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INFRASTRUCTURE IN THE CONTEXT OF REGIONAL DEVELOPMENT IN RUSSIA

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Abstract

Having identified the main infrastructural facilities that affect regional development, through regression analysis, the author evaluates their impact on regional gross domestic products. The author proposes a method for assessing infrastructural impacts on the standard of living through least squares. Since it has become necessary to address the problem of endogeneity caused by investments in infrastructure, an attempt is made to find instrumental variables and estimate it in two-step least squares. Thus, investments in transport infrastructure are reported to provide the greatest economic effect on regions in their early stages, while in the intermediate stage – investments in electricity and telecommunications. For developed regions, however, investing in education and "green" technology is likely to be the best possible solution. The problem of endogeneity is a very complex issue and it can be quite difficult to find instrumental variables. An exogenous variable must be valid and relevant. Pertaining to investment, mortality, life expectancy, road density, fatal road accidents, and migration are proposed as instrumental variables. Indeed, would anyone want to invest in a region, if people died there abundantly, would not live for long, would leave the region and there would be no roads and no new houses would be built. There are some guidelines proposed for building up those infrastructural elements that would contribute more heavily to the gross regional product and promote economic well-being.

Keywords: Infrastructure, regional development, economic growth

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1. Introduction

Exploring possible effects of infrastructure can identify both positive and negative relationships with gross regional product, which depends on specific details of a particular study. Using US data to determine the relationship between infrastructure and gross regional product, it is more likely to find a negative relationship. The researchers partly explain this relationship by a dependent variable chosen. Given that total factor productivity is chosen as a dependent variable, the sign of the correlation changes and becomes positive. The result is also significantly influenced by the horizon value: a positive correlation between the quality of infrastructure and the growth of gross regional product is more likely to be found over the long-run time series.

The authors see telecommunication infrastructure as the main driving force behind regional growth. This is a rather intuitive consideration, since over the past 10 years, the spread of telecommunications has been crucial for modern economic development. The authors suggest that each infrastructure reform can have negative externalities in the medium term. Considering regional growth in Russia, one cannot but notice that one of the main investors in large infrastructure projects is the state. The state as an economic agent deciding on financing a region can be guided by not only economic considerations, but some preferences as well.

These preferences can be based on the vote for the ruling party. Luca (2016) in his article attempts to investigate a similar phenomenon. Examining the regional data from Turkey for 2004-2012 it can be concluded that by voting for the ruling party, a region can "buy" additional preferences in stimulus policies. This, in turn, can lead to more infrastructure investment and faster economic growth. However, following econometric analysis, Luca came to the conclusion that "positive" voting has a minor effect on economic growth, and the principal driver of growth is accumulated human capital.

2. Problem Statement

To provide a rationale and develop guidelines for action on infrastructure development in regions tailored to the needs of the economy and people, it is necessary to identify significant infrastructural impacts on regional growth. With this view, the paper deals with significant social and economic infrastructure that can help increase the standard of living in regions and boost regional economies. The detailed methodology for this research has been suggested in the collective article (Serkova et al., 2018)

3. Research Questions

The author brings up a question as to whether infrastructure influences regional growth, what is the strength and direction of this influence. The paper aims to identify infrastructure elements that are thought to promote the growth of Russian regions. The hypothesis is that building up infrastructure has a positive and significant effect on the gross regional product of the constituent entities of the Russian Federation. According to the author, infrastructure is defined as a multi-tier system coming in social and economic dimensions and embracing tangible and intangible elements responsible for encouraging vital activity of the population. The social infrastructure creates enabling conditions for satisfying human material and

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spiritual needs, ensures the reproduction of the labor and creative potential of the population. The economic infrastructure ensures the efficiency of production, including maximizing profits and minimizing transaction costs. In turn, the types of social and economic infrastructure are divided into subtypes.

The types of social infrastructure includes such subtypes as health care, education, culture and sports. The type of economic infrastructure includes subtypes of transport infrastructure, power production and communication networks. Each subtype of infrastructure is represented by several infrastructure elements that measure 32 quantitative socio-economic metrics collected in the database from 2000 to 2019, which served as a basis for the study.

