Sources of Endogenous Economic Growth in 83 Russian Regions

Abstract

According to the theory of endogenous growth, technologies play a key role in economic development. Digital technologies, as innovations that create new innovations, change economic activity and create new opportunities for economic growth. Digitalization helps to reduce specific economic costs, changes the nature of work. It also causes the substitution of labor with capital. The study is devoted to characterizing the features of regional development and evaluate digital predictors of economic growth. We used a sample of data from 83 regions in the period 2009-2019, excluding from the sample years 2020 and 2021 because of changes in economic dynamics under the influence of pandemic shocks. Econometric estimates are obtained using least squares and a feasible generalized least squares method based on unidirectional panel data models. A statistically significant influence of the number of university students, innovation costs on the growth rate of gross regional product per capita was found. The impact of the number of granted patents and the number of Internet users of the organization on the regional development was not confirmed. The results of the study emphasize the necessity of state science and innovation policy to reduce technological inequality, strengthen macroeconomic stability, high level of qualifications and technologies. The direction of further research can be the creation of indicator system measuring the quality of political and economic institutions.

Endojen Ekonomik Büyümenin Kaynakları: 83 Rus Bölgesi

Özet

Endojen büyüme teorisine göre, teknolojiler ekonomik kalkınmada kilit bir rol oynamaktadır. Dijital teknolojiler, yeni inovasyonlar yaratan yenilikler olarak ekonomik faaliyetleri değiştirmekte ve ekonomik büyüme için yeni fırsatlar yaratmaktadır. Dijitalleşme belirli ekonomik maliyetleri azaltmaya yardımcı olur, işin doğasını değiştirir. Ayrıca emeğin sermaye ile ikame edilmesine neden olur. Çalışma, bölgesel kalkınmanın özelliklerini karakterize etmeye ve ekonomik büyümenin dijital belirleyicilerini değerlendirmeye ayrılmıştır. Pandemi şoklarının etkisi altında ekonomik dinamiklerdeki değişiklikler nedeniyle 2020 ve 2021 yıllarını örneklem dışında bırakarak 2009-2019 döneminde 83 bölgeden bir veri örneği kullandık. Ekonometrik tahminler, tek yönlü panel veri modellerine dayalı en küçük kareler ve uygulanabilir bir genelleştirilmiş en küçük kareler yöntemi kullanılarak elde edilmiştir. Üniversite öğrencisi sayısının, inovasyon maliyetlerinin kişi başına gayrisafi bölgesel hasılanın büyüme oranı üzerinde istatistiksel olarak anlamlı bir etkisi bulunmuştur. Verilen patent sayısı ve kuruluşun internet kullanıcı sayısının bölgesel kalkınma üzerindeki etkisi doğrulanmamıştır. Çalışmanın sonuçları, teknolojik eşitsizliği azaltmak, makroekonomik istikrarı, yüksek nitelik ve teknoloji seviyesini güçlendirmek için devlet bilim ve yenilik politikasının gerekliliğini vurgulamaktadır. Daha ileri araştırmaların yönü, siyasi ve ekonomik kurumların kalitesini ölçen gösterge sisteminin oluşturulması olabilir.

Prof. Dr. Nailya Bagautdinova (Kazan Federal University, Kazan, Russia)
ORCID: 0000-0003-3959-7134 **Email:** nailya.mail@mail.ru

Ph.D. candidate Ekaterina Kadochnikova (Kazan Federal University, Kazan, Russia)
ORCID: 0000-0003-3402-1558 **E-mail:** kad-ekaterina@yandex.ru

