Spatial externalities of technological innovation and economic growth

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In this paper, the attention is drawn to open questions of regional economic growth measurement. First, using gross regional product (in macroeconomics – GDP), it is difficult to assess the growth in the quality of goods, services and productivity in the economy, manifested in innovation [Coyle, 2014]. Second, interregional interactions can be an external determinant of the knowledge life cycle (in particular, technological innovations) in the modern digital economy, increasing the convergence of their growth rates.

The interest in innovation and technology transfer [Romer, 2010; Bloom, Romer et al., 2013], features of the technological structure allow us to intuitively assume that the leading role in the measurement of knowledge capital in the domestic digital economy belongs to technological innovations. The focus on the regions' intention to a sustainable state determined the study implementation in the context of β-convergence. The main objective of the paper is to compare the rate of β-convergence, short-term spatial externalities (effects) of annual growth rates of technological innovations and gross regional product for empirical testing of theoretical conclusions, reflected in [Coyle, 2014]. The use of static spatio-econometric models of unconditional and conditional β-convergence of technological innovations growth rates and economic growth in the context of measuring the national digital economy in the regions is the novelty of the work.

Following [Romer, 1990; Coyle, 1998; Barro, 2004], it is assumed that the speed of β-convergence in the growth rate of technological innovation outpaces the rate of β-convergence in economic growth rates, and their spatial externalities have a different influence on the processes of β-convergence.

By method of maximum likelihood in the R environment according to the anthology "Regions of Russia. Socio-economic indicators. 2017." static spatio-econometric models with the spatial lag of the dependent variable, errors, regressors or lag combinations (SLM, SEM, SDM, SDEM, SAC, SLX, GNS) [Anselin, 1988; LeSage, Pace, 2009] unconditional and conditional β-convergence for two dependent variables were estimated: the logarithm of expenditure on technological innovation growth rate per capita, the logarithm of GRP growth rate per capita. Following the studies [Barro, Sala-i-Martin, 1991; Lugovoy, 2007; Fischer et al., 2009; Kolomak, 2010; Balash, 2012; Scherngell et al., 2014; Demidova, Ivanov, 2016], control

variables were: the investments volume in fixed capital per capita, thousand rubles, the number of Universities students, thousand people, the number of patents granted for inventions, pcs., the use of the Internet in organizations,%.

The choice of static spatial models allows studying the temporal dynamics of short-term spatial effects. The unconditional and conditional β-convergence specifications – the tendency of regions to turn to the same steady state. After the selection of GNS, SAC models [Elhorst, J. P., 2014], for comparison of spatial externalities, "another region – this region" spatial autoregressive coefficients for the externalities of "this region – the other region" - indirect limit effects were used. In the spatial-econometric models of β-convergence under the assumption of the same dimension of different dependent variables by taking the logarithm of growth rate, the conclusion on statistically significant difference of the spatial autoregressive coefficients is suggested to formulate on the basis of bounds unit values of confidence intervals comparison: if the intervals overlap, there is no statistical difference between the coefficients.

Global Moran indices confirmed the strengthening of positive spatial autocorrelation and taking into account spatial effects from 2013 to 2016, which is consistent with [Balash, 2012; Demidova, Ivanov, 2016]. The economic growth rates are characterized by the predominance of regional clusters in the first (HH) and third (LL) quadrants of the Moran diagram, the growth rates of technological innovation – in the third (HH) and fourth (LH).

Consistent with [Balash, 2012; Demidova, Ivanov, 2016], the study confirms the unconditional (2013, 2014) and conditional (from 2013 to 2016) β-convergence of economic growth rates connected with the spatial competition of regions in 2015, 2016. The particular for the early stages of the digital economy development [Williamson, 1965] unconditional (2015, 2016) and a conditional (from 2013 to 2016) divergence (β-divergence) of the rate of growth of technological innovation against a background of spatial cooperation of regions in 2015, 2016 was detected, which did not allow to compare β-convergence pace. In the direction of "another region – this region" the statistical differences between the regions cooperation impact on the dismissing pace of technological innovations growth and competition of regions on β-convergence of economic growth pace were not found. In the direction of "this region – another region" statistically different influence was found in 2015: the spatial externalities of technological innovation predominated over the externalities of economic growth. These results confirm the conclusion [Coyle, 2014] that it is impossible to unambiguously assess productivity growth in the modern economy, reflected in innovation, based on the measurement of GDP.

The dependent variables of the control variable "the use of the Internet in organizations" and, unlike [Fischer et al., 2009; Scherngell et al., 2014], the control variable "the number of patents granted for inventions". In contrast to [Demidova, Ivanov, 2016], a positive relationship of the variable "the investments volume in fixed capital per capita, rub." with the rate of economic growth in most models of conditional β-convergence from 2013 to 2016 was determined, the growth rate of technological innovation in GNS models of conditional β-convergence for 2015, 2016, consistent with the results of the study [Balash, 2012].

The ambiguity of the results in the regressions of β-convergence in Russia [Glushchenko, 2010; Kolomak, 2014] was also confirmed by insignificant estimates of spatial coefficients and coefficients at spatial lags of control variables, indicating the problematic identification of short-term spatial externalities from cross-sectional data for Russian regions due to small samples [Demidova, 2014]. Therefore, in further studies it is proposed to use spatial econometric models on panel data to identify long-term spatial externalities. Comparing results of testing assumptions in comparison with the spatial concentration of economic activity [Kolomak, 2014], to assess the dispersion of technological innovations and σ-convergence of economic growth.