**Assessing the impact of digitalization on innovation activity:**

**is there a convergence of Russian regions?**

*Bagautdinova Nailya Gumerovna, Kadochnikova Ekaterina Ivanovna*

*Kazan Federal University*

The surge in the digitalization and import substitution exacerbates the discussion how digital resources affect the growth of innovative activity in the regions. The volume of innovative products produced by information and communication enterprises in 2021 amounted to 370.6 billion rubles (+43%)[[1]](#footnote-1). The positive or negative impact of resource abundance on economic growth rates is determined by government policy measures and the quality of institutions[[2]](#footnote-2). According to the studies of Simon Kuznets, Robert Lucas and Paul Romer[[3]](#footnote-3), new growth opportunities due to digitalization[[4]](#footnote-4), as well as technological, institutional, macroeconomic mechanisms of dispersed digital resources, substantiate theoretically the relevance of empirical confirmation of its effect for the creation of new (innovative) goods, work, services. Through copying and borrowing technologies, technology followers are catching up with the leaders and helping to reduce technological disparities. Therefore, the *research question* is the case of interest: Is there a convergence in the production rates of new goods, work, services in the regions in the long term? *The hypothesis of the study* is the assumption that technological inequality reduces under the influence of digitalization, taking into account spatial interaction, which means that there is no negative impact of the digital resources abundance on growth, which is an argument for evidence-based innovation policy.

*Model*. A panel data from the collections “Regions of Russia. Socio-economic indicators” was selected for 2010-2020. According to the methodology of measuring convergence[[5]](#footnote-5) to test σ-convergence/divergence, the variation coefficients of the share of innovative goods, work, services in the volume of the shipped goods, work, services are determined. To measure the unconditional and conditional β-convergence of the growth rate of innovation, the logarithm of the average growth rate of the share of innovative goods, work and services in the volume of shipped goods, work and services was used. Independent variables of interest is the use of broadband Internet access in organizations, %; number of personal computers per 100 employees, pieces. Control variables[[6]](#footnote-6) are investment in fixed capital per capita, rub. (as a proxy for the regional development), the cost of technological innovation per capita, thousand rubles (as a proxy for technology development in the region); number of personnel engaged in R&D per 10,000 population; internal expenditures on R&D per capita, thousand rubles. To detect spatial interactions, the Moran and Giri global spatial correlation indices and econometric models for analyzing panel data by SAR, SEM types with fixed and random effects[[7]](#footnote-7) (R software environment, splm package) were used:

 





 where i=1,…81 is the number of the region, [t0+T] is the year for the convergence period, yi,t0 is the share of innovative goods, work, services in region *i* in the reference period (2010), k is the independent variable number, K - the number of independent variables, αi - vector of regional fixed effects, β - estimated parameter of the share of innovative goods, work, services in the initial period of time (2010), γk - parameters for independent variables; Wij - neighbors weight matrix (N=81ˣN=81), ρ - spatial autoregression coefficient, λ - spatial autocorrelation coefficient for shock, ,  εi,t0+T - random error. The β parameter measures convergence. If β<0, then conditional β-convergence occurs. This means that enterprises in weaker regions have higher growth rates in the share of innovative goods, work, and services than in richer ones, so technological inequality is decreasing.

*Results*. There is no σ-convergence of regions in terms of the average growth rate of the share of innovative goods, work, and services. The negative dependence between the logarithms of average growth rates for the period from 2010 to 2020 and the logarithm of the reference level in 2010 predicts the process of convergence of regions in terms of the growth rate of the share of innovative goods, work, and services. There is a positive spatial correlation for the digitalization of enterprises and a change in the relationship from negative to positive for the share of innovative goods, work, services, when strong regions contribute to the use of the Internet in their neighbor regions, and technological cooperation replaced the “pulling” of innovations. There are local spatial clusters of the share of innovative goods, work, services which are similar to neighboring territories in the Tyumen and Omsk regions; the Nizhny Novgorod, Samara, Ulyanovsk and Perm regions, the Republic of Tatarstan, Moscow and the Moscow region, and digitalization of enterprises - in the Kamchatka, Magadan regions; Omsk, Tomsk, Novosibirsk regions; Belgorod, Voronezh, Lipetsk regions; Moscow and the Moscow region.