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1 Introduction

The main characteristic of modern economic growth in Russian regions is a steady growth in per capita income in the developed regions. Growth is impossible without economic development, which results in qualitative and quantitative changes in the structure of the economy, its institutional structure, workers' qualification, the level of technology which ultimately cause an increase in the quality and length of life. On the one hand, long periods of positive growth rates affect the sectoral structure of the economy and its institutions, initiating economic development. On the other hand, sustainable growth rates are impossible without the existence of its determinants, that is, without development. Traditionally, A. Smith's theory uses the production function known we know to us to model the sources of economic growth. In the Harrod-Domar model (Harrod, 1939), the specific resources of labor and capital are exogenous. More recently, neoclassical theory has identified technological progress as a major long-term exogenous factor (Solow, 1956; Swan, 1956). Then the emphasis was placed on investment for technological development, according to F. Knight, F. Ramsay, R. Solow (Solow, 1956). Proponents of the theory of endogenous growth explained why technological progress is endogenous. And in the writings of Kenneth J. Arrow (Arrow, 1962), it was suggested that the sources of technological progress are investment and human capital, which increases through training. Consequently, technological progress is formed within the economic system. At the end of the last century, scientists substantiated the theory of endogenous growth through the dissemination of knowledge, research and development (Romer, 1986; Romer, 1990; Romer, 1994, Aghion P., Howitt, 1992). The acquisition of new technologies or the copying of already known ones changes the total factor productivity (Aghion et. al., 1998), and a number of factors affect technological progress (Aghion and Howitt, 2008).

One of the properties of the Russian economy is that there is a gap in the productivity level of companies within the same industry. This gap in the productivity level ranges from 9 to 24 times (HSE University, 2019). This indicates high barriers to market entry and limited competition. A weak competitive environment or its absence does not offer incentives to create new technologies and improve labor productivity. The application of knowledge and skills enhances the intrinsic quality of investments. And the detailing of knowledge and skills gives a deep division of labor and a monopoly competitive advantage. This contributes to sustainable economic growth and increased returns on capital. The penetration of technologies through their copying brings growth closer together between countries (Barro, 2014). The mechanism of such diffusion of technologies is simple: cheap costs for copying and using ready-made inventions enable countries to catch up with their technological leaders; sometimes the technology in the successor country is adapted by attracting foreign capital from the leader country.

The rapid development of digital technology is transforming economic activity. Modern economics science does not yet have a single, "classical" definition of digitalization; the question of the benefits of digital resources for technologically advanced economies and the negative effects of resource wealth also remains controversial. There are different points of view about how digital is changing economic activity, but scholars agree on one thing - digitalization reduces a number of specific economic expenditures and leads to the replacement of labor for capital in the structure of production resources. In particular, the study (Goldfarb, Tucker, 2019) shows five such expenditures: digital search, reproduction, transportation, control and verification of business processes. Nevertheless, at the current "starting" stage of digital transformation, following the active downward cost change inherent in the digital context, one can expect qualitative and quantitative shifts in economic development. The positive relationship between information and communication technologies and economic growth is shown in different papers (Roller, Waverman, 2001; Holt, Jamison, 2009; Castaldo et.al., 2018; Pradhan et.al., 2018). For the Russian economy, similar studies were carried out in papers (Kolomak, 2011, Kramin et al., 2016, Kramin, Klimanova, 2019, Kramin, Imasheva, 2020), showing the positive impact of ICT infrastructure (Kolomak, 2011), digital industrial infrastructure capital , mobile Internet (Kramin, Klimanova, 2019), expenditures on information technology and communications (Kramin et al., 2016, Kramin, Imasheva, 2020), of the number of organizations that used the Internet (Kramin, Imasheva, 2020), on GRP per capita in the regions.

Based on these considerations, it seems interesting to answer *research questions*: What trends are characteristic of modern economic development in the regions? What results of economic development are the key determinants of economic growth in the regions?

The first section describes the methods and sources of empirical data. The second section analyzes the features of regional development in Russia and econometric analysis of panel data. The third section presents a discussion based on empirical evidence. The conclusion last section contains conclusions and directions for future research.

