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ASSESSMENT OF THE INNOVATION FACTORS IMPACT ON ECONOMIC GROWTH IN RUSSIAN REGIONS

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Abstract

Purpose: The aim of the research is to test hypothesis that ensuring economic growth innovation is important for regions with higher level of development and it is less significant in explaining growth in other regions. Public and private R&D expenditure is very highly concentrated in a small number of leading regions: those closer to the productive frontier. Regions outside these high-technology cores tend to depend on less R&D-intensive forms of innovation and on technology transfer.

Design/methodology/approach: We have identified the following factors that are relevant for the regional growth: human capital, infrastructure, labour market, innovation, agglomeration and connectivity, productivity. As the innovation factor, we use number of patents, internal expenditures on R&D, expenditures on technological innovations, the number of staff engaged in R&D, the volume of innovative goods, works and services, innovative activity of organizations. Innovation can have a positive impact on long-term growth. The data has been collected in 83 Russian regions for 2005-2015. We use a power-mode regression model with constant elasticity.

Findings: Not all innovative factors have a positive effect on the regional economic growth. The inclusion of such factors as employment rate; internal expenditures on R&D; the number of staff engaged in R&D; the innovative goods, works and services; innovative activity of organizations; density of GDP is surplus. The analysis showed that they are not statistically significant. Partly we can explain it as the more successful regions develop due to conjuncture factors, and science and technology are not the reason for economic growth. Our hypothesis has not been confirmed.

Research/practical implications: In the case when the influence of the conjuncture factors on regional economic growth is great, it is difficult to assess the significance of innovation. The division of regions into groups according to the level of per capita GRP allows us to identify significant factors of innovation for growth. From the point of view of practical application, we see that the regions below average level of per capita GDP need the development of innovation. Such institutional factors as governance, leadership, capacity should consider an active role of innovation and work force.

Originality/value: On the example of the Russian regions we have shown that ensuring economic growth innovation is important for regions with below average level of development and it is less significant in explaining of growth in other regions.

Keywords: Regional economic growth, innovation factors, technological innovation, regions of Russia

JEL Codes: O32, O41, R12

Introduction

Economic growth is the cumulative measure for the entire activity originating in the society (Lucas, 2013, p. 53). The tasks for its support become priority in all countries of the world. Accelerated economic growth rates not only improve the population welfare, step up producers competitive power, predetermine the development of social aspects, but also increase inequality among regions for a number of parameters. To provide economic growth, internal and external conditions are created for all regions of the country, but only the most developed ones use the advantages with maximum efficiency. In this case, the level of interregional inequality increases. However, inverse trend is also possible, which explains the higher rates of economic growth that lagging regions can adopt technological, managerial and other innovations of more developed regions and imitate their successful practices. This process shall result in regions convergence (Barro et al., 2010, p. 36).

The traditional economic policy focused on using the measures such as direct investment of infrastructure development, subsidies and tax incentives to attract new companies to the lagging regions does not yield positive results in decreasing interregional imbalances. It is possible that to provide high rates of economic growth, it is important to identify the main factors for certain groups of regions in terms of a level of social and economic development. Previous studies have shown that the development of innovations and their impact on economic growth in the Russian regions has its own specifics (Rastvortseva, 2015).

The aim of the research is to test hypothesis that ensuring economic growth innovation is important for regions with higher level of development and it is less significant in explaining growth in other regions.

The paper is organized as follows. Section 1 gives us a short overview of the theoretical literature on the subject. After describing the problems of the innovations and regional growth in Russia over time in section 2, the research methodology and model specification are presented in sections 3 before the main results (section 4) and summarizing and drawing conclusions.

1 Theoretical background and bibliography

To develop more effective measures, the European Union now generates a new wave of modern thinking in the sphere of the regional economic policy (Varga, 2017; Dvoulety, 2017). One may place emphasis the research aimed at growth stimulation and overcoming interregional

inequality directly through individual measures (for example, Barca, 2009) or in parallel with increased economic growth (World Bank, 2009).

The Russian regions differ in many observable parameters, so it is easy to choose some economic and cultural features and make them the engines of economic growth. To carry out the successful regional economic policy in implementing and using innovations to ensure economic growth, a model is needed that takes into account both the specific development of individual regions and the macroeconomic factors common to all ones. Such models will help the regional agencies to form the most effective combination of projects in accordance with the available budget and information.