In accordance with this classification, the author examined the following infrastructure elements: Education – a number of students attending vocational schools, secondary schools and universities per 10,000 people; Healthcare – a number of nurses and doctors per 10,000 people; Culture and art – a number of museum- and theater-goers per 1,000 people; Sports – a number of stadiums and sports facilities – all per 100,000 people; Transport – density of railways, highways, km per 10,000 km^2; Communication – a share of telecommunication services; Construction – a number of newly built square meters of housing per 1,000 people, amount of retail space for 1,000 people, km^2, price of sq.m. of residential premises; Electricity – electricity production per capita, rubles. By building up social and economic infrastructures in the regions that require significant public investment, it is possible to close large regional gaps. The state does not always consider such investments to be profitable and is therefore reluctant to invest in such a way. However, such investments pay off in the long term, and ignoring such an important issue will only aggravate the problem of regional disparities in Russian regions.

4. Purpose of the Study

A large part of the papers concerned with infrastructural effects in the light of regional growth focus on economic advance or factor productivity as an object of research. However, some of the economic reforms to improve the social and economic structure are not aimed at stimulating economic growth, but "solving" the problem of poverty in regions. Medeiros et al. (2021) investigate how building up infrastructure capacity, improving its quality and accessibility affects poverty. The examples of infrastructure included transport, telecommunications, energy and medical infrastructure. A study based on Brazilian microdata showed that providing additional infrastructure had a negative effect on poverty. Although the main factor in this effect is not the improvement of infrastructure per se, but its unevenness or heterogeneity in the region.

Some researchers often conclude that transport infrastructure has a positive effect on regional development in the long term. Similar studies are carried out in all countries and continents around the world. Recently, a similar study was conducted on Australian data. Gharehbaghi et al. (2020) concluded that more rails constructed in remote parts of Australia would have a multiplier of 2.62, which should significantly spur Australian GDP, agriculture and construction.

Based on Chinese data, some studies of regional disparities and quests for a cause-and-effect relationship are equally interesting, voluminous and detailed. The Chinese experience is also interesting because the country has quite distinct economic zones responsible for producing different commodities. Using data from 2005 to 2013, May, Hu et al. (2019) suggest that improving the quality of financial

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infrastructure has a positive effect on economic growth in a region as long as a certain threshold is crossed and for each of the national regions (eastern, central and western), this threshold is different.

Some regions in China are involved in unique infrastructure projects – seaports that are among the largest ports in the world. A study is also being carried out in China on their potential impact on gross regional product and possible externalities from interactions with land transport infrastructure. Song and van Geenhuizen (2014) conducted a similar study using data from 1999 to 2010. The researchers found a positive elasticity of output with changes in port infrastructure capacities. The authors found heterogeneity in this effect between four main regions: the Yangtze River Delta with the strongest effect, followed by Bohai Rim, Southeast and Central regions. The source of these differences is the characteristics of the port itself, the economic development of the region, the relationship with international trade routes and external effects from neighboring regions. In addition to this, the density of land transport infrastructure was found to play the least role in the differences in elasticities and, as a consequence, in output efficiencies.

When it comes to social and economic infrastructures in the light of regional development, one cannot but mention education – an area "installed to be adjacent" to these two infrastructures. Education can be stimulated in various ways: by increasing the number of places available at universities, directly improving the quality of education, raising salaries for highly qualified employees, and so on. Shindo (2010) has used direct subsidies to secondary and tertiary education as an acceptable incentive for education. Using a life cycle model and calibration parameters built on data from two Chinese regions – Shindo, Jiangsu and Liaoning – two important conclusions are drawn. Firstly, significant government subsidies to higher education greatly contribute to economic growth in the region. Secondly, a predetermined difference in regional economies only grows over time.

When it comes to building up economic infrastructure, the ultimate goal of economic policy is often to stimulate the economy. However, economic policies to improve infrastructure routinely aim not so much to boost a particular region, as to eradicate fundamental differences in neighbouring regions. Fan, Zhang have just that goal. Using census data from the rural regions of China, as well as official statistics, the authors were seeking to assess the role of infrastructure and public capital in rural areas of neighbouring regions of China (Fan & Zhang, 2004). The system of simultaneous equations was used as an estimation method. This method was chosen because of the need to estimate simultaneously the impact of infrastructure on farm and other products. The conclusions obtained in the paper are quite nontrivial. The authors argue that rural infrastructure and education contribute more to regional differences than agricultural productivity. What is more, low levels of productivity in the western regions of the country are primarily attributed to education, technology and infrastructure.

5. Research Methods

The paper uses the next econometric specifications: a Two-Step Least Squares Method with fixed-effects (2SLS).