2 Materials and Methods

The article focuses on determining the features of economic development in the regions and to assess the determinants of economic growth. The objectives of the study are descriptive statistical analysis of income, technology, savings, consumption in Russian regions and econometric analysis of GRP per capita based on panel data. Regional data sourced from the collections "Regions of Russia. Socio-economic indicators, for 2009 - 2019.

Variables	Mean	St. D.	Min	Median	Max
Growth rate of real gross regional product per capita	1,02	0,04	0,93	1,00	1,09
Growth rate of real expenditures on technological innovation per capita	1,12	0,13	0,74	1,12	1,54
The volume of investments in fixed assets per capita, thousand rubles	98,35	60,25	29,45	83,76	345,09
Number of issued patents for inventions, pcs.	271,98	316,68	0,00	160,54	2003,10
Number of university students, thousand people	250,86	84,97	46,11	249,98	571,04
Internet use in organizations, %.	88,66	7,34	69,43	93,87	99,12

Table 1. *Descriptive statistics of variables in 2019.* ***Source:*** *received by the author*

Panel study has three independent approaches: pooled model, FE, RE. Pooled regression model equation in component notation is as follows:

$$y_{i_t} = bX_{it}^{'} + a + \varepsilon_{it} \quad (1)$$

where

$X_{it}^{'}$ - row vector of deterministic regressor values;

a, b - regression coefficients, the same for all observations;

ε_{it} – regression residuals that have a normal distribution law and correspond to the conditions of the classical linear regression model.

In a pooled regression model, all objects in the sample have the same behavior. To estimate such a model, the least squares method (OLS) is used.

Regression model with deterministic individual effect (fixed effect model - FE-model). Model equation in its component notation is the following:

$$y_{i_t} = bX_{it}^{'} + a_i + \varepsilon_{it} \quad (2)$$

In the FE model, the constant ai measures the individual differences in the dependent variable for each panel. The nature of these differences does not change over time, they (differences) are due to the influence of missing variables. The main advantage of the FE model is the measurement of individual panel differences.

However, this flexibility often has to be paid for by the loss of significance of the estimates (due to the increase in their standard errors), since N unnecessary parameters have to be estimated. In addition, the need to invert a high-dimensional matrix (N + K) causes computational difficulties. Regression model with a random effect model (RE-model). In matrix notation, the model equation is:

$$y_{i_t} = bX_{it}^{'} + a_i + \alpha + \varepsilon_{it} \quad (3)$$

In the RE model, estimates have a higher statistical significance than in the FE model. This model takes into account random individual differences in economic growth in each region, these differences are measured by α_i.

3 Results

As can be seen from Figure 1, geopolitical constraints have caused a reduction in technological imports and reduced the diffusion of technologies within the country. (Figure 1).

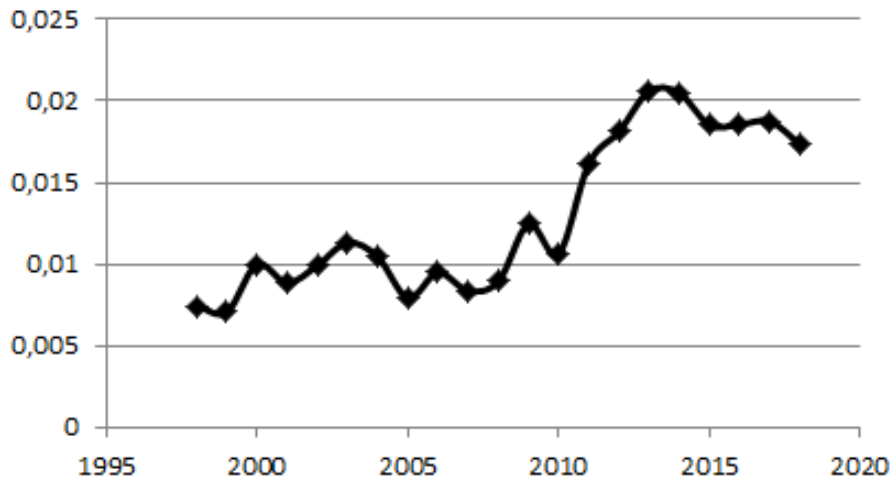

Figure 1. *The share of the cost of technological innovation in the GRP of Russia in basic prices.*

We are only at the beginning of the digitalization. Russia generates 2.8% of gross value added in the ICT sector. Estonia is the leader in Europe (6.1%). In Russia for the period 2014-2019 the average growth rate of the share Internet users was 104.72%.