Some results in the development of such models are already available. Macro, Sectoral and Territorial model – MASST was proposed by P. Capello in 2007 (Capello, 2007), Geographic Macro and Regional model – GMR from A. Varga (Varga, 2007), European Commission Model (RHOMOLO model) – A. Brandsma, O. Ivanova and A. Kants (Brandsma et all., 2015).

Thus, the Europe GMR model applies the following production function of knowledge for the region:

$$\dot{A}_{i,t} = RD_{i,t-k}^{\alpha_{\dot{A}_1}} A_{N,t-k}^{\alpha_{\dot{A}_2}} \quad (1)$$

where $\dot{A}$ is a temporary change (increment) of new knowledge (it is measured by a number of patents and publications in two different equations) in the *i* region and *t* period of time;

RD is researches and developments (it is measured as a costs volume for researches and developments);

A is accumulated knowledge (it is measured by a total number of patents and publications, respectively);

$\alpha_{\dot{A}_1}$ and $\alpha_{\dot{A}_2}$ are parameters, lower indices for which they are a region (*i*), country (*N*)? time *(t*) and lag of time (*k*);

$\alpha_{\dot{A}_1}$ is a parameter of elasticity for new technological ideas relative to the researches, it is accepted as a measure for capacity of the regional researches and developments.

An effect level of research costs for new technological ideas is evaluated by a size of indicator $\alpha_{\dot{A}_1}$, which value depends on the concentration of technologically intensive industries within the region and reputation of partners of interregional scientific-technical cooperation. The research concludes that having the equal level of costs for researches and developments, the regions may generate more technological ideas, while concentrating knowledge-intensive industries within its territory, attracting the first researchers inducing interregional research

cooperation. Capacity of scientific researches and developments is a key factor for concentration in the region of technologically intensive industries. Therefore, the regional policy focused on the support of scientific researches may lead to the higher level of knowledge and creation of centripetal force of economic activity concentration through the efficiency increase in the innovative sector.

In OECD countries, an empirical study was conducted to determine the factors of economic growth, including innovative ones. Innovation is shown to be important for regions with higher levels of development, but is less significant in explaining growth in other regions. Both public and private R&D expenditure as well as patenting activity are very highly concentrated in a small number of leading regions: those closer to the productive frontier. Regions outside these high-technology cores tend to depend on less R&D-intensive (and less easy-to-measure) forms of innovation and on technology transfer, which probably explains why innovation does not stand out as a growth factor in those regions (OECD, 2012).

Growth rates depend chiefly on the human capital, infrastructure and innovation already present in a region. Such institutional factors as governance, leadership, capacity include an active role to key actors focusing on innovation and work force. Innovation appears to be a critical pillar for advanced regions. Innovation can be promoted through strong open innovation supply chains, encouraging entrepreneurial activities and innovation clusters

.

2 Innovation and economic growth in different types of Russian regions

Studying the innovations and their impact on the socio-economic development of the Russian regions, we have obtained some results earlier (Rastvortseva, 2015, 2016). Growth of innovative resources concentration is not always accompanied by increase of inequality among regions on relevant indicators. The crisis impacts negative on the development of innovation in non-central regions. Consequently, only the stable development of the economy will contribute to the dispersal of innovations in all regions of Russia. A stable relationship between the development of innovative and economic sectors in Russian regions appears in 2012.

The level of population education is weighty factor of economic growth, and a share of highly educated employees has positive influence on the rates of economic growth after three years. Influence of patent activity on regional economic growth is positive and statistically significant with lagged value of two years.

In this study, we will extend the observation period from 2005 to obtain a more representative sample, even if the influence of some factors becomes statistically insignificant.

In order to determine whether innovation affects the economic growth in regions with different levels of socio-economic development, we've divided 83 Russian regions into three groups:

1) above average GDP per capita (I group) – 23 regions;
2) 75-100 % of average GDP per capita (II group) - 20 regions;
3) below 75 % of average GDP per capita (III group) – 40 regions (table 1).

