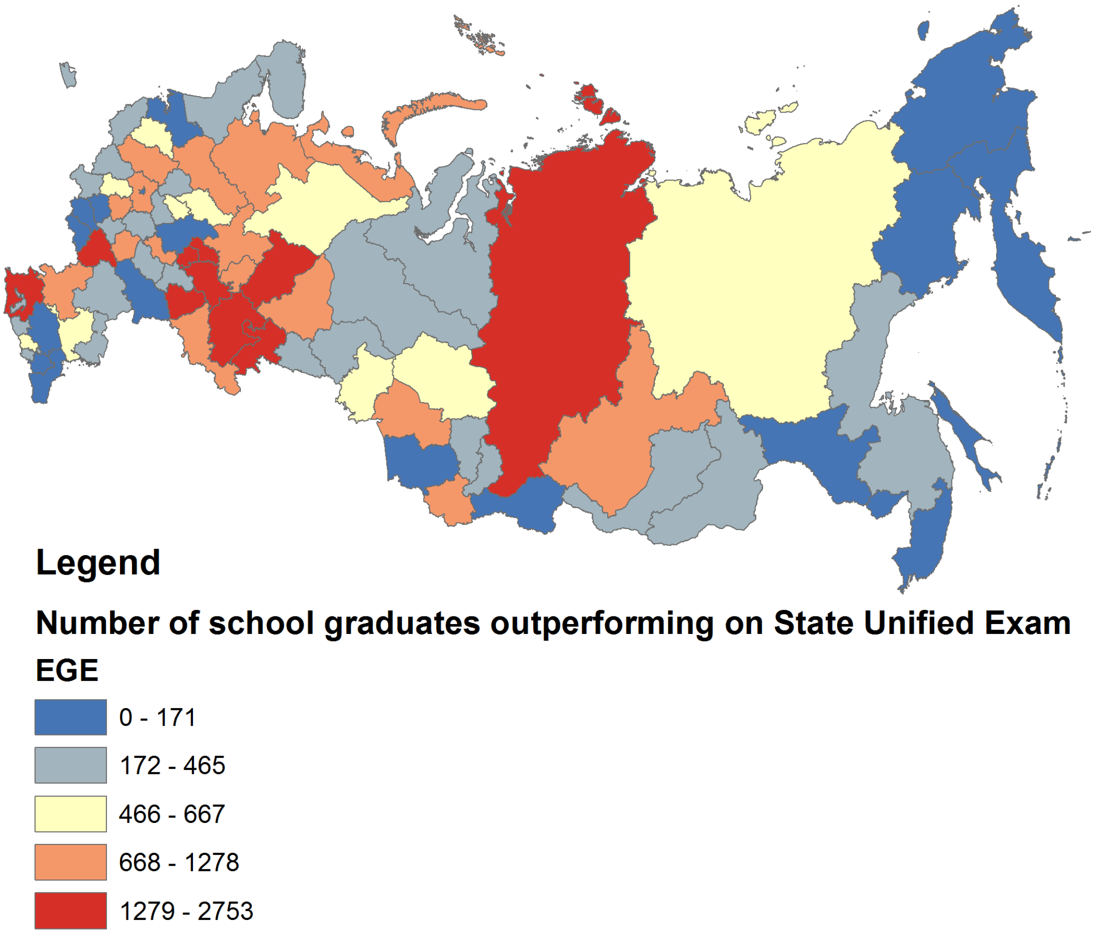
Data source: Starodubzev A.V. (2011)