Description of 2SLS model:

$$\ln(GRP_{it}) = \beta_{econ,j} X_{econ,it} + \beta_{socio,j} X_{socio,it} + \beta X_{it} + FE_t + \epsilon_{it},$$

where $\ln(GRP_{it})$ is the natural logarithm of gross regional product in nominal terms in region i during period t; $X_{econ,it}$ is quality of economic infrastructure in region i in period t; $X_{socio,it}$ is quality of

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social infrastructure in region i in period t; $\boldsymbol{X_{it}}$ are control variables of region i in period t; $\boldsymbol{FE_t}$ are fixed effects in period t, dummy variable equal to one for some regions of the country; $\boldsymbol{\epsilon_{it}}$ is the regression error of region i in period t.

With this specification, the problem of endogeneity is likely to come up: financial capacity, initial quality of infrastructure in developed regions is much higher than in developing regions. Roughly speaking, a developed region can afford to build one more stadium but a developing region cannot. Real gross regional product, as well as nominal and real GRP per capita, were used as a dependent variable.

Investing more money in wealthy regions can be easier and in larger volumes than in poor regions. There are several ways to address this challenge. The first way is to examine changes rather than absolute indicators. In other words, it is necessary to construct a 2SLS model estimate where the increment of the logarithm of the gross regional product would be the dependent variable, rather than the logarithm of the gross regional product. This approach partially removes the problem of endogeneity, since it gives the percentage difference. The problem is that this approach does not address simultaneous causality. The second way to overcome endogeneity is rather traditional. It implies using an instrumental variables. In general, two-step regressions with instrumental variables have the following specification:

$$\ln(\boldsymbol{GRP_{it}}) = \boldsymbol{\alpha_i}\, \boldsymbol{\beta_{econ,j}X_{econ,it}} + \boldsymbol{\beta_{socio,j}X_{socio,it}} + \boldsymbol{\beta\widehat{X}_{it}} + \boldsymbol{FE_t} + \boldsymbol{\epsilon_{it}}$$

$$\boldsymbol{\widehat{X}_{it}} = \boldsymbol{\beta_{istr,j}X_{instr,it}} + \boldsymbol{\beta_{exog,it}X_{exog,it}} + \boldsymbol{\varepsilon_{it}},$$

where $\boldsymbol{\widehat{X}_{it}}$ are endogenous variables, $\boldsymbol{X_{instr,it}}$ are instrumental variables. Such models are estimated through a general rule of thumb saying that the number of instruments should be no less than the number of endogenous variables. An equity contribution aimed at reconstruction and renovation in the total volume of investments in fixed assets will be used as an endogenous variable. This metric measures the extent to which the region is ready to invest and is investing in infrastructure renewals. The following indicators will be used as instruments: life expectancy, number of deaths per 100,000 people of working age, population density per 10,000 persons (as of January 1), migration growth per 10,000 people, number of road accidents and victims per 100,000 people, density of autoroads with hard covering, km. per 10,000 km2.

The chosen endogenous variable and instruments are due to the following set of factors. Firstly, investment behaviours in the region should be explored based on the “size” of the region, both in economic, social and demographic dimensions. Accordingly, the metrics used to measure investments in infrastructure should be relative, i.e. expressed as a percentage of the economic indicators of the region, be it the consolidated budget of the region or the volume of investments in the region. Secondly, 2008-2009 was marked with an external investment shock – a crisis in the US financial market. Investments in many regions were either completely curtailed or partially suspended. Many investment projects were in doubt. Accordingly, it can fairly be argued that in 2010 a new investment cycle began, requiring new calculations of regional investment efficacy. Of course, it is impossible to take into full account the pre-crisis heterogeneity of the regions. However, this approach is designed to mind the difference in investment recovery, tied to the initial heterogeneity. Hence, the endogeneity can be considered as largely solved herewith.

To avoid the problem of endogeneity, the variables responsible for the Siberian and Far Eastern Federal Districts were excluded from the fixed effect variables. Therefore, the fixed effect variables need

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to be viewed in comparison with these two districts. Most of the significant variables in all regression specifications are influenced according to theoretical predictions. Of the variables responsible for assigning to the federal district, the Ural Federal District variable alone is significant in all four specifications, which suggests that the differences between the Ural Federal District and the Far Eastern Federal District, as well as the relative homogeneity of the regions within the immediate federal district, are relatively stable. The effect that the number of nurses has on GRP per capita indicates a significant marginal effect of further medical infrastructure improvements. The number of stadiums per capita has an unexpectedly negative impact on nominal GRP. This is most likely an indication that such investments are inefficient: substantial investments in stadiums do not generate meaningful income for the city or region. Interestingly, the number of theaters significantly affects the nominal GRP, rather than the real one. However, this relationship is not frequent and meaningful enough to talk about a major impact. Electricity infrastructure and retail space also have a positive and sound effect on the economic growth of the region, which is consistent with the theory.

