STATISTICAL RESEARCH OF TERRITORIAL INTERACTION AT SIMULATION OF ECONOMIC GROWTH

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Keywords: the space correlation, the space matrix of scales, factor Moran, the space clusterization, economic growth, the space log, unconditional convergence, regression, the analysis.

Problems of estimation of the space correlation in regions of Russian Federation on an instance of a model of economic growth are considered. Methods of the space econometric for the account of possible autocorrelation of evaluated indexes in space were used. Outcomes of empirical research are given and resulted, problems of presence of the space correlation of economic growth are considered, models of convergence taking into account the space links are analyzed.

Operation with regional data calls a number of the problems studied within the limits of space econometrics. From the economic point of view within the limits of customary model (unconditional or conditional) convergences the possibility of the space interaction is ignored, as it is supposed that the regions in the considered economic system represent independent geographical units. Such factors as the mobility of the capital, mobility of the human capital and a manpower, extending (diffusion) of knowledge and techniques, transport expenditures essentially influence inter-regional interaction, and on the basic indexes of region and their rates of growth. Economic ratios of the next regions are more integrated among themselves, than with others. Therefore the basic conjecture consists of the fact that regional observations can be correlated in space, that is, can be linked among themselves geographically, socially, and institutionally by factors.

From the econometric point of view the problem lies in violation of the premise of theorem Gausa-Markova about independence and non-correlatedness of errors. Errors can be correlated with explaining variables and can be spatially correlated with each other. In this case least squares method application can lead to dislodged, ineffective or inconsistent estimations. Another problem is that estimations can be dislodged because of the let pass variables: it is necessary to consider the space logs in the model which can be significant.

From the methodological point of view the endogenic and exogenic variable econometric models of regional growth as well as the residuals of the model sized up by the least squares method, should be mustered on possible space correlation. Such inspection is carried out by means of calculation of Moran's common space autocorrelation factor (Moran's I) (1), and by means of the Moran's space dispersion glow iris.

$$I = \frac{n}{S_0} \frac{\sum_i^n \sum_j^n w_{ij}(Y_i - \overline{Y})(Y_J - \overline{Y})}{\sum_i^n (Y_i - \overline{Y})^2},$$

where Y - an examined indication, $\overline{Y}$ - indication average value, and - the sum of scales of the space matrix W.

$$S_0 = \sum_i^n \sum_j^n w_{ij}$$

The key role in the space analysis is played by the matrix of scales, in which a distance measure (proximities, remoteness), and proportionality of regions are set up this or that way.

We used a standard matrix of distances in our work. Its space weights are calculated as follows:

$$W_{ij}(q) = \begin{cases} 0, & \text{если } i = j \\ 1/d_{ij}^{\gamma}, & \text{если } d_{ij} \le D(q), \\ 0, & \text{если } d_{ij} > D(q) \end{cases}$$

where d_{ij} - the distance between the regional centres, and $D(q)$ - quartiles of distances, q=1,2,3,4.

We have assumed factor r to be equal to a unit. In this case, an attraction of regions is in inverse proportion to distance. Thus, the further

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the regions are geographically the less influence they have with each other. In a case if q <4, the critical distance of cutting off out off which the intercoupling is considered insignificant, is a matching distance quartile $D(q)$. We took q=4, in this case, in a matrix of scales all distances are taken into account, so nulls contain principal diagonal elements only.

At the space analysis as distance measures between regions we used distance between centroids of regions. Calculation of distances has been implemented by means of software MapInfo. The use of such index as minimum distance between regions at the analysis is more preferable from the geographical point of view as this index displays the shortest "geographical" distance reflecting minimum temporary expenditures for passing the distance between centroids of regions. It is necessary to note, that in this case we don't take into account what type of transport (air, railway or motor transport) will be used to get to the regions. It is obvious, that railways and roads are the least suitable means to measure such distance as their traffic route is not rectilinear at all.

The starting point for the convergence analysis is the so-called the model of unconditional β - convergence, based on the neoclassical theory of growth. Within the limits of this model, rates of economic growth are positively correlated with the rupture of per capita GRP for the given region and per capita GRP, being on a resistant growth path (steady state) which is characterized by fixed rates of growth. The resistant path of growth is understood as an equilibrum path of proportional (linear) growth in the stable equilibrium condition, which is characterized by fixed rates of growth of income level per capita. Hence, poor regions should grow faster, than rich ones, and in long-term perspective there will be a leveling of regional levels of economic development.

Formally it is possible to present the model of unconditional convergence in the aspect:

where g_T - the log of average rates of growth during length T:

$$g_T = (y - y_0) / T,$$

y_0 - The log of the original value of the indication examined for convergence, y - the log of a finite value of an indication, α - the parametre containing the norm of technological advance, - a convergence factor, - a casual component.

Convergence process is usually characterized by a convergence velocity (convergence speed) and by a time of passing a half of the distance separating the economics of the region from its stable state (half-life). These indexes can be calculated by means of an estimation of factor of convergence as well as

and accordingly.