The experiment status of the reform actually ended in 2008. As a result, modern Unified State Exam is held in the following subjects: Russian language; mathematics; Russian literature; physics; chemistry; biology; geography; history; social sciences; foreign languages (English, German, French and Spanish) and informatics (informational technologies). Russian language and mathematics are an obligatory minimum and the selection of other exams depends on the future specialization of the graduate. Maximum relative test points are always 100 per subject. However, minimum benchmark slightly varies from one year to another. Each subject exam contains 3 levels according to the complexity of the answers: A – multiple choice, B – expanded answer, C – argumentation or an essay. Thus, scoring above 200 points in 3 subjects is considered as outperforming and scoring 250 and above 275 is exceptional performance. Let us display the spatial distribution of school graduates who scored above 200 points in 3 subjects – this can be seen in map 2. The distribution of absolute numbers using 5 categories does not significantly differ from the distribution of the relative shares of outperforming school graduates to total participants. Due to this fact we display an absolute number as a representation of spatial distribution of the human capital stock or the stock of outperforming graduates.

The Unified State Exam is organized by the federal educational supervision authority ‘Rosobrnadzor’ in cooperation with the regional State Examination Committee which incorporates representatives of schools, universities and other educational entities in the region. The Appeal Committee and observers have a legislative status enforcing the transparency of the examination procedures.

Nevertheless, the Unified State Exam is actively criticized for remaining corruption loopholes, for example, according to certain sources, there were cases of test results leakage in internet prior to the examination day. Other heavily criticized aspects include: simplification of school teaching, when the last years of school turn into sole preparation for the Unified State Exam, diverging from the traditional school program; inadequate evaluation of knowledge through the test system of multiple choice; redistribution of corruption from the local to regional level at which the tests are created and evaluated.

Map 2. Outperforming school graduates



Data source: Unified State Exam Statistical Data Base

The data on the Unified State Exam have not been exploited before in the framework of regional growth analysis, and as we will see from the results, this dataset can be used as a valid instrument for human capital in growth regressions.

In a base model (1) we use a customized growth regression with a robust Fixed Effects (FE) estimator using UNDP human capital index as an exogenous variable and controlling for resource and innovation background. We should note that by using a FE estimator and time-demeaning procedure to eliminate unobserved regional effects, our growth model looses dynamics and turns into a static model explaining economic performance rather than growth.

The results suggest that human capital index is a positive determinant of regional GDP per capita which is significant on all levels. Interesting to note, that resource background, for which oil and gas extraction quantities are used as a proxy, is more significant (on all levels) than innovation background proxy, which in our case constitutes a number of persons involved in research activities (significant only on 5 percent level). A robust FE estimator allows us to cope with the unobserved effect and heteroscedasticity in addition to serial correlation (Wooldridge, P. 275). The latter is not an issue since only two years 2007-2008 are used. Nevertheless, this estimator does not resolve reverse causality and endogeneity of human capital.

In attempt to deal with the empirical issues we have developed the following model:

GDP and Endogenous Human Capital (approach 1)

$gdp_{i,t} = \beta_0 + \beta_1 I\_hucap*100_{i,t} + \beta_2 oi\lg as_{i,t-1} + \beta_3 researchers_{i,t-1} + \sigma_i + \varepsilon_{i,t}$	FE (4.1)
$I\_hucap*100_{i,t} = \alpha_1 oi\lg as_{i,t-1} + \alpha_2 researchers_{i,t-1} + \alpha_3 EGE_{i,t} + \alpha_4 I\_educa*100_{i,t} + \sigma_i + \mu_{i,t}$	First Stage (4.2)
$gdp_{i,t} = \hat{\beta}_1 I\_hu\hat{c}ap*100_{i,t} + \hat{\beta}_2 oi\lg as_{i,t-1} + \hat{\beta}_3 researchers_{i,t-1} + \sigma_i + \hat{\varepsilon}_{i,t}$	IV FE, 2SLS (4.3)

where:

$gdp_{i,t}$ - regional GDP per capita in PPP USD (UNDP)

$I\_hucap*100_{i,t}$ - Human Development Index (UNDP)

$oi\lg as_{i,t-1}$ - oil and gas extraction (thsd. tonnes)

$researchers_{i,t-1}$ - number of researchers engaged RD activities per 1000 population

$EGE_{i,t}$ - number of school graduates who scored more than 200 points in the Unified State Exam