For the period from 1998 to 2019, there is a decrease in the growth rate of the GRP. The sustainable economic development is determined by its internal market (basic industries, resources, jobs, income) and external factors (Chart 2).

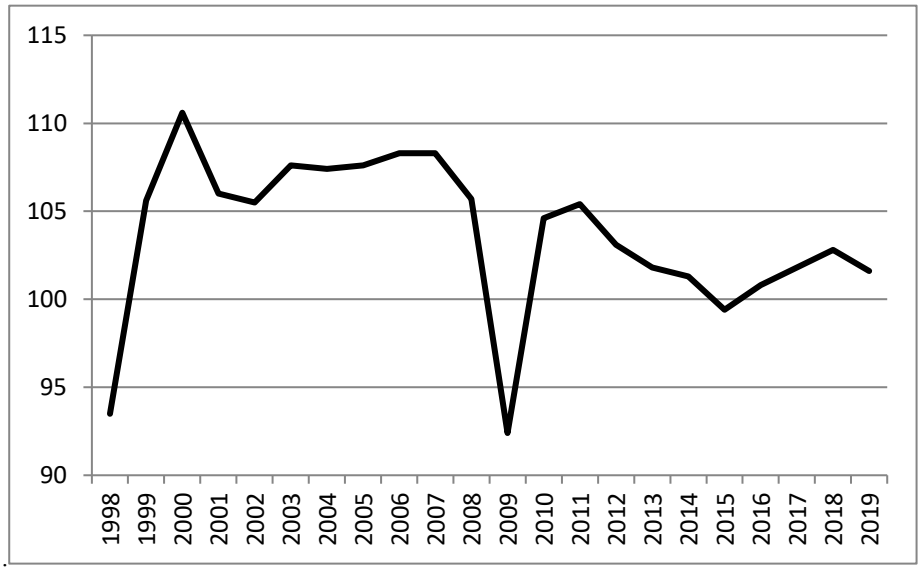

***Figure 2**. GRP growth rate, in constant prices, for the period of 1998-2019.*

What features are observed in the development of Russian regions today? The variation in the level of per capita income is increasing, and the growth rates of income in the most developed regions are more stable (tabl.2). GRP per capita in 2018 ranges from 112 thousand rubles (the Republic of Ingushetia) to almost 7 million rubles in the Nenets Autonomous District. Average income per capita in 2019: from 16 thousand rubles (Republic of Tyva, Republic of Ingushetia) to 83 thousand rubles (Yamalo-Nenets Autonomous Okrug, Chukotka Autonomous Okrug).

	2010	2011	2012	2013	2014	2015	2016	2017	2018
GRP per capita, thousand rubles									
Aver.	277.4	331.2	359.4	387.8	427.6	481.1	512.0	406.8	637.5
Min	48.2	63.6	77.9	91.6	109.6	106.8	106.8	81.1	112.6
Med.	181.7	223.6	246.4	265.8	296.1	323.4	344.5	276.9	417.9
Max	3466.2	3910.9	3687.0	4036.7	4328.9	5210.9	5819.9	4419.1	6950.4
Monetary income of the population per capita, rub									
Aver.	17339.5	18959.01	21353.4	23400.3	25317.8	28189.6	28631.5	29505.6	30657.4
Min	7774	8829	10190	11673	12992	15191	14963	15011	15603
Med.	14697	16032	18450	19950	21979	25283	25355	26058	26828
Max	52270	54632	62323	66887	66981	72146	72358	76027	79398