Fig. 1. Cartogram of the share of innovative goods, works, services in the volume of shipped goods, works, services in the regions of Russia in 2020

 On the spatial Moran’s diagrams, the number of regions in the HH and HL quadrants increases over time. Models of unconditional and conditional β-convergence predict convergence in the regions in the long term, while in the short term the technological inequality of the regions grows[[8]](#footnote-8), which does not contradict theoretical judgments about a decrease in growth rates due to diminishing returns of production factors[[9]](#footnote-9). Specific features of regional economies are confirmed by the models of conditional β-convergence on panel data. The spatial coefficients (ρ) and (λ) predict technology competition in regions and the impact of shocks in neighboring regions on the growth rate of the share of innovative goods, work, and services in a given region. The models forecast a positive impact of investments in fixed capital and expenditures associated with technological innovations on the average growth rate of the share of innovative goods, work, and services in a given region (direct effects) and among neighbors (indirect effects). Significant positive direct effects of enterprises digitalization on the average growth rate of the share of innovative goods, work, and services were found, confirming the hypothesis being tested.

*Conclusions*. Econometric analysis revealed the convergence of regions to a stable equilibrium state in the growth rates of the share of innovative goods, work, services and their spatial dependence. However, this process is hampered by increasing dispersive internal and external economic shocks that correlate with explanatory variables and affect groups of regions. The analysis confirmed the need for state policy measures, taking into account spatial differentiation, aimed at expanding the digitalization of enterprises and maintaining innovative activity in neighboring regions in order to manage the problem region through cooperation.

*The study is* *novel* in measuring the σ- and β-convergence of innovations, taking into account the influence of digital resources and spatial relationships, in empirical evidence of the positive impact of digital resources on the growth of innovation activity and the reduction of technological inequality in regions, which is contrary to the traditional hypothesis of the resource curse.

1. Development of innovative activity in 2021. ISSEK NRU HSE.URL: <https://issek.hse.ru/news/760571653.html> [↑](#footnote-ref-1)
2. Polterovich V., Popov V., Tonis A. Mechanisms of the "resource curse" and economic policy. Questions of Economics. 2007. No. 6. pp. 4-27.

Yakovleva I. I. Econometric analysis of the "resource curse" factors. XXIII International Scientific Conference on the Development of the Economy and Society, April 4-8, 2022, Moscow, Higher School of Economics. [↑](#footnote-ref-2)
3. Kuznets, S. Modern economic growth. New Haven: Yale University Press, 1966

Romer P. Increasing returns and long-run growth. Journal of Political Economy, 1986, vol. 94, pp.1002-1037.

Romer P. Endogenous. Technological Change. Journal of political economy, 1990, vol. 98, pp. 71-102.

Lucas R. On the mechanics of economic development. Journal of monetary economics, 1988, vol. 22, pp. 3-42. [↑](#footnote-ref-3)
4. Bagautdinova N.G., Kadochnikova E.I. Digitization of the economy in the context of the COVID-19 pandemic: a view based on growth theories. In the book: Business Management in the Digital Economy. Collection of abstracts of speeches of the Fifth International Conference. St. Petersburg, 2022, pp. 13-19.

Bagautdinova N.G. On the issue of the mechanisms of the "resource curse" in the digital economy. In the collection: Fifth International Economic Symposium - 2021. St. Petersburg, 2021. P. 164-170 [↑](#footnote-ref-4)
5. Rey S J., Montouri B.D. (1999). US Regional Income Convergence: A Spatial Econometric Perspective. Regional Studies, 33(2), 143 – 156. [↑](#footnote-ref-5)
6. Griliches Z. Issues in assessing the contribution of research and development to productivity growth. The Bell Journal of Economics. 1979.Vol.10. P. 92–116.

Tereshchenko D.S. Institutional factors of innovation processes in Russian regions. Bulletin of the South Ural State University. Series: Economics and Management. 2018. V. 12. No. 2. S. 55-62 [↑](#footnote-ref-6)
7. Barro R. J., Sala-i-Martin X. Convergence. Journal of political Economy. 1992, 100 (2): P. 223–251 [↑](#footnote-ref-7)
8. Bagautdinova N, Kadochnikova E., Technological innovations: Analysis of short-term spatial effects in regions by development of econometric model//Industrial Engineering and Management Systems. - 2020. - Vol.19, Is.4. - P.888-895. [↑](#footnote-ref-8)
9. Krugman P. R. (1979). Increasing Returns, Monopolistic Competition and International Trade. Journal of International Economics. No. 9.

Solow R. M. (1999). Neoclassical Growth Theory. Handbook of Macroeconomics. ed. by J. B. Taylor, M. Woodford. North-Holland: Elsevier, Vol. 1. [↑](#footnote-ref-9)