$EGE\_share_{i,t}$ - *share of school graduates who scored more than 200 points in the Unified State Exam - replaces* $EGE_{i,t}$ *in equations (4.4) and (4.5) in the estimation table*

$I\_educa*100_{i,t}$ - Education Index (UNDP)

σ_i - unobserved regional effects

$\varepsilon_{i,t}$ - idiosyncratic error

A brief description of the variables used is necessary to shed light on the empirical strategy. A proxy for economic performance, used as a dependent variable in (4.1), (4.3) and (4.5), is GDP per capita in USD according to Purchasing Power Parity (PPP). As a proxy for human capital, the UNDP human development index is used. The human development index is calculated with regards to personal income, education level and life expectancy of regional population (National Human Development Report in the RF, 2010, P. 152). Endogeneity and reverse causality are obviously relevant issues for this determinant of regional economic performance and thus in the first stages the following instruments will be used: a number of outperforming school graduates who scored more than 200 points in the Unified State Exam (for equation (4.2)); a share of outperforming school graduates who scored more than 200 points in the Unified State Exam (for equation (4.4) – see estimation table); UNDP index for education which incorporates literacy levels and a share of young people involved in studies aged from 6 to 23 (for equations (4.2) and (4.4)). In addition, we control for resource background using lagged oil and gas extraction quantities and, to account for an innovation background, we use the number of researchers involved in research and development activities.

A note on using the lagged exogenous variables is necessary. The violation of exogeneity assumption in this case may not necessarily occur. It is a rare practice to use a model with such specification, however one can still find such set up, for example in Wooldridge (2002, pp. 255-256). The purpose of such specification is to obtain the causal effect of the resource and innovation background proxies and thus avoid simultaneous reverse causality between these proxies and the output.

Thus, robust 2SLS FE estimation was implemented in order to endogenize human capital index by the Unified State Exam results as a proxy for ability and UNDP education index as a proxy for schooling. To be precise, the variable $EGE_{i,t}$ in equation (4.2) represents the number of school graduates who scored more than 200 points in 3 exams which is a 'better than average' score for the Unified State Exam. In order to exceed 200 points in 3 exams only schooling may not be sufficient – due to this fact we have selected this variable as a proxy for ability in general or an ability to perform better than average. In order to ensure the reliability of the obtained results, we have additionally used the share of outperforming school graduates.

As expected, resource and innovation backgrounds are irrelevant for human capital. However, number of outperforming school graduates according to the Unified State Exam and the education index is significant on all levels. The Hansen test for over-identification (an analogue of the Sargan test) produces the p-value of 0.5287 which suggests that selected instruments are exogenous to the IV equation (4.3) and thus are not impacted by the shocks which affect GDP per capita making them valid instruments.

The exogeneity of ability proxies, used as instruments for human capital, is statistically sound and essential for our estimations. However, it is a depressing discovery since it appears that ability of young graduates to outperform is irrelevant to regional economic performance.

Table 6. Ability and schooling approach

	(4.1)	(4.2)	(4.3)	(4.4)	(4.5)
	(FE)	**First Stage**	**(IV)**	**First Stage**	**(IV)**
VARIABLES	**GDP**	**l_hucap_100**	**GDP**	**l_hucap_100**	**GDP**
l_hucap*100	1 266***		1 143***		1 155***
SE	*(103.6)*		*(133.3)*		*(132.2)*
T-stat	*12.22*		*8.581*		*8.735*
L.oilgas	0.287***	0.0000197	0.285***	0.0000295	0.285***
SE	*(0.0541)*	*(0.0000661)*	*(0.0452)*	*(0.0000671)*	*(0.046)*
T-stat	*5.304*	*0.299*	*6.307*	*0.439*	*6.207*
L.researchers	0.238**	0.0000467	0.231*	0.0000349	0.231*
SE	*(0.114)*	*(0.0000675)*	*(0.126)*	*(0.0000647)*	*(0.125)*
T-stat	*2.092*	*0.692*	*1.828*	*0.539*	*1.85*
EGE		0.0007007***			
SE		*(0.0002009)*			
T-stat		*3.489*			
EGE_share				0.1276443	
SE				*(0.0334263)*	
T-stat				*3.818*	
l_educa*100		0.9517519***		0.9671451	
SE		*(0.1653524)*		*(0.1336078)*	
T-stat		*5.756*		*7.238*	
Constant	- 92 629***				
SE	(8453)	suppressed		suppressed	
T-stat	-10.96				
Observations	160	160	160	160	160
Number of code	80	80	80	80	80
R-squared	0.798	0.481	0.791	0.497	0.792
Hansen (p-value)			0.5287		0.2218
First stage (F-test (2, 76) p-value)		0		0	
First stage (F-test (2, 76)		34.01		50.92	