Tab. 1: Average value of main growth indicators for the three groups of Russian regions in 2005-2015

	I group *Above average GDP per capita*	**II group** *75-100 % of average GDP per capita*	**III group** *Below 75 % of average GDP per capita*
GDP per capita, thous. rub.	504681.15	218851.94	137687.16
Regional growth, %	1.1552	1.1426	1.1554
Motorway density, km. per 1000 sq. km. of area	152.5	169.5	198.5
Higher education, share in employment, %			
2002-2012 (lag3)	25.72	22.67	23.64
2003-2013 (lag2)	26.53	23.39	24.37
2004-2014 (lag1)	27.40	24.14	25.12
2005-2015	28.28	24.91	25.89
Employment rate, %	66.81	63.56	58.91
Wage ratio, ratio to average wage in Russia, index	1.42	0.847	0.68
Patents, number of issued patents	791.77	326.31	269.43
Internal expenditures on R&D, regional share, %	3.13	0.953	0.22
Expenditures on technological innovations, regional share, %	2.36	1.566	0.36
The staff engaged in R&D, regional share, %	2.88	2.07	0.32
Innovative goods, works and services, mln. rub.	49370.96	26738.00	6944.24
Innovative activity of organizations, %	11.24	9.2	8.04
Population density, pop. per sq. km of area	524.34	28.71	33.79
GDP density, thous. rub. of GDP per sq. km of area	313505.6	6247.6	4281.8

Thus, we see that the rates of economic growth are approximately equal in the three groups of regions. Economic growth rates vary from 1.1426% in group II to 1.1554 % in the group III. In the group I (above average GDP per capita), the highest share of employees with higher education (28.28%) is observed, high level of employment (66.81%), wages (1.42 ratio to average wages in Russian regions), number of patents (791.77) and other factors of innovation development. High density (population and GRP) also occurs on the regions of this group. High density of motorway occurs on the III group regions (below 75% of average GDP per capita – 198.5 km. per 1000 sq. km. of area). These regions exceed the II group by indicators of the proportion of workers with higher education and population density.

3 Model spesification

To assess the impact of innovative factors on regional economic development, we will use a power-mode regression model with constant elasticity:

$$\hat{Y}_t = \alpha \prod_{i=1}^{m} x_{i,t-1}^{b_i}, \quad (1)$$

where $\hat{Y}_t$ is GRP, predicted in the time period *t*;

α is absolute term of equation;

x_i is innovative factors, included in the regression model;

b_i is equation parameters - regression coefficients, particular elasticity coefficient of GRP on investigated factors;

i is serial number of the factor;

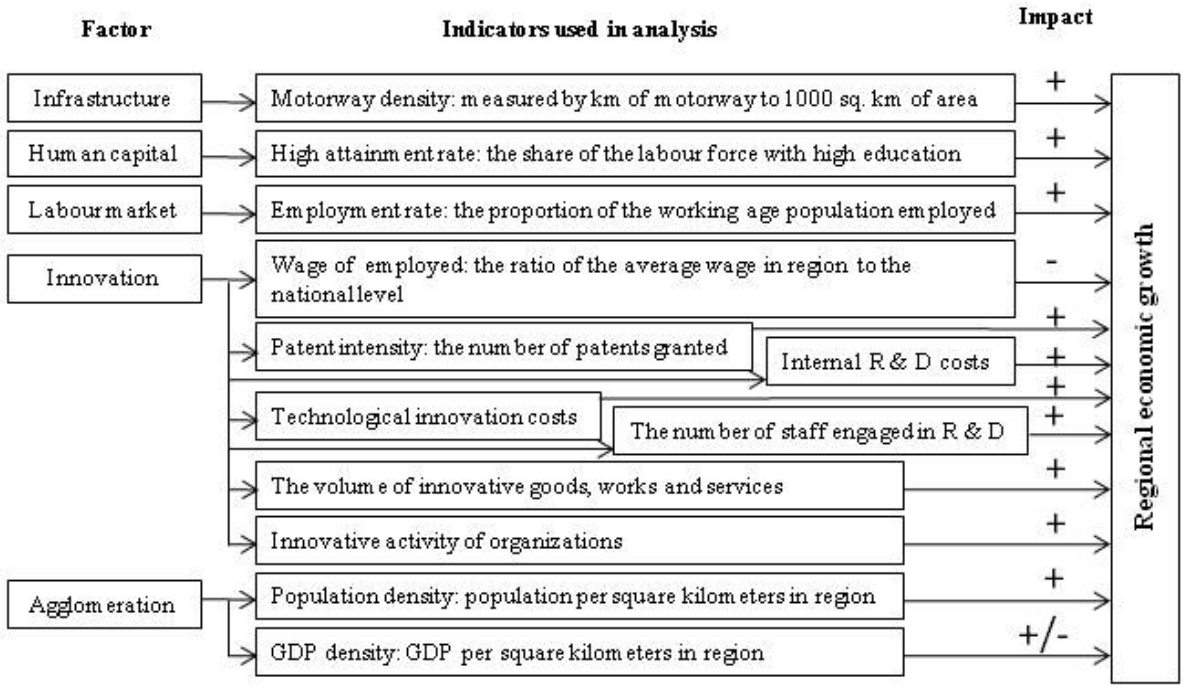
m is number of factors, included in the model.