6. Findings

An example specification for instrumental variable model is shown below and the results of 2SLS estimation are given in Table 1:

First-step regression equation:

$$\boldsymbol{Investment_{it} = \alpha + \beta_0 * Life.expectancy_{it} + \beta_1 * Price.sq.m_{it} + \beta_2 * Migration.coef_{it} + \beta_3 * Deaths.per.100000_{it} + \beta_4 * Road.Accidents_{it} + \beta_5 * Roads_{it} + \beta_6 * Newly.built.buildings.space_{it} + \epsilon_{it}}$$

Second-step regression equation:

$$\boldsymbol{ln(GRP_{it}) = Region.dummy_{it} + \alpha_0 * Digitalization_{it} + \alpha_1 * Market.place_{it} + \alpha_2 * Doctors_{it} + \alpha_3 * Medical.intern_{it} + \alpha_4 * Stadiums_{it} + \alpha_5 * Theaters_{it} + \alpha_6 * Railroads_{it} + \alpha_7 * Energy_{it} + \alpha_8 * University.students_{it} + \varepsilon_{it}}$$

Table 1. Results of 2SLS estimation[1]

Variables	log(GRP nom)	log(GRP real)	log(GRP nom per c)	log(GRP real per c)
Reconstruction investment share	-0.0723***	-0.0212***	-0.0987***	-0.0275***
	(0.0264)	(0.00792)	(0.0274)	(0.00995)
Central	-0.137	-0.451	0.223	-0.117
	(0.579)	(0.500)	(0.335)	(0.235)
North West	-0.588	-0.406	-0.271	-0.0409
	(0.567)	(0.517)	(0.309)	(0.231)
South	0.117	-0.333	0.0166	-0.295
	(0.635)	(0.587)	(0.342)	(0.259)
North Caucasus	-0.523	-1.032*	-0.414	-0.783***
	(0.597)	(0.548)	(0.333)	(0.243)
Volga	0.468	0.196	0.219	-0.0643
	(0.519)	(0.456)	(0.312)	(0.211)
Ural	1.162	1.021	0.592	0.280
	(0.725)	(0.671)	(0.409)	(0.296)

[1] compiled based on the calculations of the author in the Stata14 package

Digitalization	0.00288	-0.000454	0.00222	0.000300
	(0.00350)	(0.00103)	(0.00437)	(0.00131)
Retail space per 1,000 people sq	0.000421	-3.89e-05	0.000262	-7.53e-05
	(0.000441)	(0.000134)	(0.000468)	(0.000166)
Doctors per 10,000 persons	-9.293	6.451	43.61	15.26
	(35.59)	(10.36)	(43.67)	(13.34)
Medical intern per 10,000 persons	76.39**	-0.00821	63.06	35.51**
	(37.04)	(10.73)	(47.18)	(13.87)
Stadiums per 100,000 persons	0.0370	0.0107	0.0136	0.0197
	(0.0406)	(0.0117)	(0.0516)	(0.0152)
Theater visitors per 1,000 persons	0.000611	-0.000105	0.000669	-0.000212
	(0.000988)	(0.000315)	(0.000892)	(0.000376)
Railroads	0.00294	0.00271*	0.000772	0.000406
	(0.00187)	(0.00144)	(0.00106)	(0.000760)
Energy in rubles per capita	2.56e-05**	6.31e-06	1.41e-05*	1.07e-05**
	(1.12e-05)	(4.00e-06)	(8.39e-06)	(4.32e-06)
University stud per 10000 persons	-15.94***	-2.058*	-17.74***	-3.544**
	(3.661)	(1.085)	(4.292)	(1.377)
Intercept	12.92***	12.66***	6.510***	5.418***
	(0.986)	(0.407)	(1.012)	(0.375)

Standard errors in parentheses

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

Table 2. Results of 2SLS estimation with a lag tool. Second version of the specification[2]