***Table 2.** Dynamics of income indicators in the in Russian regions*

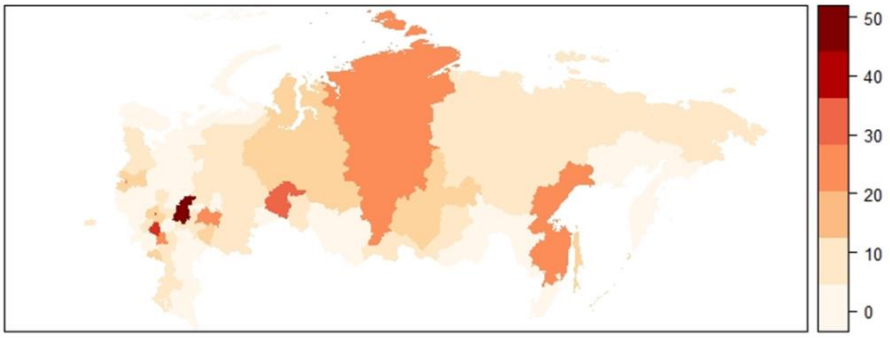

***Figure 3.** Cartogram of ETI per capita of the employed population, in 2019, thousand rubles.*

In the consumer sector - insufficient use of digital technologies and digital inequality in the regions (Chart 4). In 2019, 52% of Internet users in Russia carried out online banking operations, 37% - searched for health-related information, 33 % - purchased goods and services online, 8% - searched for the job, 7% - used online goods and services, 5% - rent housing, 3% - were learning online. In 2019, the share of Internet users in Russian population ranges from 71% (Ryazan region) to 97% (Yamalo-Nenets Autonomous Okrug).

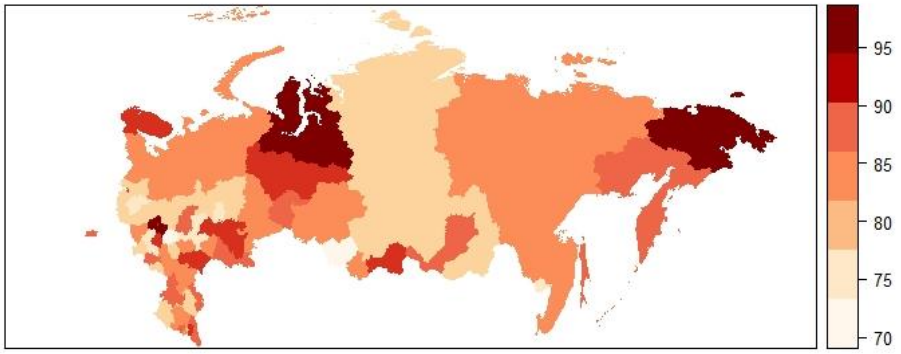

Figure 4. *Cartogram of the share Internet users in Russian population in 2019.*

All specifications of panel data analysis models for the growth rate of GRP per capita (Table 3) for 70 regions (after eliminating emissions) from 2010 to 2019 confirmed the statistically significant influence of the volume of investment in fixed assets per capita, the number of university students, the expenditures on technological innovation, which is consistent with the concept of endogenous economic growth. The impact of the number of granted patents for inventions and the use of the Internet in organizations on the growth rate of GRP was not found. It can be assumed that ICTs are widely used in the regions and there is often a lack of a high level of inventions.