In linear representation the model looks in the following way:

$$\ln\left(\frac{\hat{Y}_{i,t}}{Y_{i,t-1}}\right) = \ln\alpha + \sum_{i=1}^{m} b_i \ln x_{i,t-1}. \quad (2)$$

As a productive indicator we denote the average growth of gross regional product for 2005-2015 (*GDP*). Let's define factor indicators. We have identified the following factors that are relevant for regional growth: human capital, infrastructure, labour market, innovation, agglomeration (fig.1).

Fig.1. The main links of factors of economic growth in the region



Constructed by the author

Neo-classical growth theories stress the role of physical capital as the main determinant of economic growth. Infrastructure as a density of motorway (*Infrast*) is used as a measure of physical capital (OECD, 2009). Endogenous growth theories rely on human capital as the main determinant of economic growth. High attainment rate (the share of higher educated workers – *High_Edu* and *High_Edu_lag2* for 2-years lag) as a measure of human capital is used in the model. Employment rate and the average wage of employed (*Wage_Ratio*) estimate labour market.

As the innovation factor internal expenditures on R&D, number of patents (*Patent*), expenditures on technological innovations (*Expend_tech_inn*), the number of staff engaged in R&D, the innovative goods, works and services, innovative activity of organizations used. Innovation can have a positive impact on long-run growth. The agglomeration factors are *density of population* (*Density_pop*) and *density of GDP*.

4 Interpretation of the results

The results of the preliminary analysis showed that in the Russian regions in general and in three groups in particular, the following factors of economic growth are statistically insignificant: employment rate; internal expenditures on R&D; the number of staff engaged in

R&D; the innovative goods, works and services; innovative activity of organizations; density of GDP. Let's construct models with other factors of economic growth (Table 2).

Tab.2: Regression results, all Russian regions panel model, 2005-2015

	Model 1	Model 2	Model 3	Model 4	Model 5
Constant	0.143***	0.365***	0.361***	0.487***	0.487***
	(0.01)	(0.051)	(0.052)	(0.056)	(0.054)
Infrast	-0.0013	-0.00013	-0.0035	-0.021***	-0.018***
	(0.001)	(0.001)	(0.003)	(0.0065)	(0.0056)
High_Edu_lag2		-0.07***	-0.067	-0.094***	-0.094***
		(0.016)	(0.018)	(0.019)	(0.016)
Wage_Ratio			-0.019	-0.017	
			(0.016)	(0.019)	
Patent				-0.0059**	-0.0082***
				(0.0029)	(0.0026)
Expend_tech_inn				-0.0005	
				(0.0027)	
Density_pop				0.023***	0.024***
				(0.0061)	(0.006)
R^2	0.00043	0.022	0.024	0.067	0.07
$Adj\ R^2$	-0.0007	0.02	0.021	0.061	0.063
F	0.53	0.000037	0.00006	$7.3 \cdot 10^{-11}$	$2.5 \cdot 10^{-12}$
n	902	900	900	852	870

* Significant at the 5% level

The results of the empirical analysis prove that the most significant factors for the economic growth in all Russian regions are infrastructure (density of motorway), share of higher educated workers, patent activity and density of population. We include average wage of employed and expenditure on technological innovations because they are significant for some groups of regions. Let's construct models of economic growth for the group I of Russian regions - above average GDP per capita (Table 3).