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

The first stage (4.2) helps to explain approximately 48 percent of regional variation of human capital index by the Unified State Exam results and education index. The IV equation (4.3) accounts for 79 percent of variation using only that part of the human capital index which is explained by proxies for ability and schooling in the first stage. The coefficient of human capital index is still significant at all levels decreasing from 1 266 in the base equation (4.1) to 1 143 in the IV equation (4.3). The T-statistics has decreased from 12.22 to 8.581. As a result, a 0.01 increase of the human capital index (or a one unit increase of the human capital index * 100) explained by proxies for ability and schooling, would lead to an increase of the regional GDP per capita by 1 143 PPP USD according to PPP in 2008 or by 926 PPP

EUR. In addition, a relatively high F-statistics of 34.01 after comparing with Stock-Yogo critical values (Stock-Yogo (2005)) allows us to state that the problem of weak instruments is not highly relevant in our case.

Similar results are obtained by changing the number of outperforming students to the share in total. In this case, the first stage equation (4.4) has a better explanatory power explaining almost 49 percent of human capital variation. The share of outperforming school graduates, as well as the UNDP education index, is more significant giving higher F-test statistics of 50.92 for the first stage. Nevertheless, the Hansen test statistics is slightly lower, suggesting that instruments are still valid and exogenous. Equation (4.5) coefficient on human capital is slightly higher resulting in a 1 155 PPP USD or 936 PPP EUR effect.

Ensuring statistically sound results, we can make several conclusions based on our estimation:

- IV approach can be successfully used to resolve reverse causality and endogeneity of human capital;
- human capital, explained by ability to outperform and schooling index, is a significant and dominant determinant for regional economic performance;
- resource extraction is a less significant determinant for economic performance;
- number and share of outperforming graduates according to the Unified State Exam results are valid exogenous instruments for human capital;
- research is the least significant determinant of economic performance;
- ability of graduates to outperform does not directly contribute to regional economic performance (but rather contributes to regional economic performance through human capital indirectly).

Nevertheless, there are three serious issues in the first approach: using lagged variables may cause autocorrelation which may not be resolved even by the GMM2S estimation; the instruments such as school graduation results may have reverse causality problem with the human capital level; time-constant variables are not considered due to fixed effects transformation. In order to resolve these two issues, we develop a different model based on historical approach.

5.3 Endogenous human capital: historical/spatial approach

Having listed the pitfalls of the previous approach, we now proceed to a simpler cross section model without lags and with different instruments. It is assumed that historical dates such as the foundation of the first university in the given region and the geographical distance to Moscow, which has been the capital since 1918, are better causal instruments which predetermine regional human capital levels. The spatial variable distance to Moscow, measured in kilometres from Moscow to the capital of the given region, is a proxy for periphery and related problems, which may be related to the distant position of the remote regions. The dates of university foundation were obtained from the federal database of higher education entities[3]: the date when the first university was founded was indicated as a value for a given region, in case if the first university was a branch then the date of a branch establishment was taken, in case of absence of universities in the given region, the date of establishment of similar higher education entity was taken as a value. The model can be formulated as follows:

GDP and Endogenous Human Capital (approach 2)

$gdp_{i,t} = \beta_0 + \beta_1 I\_hucap*100_{i,t} + \beta_2 oi\lg as_{i,t} + \beta_3 gdp\_start_{i,t} + \varepsilon_{i,t}$	OLS (5.1)
$I\_hucap*100_{i,t} = \alpha_0 + \alpha_1 oi\lg as_{i,t} + \alpha_2 gdp\_start_{i,t} + \alpha_3 uni\_date_{i,t} + \alpha_4 distmsc_{i,t} + \mu_{i,t}$	First Stage (5.2)
$gdp_{i,t} = \hat{\beta}_0 + \hat{\beta}_1 I\_hu\hat{c}ap*100_{i,t} + \hat{\beta}_2 oi\lg as_{i,t} + \hat{\beta}_3 gdp\_start_{i,t} + \hat{\varepsilon}_{i,t}$	IV (5.3)

where:

$gdp_{i,t}$ - regional GDP per capita in PPP USD (UNDP)

$I\_hucap*100_{i,t}$ - Human Development Index (UNDP)

$oi\lg as_{i,t-1}$ - oil and gas extraction (thsd. tonnes)

$gdp\_start_{i,t}$ - level of GDP per capita at 1995

$uni\_date_{i,t}$ - first university foundation date

$distmsc_{i,t}$ - distance to Moscow

$\varepsilon_{i,t}$, $\mu_{i,t}$ - errors

The robust GMM2S estimation ensures absence of heteroscedasticity. We have not encountered any issues during the estimation. The baseline equation (5.1) states that one unit increase of I_hucap*100 would relate to a 997.5 PPP EUR increase in regional GDP per capita. After instrumenting human capital the effect, explained by dates of university establishment and distance to Moscow, is twice less significant and the coefficient is only 736.5 as obtained in IV equation (5.3). The first stage results (5.2) state that both historical dates and the distance are relevant instruments: dates of university establishment have a negative effect on human capital which is significant at all levels, whereas distance to Moscow is also a negative determinant of human capital, however less significant. The effect

[3] http://www.edu.ru/

can be summarized as follows: the later the first university in a given region was founded, the worse the human capital level is. In addition, in regions which are remote from Moscow, the level of human capital is likely to be lower. The first stage (5.2) and the given instruments explain approximately 64 percent of regional human capital variation which is significantly better comparing to the first stage of the first approach where educational instruments were used.

The Hansen test for overidentification has a very high probability which suggests that the historical and geographical instruments are exogenous.

The results obtained are plausible; however, there are some potential issues. First of all, for 204 years (1712-1918[4]) Saint-Petersburg used to be the capital of the Russian Empire. Thus distance to Moscow may not be the only spatial variable to be used. Secondly, the 1995 level of GDP per capita is significant in both IV and the first stage which means that initial levels of economic performance are also relevant for human capital. Thus, this variable may contain some unobserved regional characteristics which are extremely hard to reveal.

Table 7. Historical/spatial approach

VARIABLES	(5.1) OLS, Robust UNDP_GDP	(5.2) First, Robust I_hucap*100	(5.3) IV, GMM2S Robust UNDP_GDP
I_hucap*100	997.5***		736.5**
SE	*(202.9)*		*(336.7)*
T(Z)-stat	*4.917*		*2.187*
oilgas	0.464***	3.37e-06	0.569***
SE	*(0.112)*	*(5.75e-06)*	*(0.137)*
T(Z)-stat	*4.140*	*0.585*	*4.158*
GDP_start	0.0633***	0.000454***	0.0642***
SE	*(0.00766)*	*(7.50e-05)*	*(0.00834)*
T(Z)-stat	*8.262*	*6.052*	*7.701*
uni_date		-0.0302***	
SE		*(0.00774)*	
T(Z)-stat		*-3.902*	
distmoscow		-0.000216*	
SE		*(0.000115)*	
T(Z)-stat		*-1.873*	
Constant	-71,418***	133.7***	-51,747**
SE	*(15,463)*	*(15.01)*	*(25,652)*
T(Z)-stat	*-4.619*	*8.905*	*-2.017*
Observations	79	79	79
R-squared	0.883	0.643	0.873
Hansen (p-value)			0.8974