Variables	log(GRP nom)	log(GRP real)	log(GRP nom per c)	log(GRP real per c)
Reconstruction investment share	-0.00261	-0.00877***	-0.00755	-0.00868**
	(0.00592)	(0.00318)	(0.00662)	(0.00344)
Central	-0.612	-0.480	-0.227	-0.181
	(0.457)	(0.432)	(0.195)	(0.193)
North West	-0.625	-0.357	-0.223	0.0273
	(0.457)	(0.457)	(0.189)	(0.190)
South	-0.0762	-0.343	-0.0406	-0.315
	(0.521)	(0.522)	(0.215)	(0.216)
North Caucasus	-0.349	-0.882*	-0.193	-0.730***
	(0.510)	(0.515)	(0.213)	(0.212)
Volga	-0.00582	0.118	-0.281	-0.195
	(0.407)	(0.405)	(0.171)	(0.170)
Ural	0.834	0.980	0.105	0.208
	(0.593)	(0.601)	(0.243)	(0.245)
Digitalization	0.00835***	0.00153*	0.00933***	0.00294***
	(0.00155)	(0.000834)	(0.00172)	(0.000899)
Chain share in retail trade	0.0173***	0.00155**	0.0180***	0.00265***
	(0.00120)	(0.000646)	(0.00130)	(0.000691)
Doctors per 10,000 persons	-1.183	2.863	4.955	10.44
	(11.03)	(5.956)	(11.96)	(6.374)

[2] compiled based on the calculations of the author in the Stata14 package

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Medical intern per 10,000 persons	58.79***	-5.416	92.75***	27.24***
	(11.58)	(6.251)	(12.61)	(6.695)
Stadiums per 100,000 persons	0.0541***	0.0118*	0.0577***	0.0226***
	(0.0121)	(0.00653)	(0.0135)	(0.00704)
Theater visitors per 1,000 persons	0.00115***	5.16e-05	0.00121***	0.000193
	(0.000248)	(0.000134)	(0.000265)	(0.000143)
Railroads	0.00313**	0.00256**	0.000444	0.000240
	(0.00138)	(0.00110)	(0.000636)	(0.000606)
Energy	1.18e-05***	3.13e-06	1.21e-05***	5.60e-06**
	(4.13e-06)	(2.30e-06)	(3.72e-06)	(2.31e-06)
University students per 10,000 persons	-15.80***	-0.198	-16.17***	-0.830
	(1.529)	(0.826)	(1.648)	(0.883)
Intercept	10.98***	12.26***	3.723***	4.797***
	(0.372)	(0.307)	(0.300)	(0.184)
	Standard errors in parentheses			

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

7. Conclusion

In the specification in Table 2, the data on retail space per thousand people is replaced by the percentage of retail chains in retail turnover. This replacement produced several interesting effects. The level of digitalization began to have a significant impact on the economic growth of the region. Most likely, this change is due to the fact that digitalization was rather responsible for the extensive part of the economic growth of the region, while the percentage of retail chains acted as an indicator of intensive growth. A similar logic applies to the newly significant variables that characterize the number of stadiums per capita and the number of theatres.

The construction of buildings is more likely to be extensive growth, while the replacement of local retail players with established brands increased the quality of products sold (intensive growth), and hence the regional produce. A negative impact of the number of universities came to be a rather unexpected result of the model. It would seem that educated people should increase the region's GRP, not decrease it. This part of the study remains unclear. Perhaps this relationship is due to the fact that the costs of training professionals do not pay off within the region or the fact that the establishment of another university is not so productive for the regional economy.

Having studied the literature describing the experience of Russian and foreign researchers of the regional economy in assessing the importance of social and economic infrastructures, the main sources of economic growth in regions, as well as states and/or provinces, were identified depending on the status of the region, its current level of development, geographical position and population quality. The researchers of regional development gradually came to investigate the quality of social and economic infrastructures for the economic development of regions. At first, not all types of infrastructures were considered determinative in regional development.

Being gradually integrated into studies of regional development and disparities, social, political, economic impacts significantly improve the quality of economic analysis of the situation in the regions and propose a new set of measures to combat regional inequalities. Investing in the same type of infrastructure in different regions can have fundamentally different effects. The heterogeneity of regions in terms of the quality of institutions, economic and resource potential makes it necessary to divide regions into groups that have composition differing from that of the federal districts. Following Zubarevich's classification, the regions can be divided into three categories: regions with a low, medium and high level of social and economic infrastructures. The regions with a low level of social and economic infrastructure should allocate resources to develop transport network in order to achieve the maximum effect from investments. The regions with a medium level of social and economic infrastructure, in order to achieve the maximum effect from investments, should direct resources to the telecommunications network, as well as construction. The regions with a high level of social and economic infrastructure should allocate resources to education and "green" technologies in order to achieve the maximum effect from investments (Zubarevich, 2010).

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