Tab.3: Regression results, Russian regions (I group - above average GDP per capita) panel model, 2005-2015

	Model 1	Model 2	Model 3	Model 4	Model 5
Constant	0.143***	0.402***	0.408***	0.51***	0.493***
	(0.0087)	(0.102)	(0.107)	(0.105)	(0.124)
Infrast	-0.002	-0.0002	-0.002	-0.008***	-0.01***
	(0.002)	(0.002)	(0.004)	(0.003)	(0.003)
High_Edu_lag2		-0.083***	-0.088**	-0.131***	-0.11***
		(0.032)	(0.036)	(0.04)	(0.037)
Wage_Ratio			0.016	-0.019	
			(0.025)	(0.028)	
Patent				0.0006	
				(0.005)	
Expend_tech_inn				-0.0083**	
				(0.004)	
Density_pop				0.0156***	0.011***
				(0.004)	(0.003)
R^2	0.002	0.037	0.04	0.1	0.06
Adj R^2	-0.002	0.029	0.03	0.07	0.04
F	0.46	0.01	0.024	0.0012	0.0027
N	243	243	243	223	243

* Significant at the 5% level

The results of the empirical analysis prove that the most significant factors for the economic growth in the group I of Russian regions are *infrastructure* (density of motorway), share of higher educated workers and density of population. Let's construct models of economic growth for the group II of Russian regions - 75-100 % of average GDP per capita (Table 4).

Tab.4: Regression results, Russian regions (II group - 75-100 % of average GDP per capita) panel model, 2005-2015

	Model 1	Model 2	Model 3	Model 4	Model 5
Constant	0.158***	0.425***	0.439***	0.503***	0.52***
	(0.0198)	(0.095)	(0.115)	(0.117)	(0.105)
Infrast	-0.006	-0.002	0.007	-0.046**	-0.054***
	(0.004)	(0.006)	(0.009)	(0.022)	(0.017)
High_Edu_lag2		-0.092***	-0.105**	-0.082*	-0.061***
		(0.033)	(0.043)	(0.045)	(0.034)
Wage_Ratio			0.094	0.054	
			(0.073)	(0.0696)	
Patent				-0.012	-0.018***
				(0.0096)	(0.0067)
Expend_tech_inn				-0.0048	
				(0.0048)	
Density_pop				0.051***	0.053***
				(0.017)	(0.016)
R^2	0.003	0.026	0.031	0.064	0.058
Adj R^2	-0.001	0.017	0.017	0.037	0.04
F	0.423	0.0597	0.079	0.028	0.011
N	220	220	220	220	220

* Significant at the 5% level

The results of the empirical analysis prove that the most significant factors for the economic growth in the group II are infrastructure (density of motorway), share of higher educated workers, patent activity and density of population. Let's construct models of economic growth for the group III of Russian regions - 75 % of average GDP per capita (Table 5).

Tab.5: Regression results, Russian regions (III group - below 75 % of average GDP per capita) panel model, 2005-2015

	Model 1	Model 2	Model 3	Model 4	Model 5
Constant	0.148***	0.334***	0.368***	0.523***	0.496***
	(0.0197)	(0.064)	(0.062)	(0.0542)	(0.061)
Infrast	-0.001	0.0038	-0.007	-0.0532***	-0.057***
	(0.004)	(0.0039)	(0.0052)	(0.009)	(0.009)
High_Edu_lag2		-0.066***	-0.078***	-0.073***	-0.079***
		(0.0196)	(0.018)	(0.016)	(0.019)
Wage_Ratio			-0.143***	-0.131***	-0.11***
			(0.033)	(0.027)	0.028
Patent				-0.013***	-0.0091***
				(0.0026)	(0.0026)
Expend_tech_inn				0.0057	
				(0.003)	
Density_pop				0.05***	0.056***
				(0.01)	(0.009)
R^2	0.001	0.017	0.051	0.15	0.14
Adj R^2	-0.002	0.012	0.044	0.13	0.13
F	0.83	0.025	0.000049	$6.7 \cdot 10^{-12}$	$1.3 \cdot 10^{-12}$
n	439	437	437	409	427

* Significant at the 5% level

The coefficient of determination in the models is low because the model includes mainly innovative development factors, rather than traditional ones - labor and capital. We also note that GRP growth rates largely depend on the conjuncture factors: the dynamics of prices for oil, gas, non-ferrous and ferrous metals (which is important for the Russian economy), foreign policy, and the national currency rate. Innovative factors influence economic growth in the long term and, often, conjuncture factors do not allow an adequate assessment.