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

[4] excluding the period during 1728-1730

6. Conclusion

In section 1, after having demonstrated the important role of the Russian economy on a macroeconomic level of the ex-USSR region, we focus on regional heterogeneity of the Russian regions which represents fruitful grounds for growth regressions. Setting the main direction of the research, which is empirical analysis of growth and economic performance determinants of the Russian regions considering human capital, we proceed to describing the research background, presented in section 2. A brief presentation of empirical works related to regional economic growth including papers focused on Russia is provided in order to outline the well-established approaches and highlight its potential drawbacks such as reverse causality and endogeneity of human capital. Marking these as key challenges, we move on to section 3 where we discuss the empirical strategy implemented in the given research to outmanoeuvre the issues mentioned. The empirical strategy is designed in a way to identify the determinants of growth dynamics and economic performance in static environment. In section 5 we introduce the data set used in the paper. The data collected from various sources such as Goskomstat, UNDP and The Unified State Exam database, in addition to geographical and historical sources allow us to fully take advantage of the empirical strategy which was suggested previously: the panel data with long time span of 13 years and 80 regions with Goskomstat data was used for the dynamic panel data model, whereas the UNDP and the Unified State Exam databases as well as the distance matrix and historical dates serve as grounds for the approach with instrumental variables. Section 5 mainly focuses on the implementation of the empirical strategy. Using different econometric tools allows us to consider economic performance determinants in the Russian regions from different perspectives. First of all, the dynamic system GMM estimation, presented in sub-section 5.1 provides elasticity coefficients of capital, labour and innovation. Absence of convergence among Russian regions is a valuable finding among with the elasticity coefficients obtained. Exploiting the full panel structure with on average 6 observations per group and 65 groups we have additionally collapsed the instrument matrix reducing the number of instruments from 61 to 17 which diminished the problem of too many instruments. Having established the fact that labour, and to be more precise, privately employed labour is a significant determinant of economic growth, we proceeded to a deeper analysis of human capital as a determinant of economic performance, which is presented in sub-section 5.2 and 5.3.

Facing the issues of reverse causality of human capital, we elaborate two approaches to endogenize it: the ability and schooling discussed in sub-section 5.2 and historical/spatial approach provided in sub-section 5.3. In frames of the first approach we find that the absolute and relative results of the Unified State Exam an education index are valid and relevant instruments for human capital as a determinant for economic performance measured by GDP per capita and controlled for raw resource and innovation background. Acknowledging potential issues of causality between exam results and human capital in the first stage we offer a second approach in which historical and spatial instruments such as dates of the foundation of first universities and distance to Moscow are assumed to have a stronger causal effect on human capital, as stated in sub-section 5.3. The first stage estimation yields that the effect of the latter instrument on human capital is negative making both of them valid and relevant. Additionally the initial GDP per capita level has a very strong positive impact on current economic well being which may invite further research on the matter.

The overall conclusion can be summarized as follows. Whereas labour is one of the key growth determinants for the Russian regions, it is obvious that qualitative characteristics of it prevail over the quantitative side. By improving education policies and supporting and developing well established universities we can indirectly impact regional economic performance through human capital. The high negative impact of spatial distance to Moscow on human capital level suggests potential improvements in strategic regional development.

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Universität Hohenheim
D-70593 Stuttgart

Prof. Dr. Heinz-Peter Spahn peter.spahn@uni-hohenheim.de
Institut für Volkswirtschaftslehre (520A)
Universität Hohenheim
D-70593 Stuttgart

Prof. Dr. Hans-Michael Trautwein michael.trautwein@uni-oldenburg.de
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