Regressors	Dependent variable: growth rate of real gross regional product per capita by 2009		
	OLS	FE	RE
Growth rate of real expenditures on technological innovation per capita	2.175e-06**	1.118e-05**	1.217e-07**
Investments per capita, thousand rubles	2.672e-04***	4.221e-04 ***	3.239e-04 ***
Number of students in higher educational institutions, thousand people	2.263e-04***	3.995e-04 ***	3.263e-04 ***
Number of issued patents for inventions, pcs.	9.073e-06	-1.540e-05	-2.889e-07
Internet use in organizations, %.	3.026e-04	2.295e-04	1.656e-04
Intercept	5.312e-02		4.873e-02
Adj. R^2	0.157	0.150	0.212
p-value (F)	< 2.21e-16	2.21e-16	
p-value (Xi^2)			2.21e-16
n	700	700	700

Table 3. *Results of evaluating panel data analysis models.*

4 Discussion

At present, amid the differentiation of regional development in our usual sectors of the economy, a fairly stable growth of digital markets and acceleration of the digital transformation of the economy should be expected due to its advantages: rapid reengineering of business processes, business models with a minimum of physical assets, the replacement of labor with capital, and the growth of information and knowledge resources. In this regard, we note that in the context of the mechanisms of the “resource curse” (Polterovich et. al., 2007), dispersed digital resources require the availability and transfer of complex technologies, contribute to the accumulation of knowledge, the development of human capital, the openness of the regional economy (technological mechanism), and contribute to transparency of institutions and a decrease in corruption through electronic public services (institutional mechanism), cause an increase in the share of highly qualified labor force, social capital, faster development of civil society, an increase in demand for democratic institutions (political mechanism), make it possible to respond quickly and rebuild business processes, promote an increase in demand and investment through the diffusion of technologies through their replication (macroeconomic mechanism).

As with resource-rich economies, digital abundance requires government intervention, and market efficiency in accounting for the economic and political benefits of digital wealth will be determined by the quality of institutions in society.

The study graphically demonstrated the negative impact of the savings rate on the average growth rate of consumer spending per capita, which may indicate the dynamic inefficiency of the economy in the regions and inequality in the distribution of income and consumption. The savings rate is physically limited to one. Therefore, for the long-term growth of average per capita income and consumption within the framework of the neoclassical structure, it is advisable to use an unlimited resource - knowledge and technology. This means that growth and development should be generated by technological progress, and not by the accumulation of physical capital.

As the cartograms show, the uneven distribution of knowledge in the regions is associated with technological inequality. There are clubs of regions with high and low costs of technological innovation. The methods of spatial econometrics (Bagautdinova, Kadochnikova, 2020) showed the technological cooperation of regions in the short term: clubs of technological leaders “pull out” their neighbors. In the long term (Bagautdinova, 2021), almost all models demonstrated regional competition in terms of technological innovation: strong attraction of innovations from weak ones. The models also showed a statistically significant negative spatial autocorrelation coefficient for the shock, again predicting regional competition in technological innovation spending over the long term.

5 Conclusion

The empirical results presented above make it possible to ascertain the economic and technological inequality of Russian regions and determine the key properties of the economy necessary for sustainable economic growth: developed political and economic institutions, macroeconomic stability, a high level of education, skills and technologies, and a moderate level of economic inequality.

It seems possible to use the results of the study for institutional decisions in the field of national programs for the development of regions. It is useful to influence the technological innovation expenditures in the leading and outsider regions in order to manage the problem region through the system of interaction between regions. It is also advisable for the institutes of strategic management of regional development to influence the savings rate in order to involve cash liquidity in economic circulation, on demand and digitalization in the consumer sector in neighboring regions in order to manage the problem region through the system of regional cooperation, develop online services in systematic household practices (investing savings, obtaining public services, purchase of goods and getting financial, educational and other services). The findings can be used to implement the concept of sustainable economic growth in the regions based on an institutional approach, taking into account spatial differentiation.

Further research on the economic growth and development of Russian regions may be devoted to measurement of statistical indicators of reserves, production and export of digital resources, the formation of a system of indicators measuring the quality of political and economic institutions (the export basket index, the index of doing business, the index of economic freedom, the index of life expectancy, etc.).

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