Let's consider the received models in more details. For 83 regions of Russia the model, which includes all the most significant factors, looks as follows:

$$\frac{GDP_t}{GDP_{t-1}} = 0.478 \cdot Infrast^{-0.018} \cdot High\_Edu\_lag_2^{-0.094} \cdot Patent^{-0.082} \cdot Density\_pop^{0.024} \quad (3)$$

We see that population density positively affects economic growth (as in models by groups). This confirms the provisions of the new economic geography (NEG) on agglomeration effects from the territorial concentration of the population. Theories of the NEG say that

agglomeration effects are accompanied by the spread of knowledge that contributes to innovative development. A negative (but statistically significant) impact on economic growth is provided by a share of higher educated workers and patent activity. At present, measures are being taken in Russia to increase the attractiveness of secondary professional education, since specialists of this level are in demand in the labor market, and a low supply leads to inefficient high wages.

In the third group (less developed regions), the wage factor has a significant impact on economic growth. The negative influence of patent activity confirms the conclusions were made earlier by Rastvortseva (2015) about the insufficient level of development of this sector. We see that the largest number of patents falls on the I group of regions (an average of 791.77 issued patents per region per year in 2005-2015). But it is in this group of regions that the influence of this factor is not statistically significant. The model for the first group of regions has the form:

$$\frac{GDP_t}{GDP_{t-1}} = 0.493 \cdot Infrast^{-0.01} \cdot High\_Edu\_lag_2^{-0.11} \cdot Density\_pop^{0.011} \quad (4)$$

Note that when six factors of economic growth are included, a significant connection is observed with the expenditures of technological innovation. Economic growth in the II group of regions is formed due to such innovative factors as share of higher educated workers and patent activity. The influence of both factors is negative. The model has the following form:

$$\frac{GDP_t}{GDP_{t-1}} = 0.52 \cdot Infrast^{-0.054} \cdot High\_Edu\_lag_2^{-0.061} \cdot Patent^{-0.018} \cdot Density\_pop^{0.053} \quad (5)$$

We have classified 40 regions of Russia as less developed regions (below 75 % of average GDP per capita). The economic growth in this group of regions has a statistically significant influence factors - higher education, patent activity, wage level:

$$\frac{GDP_t}{GDP_{t-1}} = 0.496 \cdot Infrast^{-0.057} \cdot High\_Edu\_lag_2^{-0.079} \cdot Wage\_ratio^{-0.11} \times$$
$$\times Patent^{-0.0091} \cdot Density\_pop^{0.056} \quad (6)$$

The conclusion of the analysis that a high level of wages negatively affects the rates of economic growth seems logical. The negative influence of the density of motorway on economic growth, in our opinion, can be explained by the large geographical areas of the Russian regions. Roads are important, but not exhaustive type of transport infrastructure. In richer regions (Group I) air, sea and pipeline transportation is important. We think that this direction can be investigated additionally.

We will try to explain the negative impact of innovation factors on economic growth by the following reasons:

1) as a resultant indicator, we accept not the socio-economic development of the region at a particular point in time, but the economic growth. This corresponds to the purpose of the study, but does not exclude a significant influence of the conjuncture factors. The regions grow faster not because of the innovations that have been accumulated over the years, but because of the successfully external conditions;

2) innovations at the current stage of the Russian economy development are not sufficiently demanded by the regions for growth. Their returns are low, there are alternatives to obtaining a faster profit. Earlier it was showen that the impact of innovations on the development of the Russian regions economy has become statistically significant since 2012. We think that, when more data are available for a representative sample, we can additionally investigate the period from 2012.

3) imperfection of official statistics on indicators of innovation. If the statistics reflect the real state of affairs by the share of higher employed workers and the number of issued patents, it is quite difficult to assess the reliability of such indicators as internal costs of research and development, the cost of technological innovation.

Conclusion

Thus, the hypothesis put forward by us that regions with higher rates of economic growth are more dependent on innovations, has not been confirmed. In these regions, the influence of conjuncture factors is great. In regions with medium and below average levels of development, the link between economic growth and innovation is stronger. The density of the population positively influences the growth in the Russian regions. This confirms the conclusions of the new economic geography and suggests that agglomeration effects from the geographical concentration of the population will arise, including from the dissemination of knowledge, which will contribute to innovation.

The negative influence of the density of motorway can be explained by the large geographical areas of Russian regions - road transport is not the main one in all regions. Negative, but statistically significant, influence of the share of higher educated workers indicates the presence of imbalances in the labor market. Patent activity has an impact on economic growth in groups II and III. In the regions of the III group, the level of wages has a

negative impact on economic growth. This indicates an insufficient level of development of this sector.

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