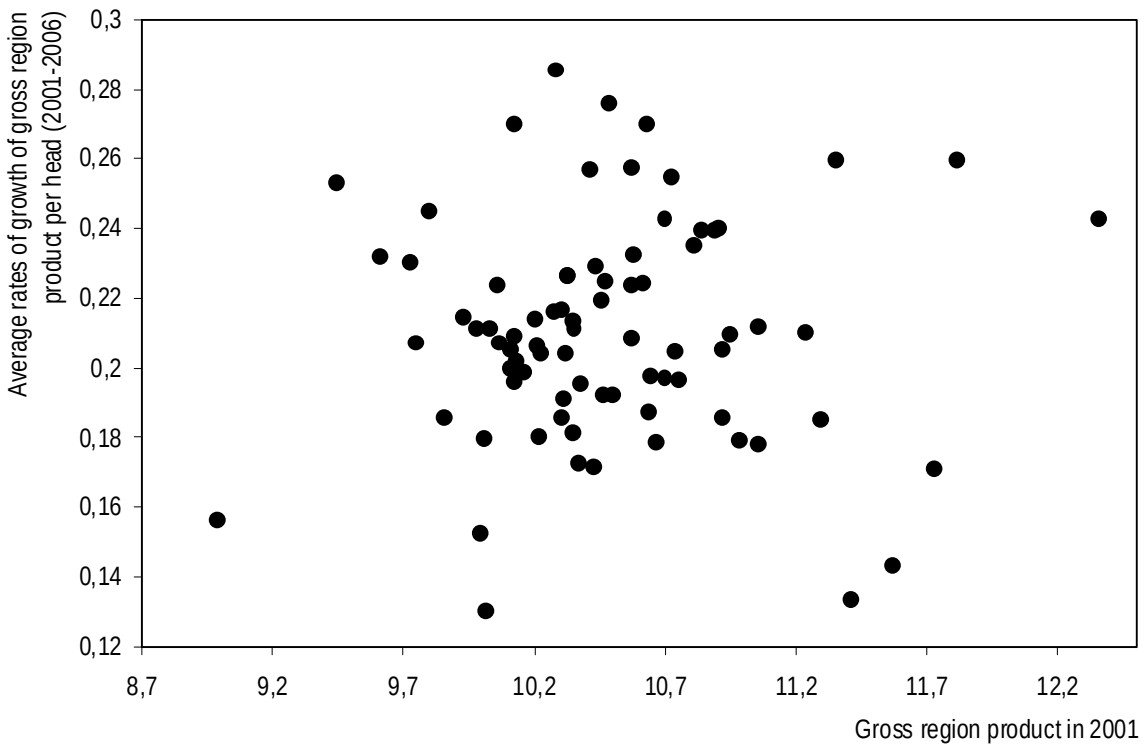
According to the complete sample Russtata consisting of 79 regions, in phase from 2001 to 2006 the divergence of levels of economic development of regions was observed. The following glow iris displays a scatter of values (log) of average rates of growth for phase depending on (log) GRP per capita in 2001 (fig. 1).

It is well shown on the glow iris, that the Magadan area (28) and Republic Kalmykia (48) were regions with low enough rates of growth during the phase while Moscow (30) and Omsk (35) areas have shown the highest rates of growth in the country.

The estimation of the equation of unconditional convergence on complete sample of 79 regions for GRP per capita has not given statistically significant estimation of convergence factor β. In other words, we can confirm neither presence, nor lack of convergence of economic development of the regions. As we can see from the equation (4), the magnitude of factor of convergence is positive, but statistically insignificant at any level of confidence. Thus, the null hypothesis about lack of convergence is not rejected. In this connection, a convergence velocity is low enough. So, a period of approximately 416 years is requires to regions for passing a half of the distance to a path of resistant growth as far as the index GRP per capita is concerned.

Let's note, that the unconditional model can be potentially specified abnormally because of the presence of the space autocorrelation of errors. The outcome of inspection of the rated OLS-RESTS of the model as far as the space autocor-

Fig. 1. **The glow iris of dispersion of the log of average rates of growth GRP per capita in 2001-2006 concerning the log of original value GRP in 2001**



relation is concerned has appeared significant

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age rates of GRP growth per capita and the log of GRP original level per capita appeared statistically significant on 95%-significance level.

So the factor of the space correlation for the log of average rates of GRP growth has appeared equal to: Moran's I=0,192. And for the log of GRP original values the Moran's I statistics is equal to 0,109 (Moran's I=0,109).

According to the outcomes, the null hypothesis about lack of the space autocorrelation is not accepted for both variables on 5%-significance level. With a certain extent of confidence it is possible to say, that level indexes per capita incomes and rates of their growth positively are space clustered. In other words, the regions with rather high values of average rates of GRP growth per capita on the average are in an environment of fast-growing neighbours, as well as rather rich regions are in an environment of rich (in 2001 yr.).

The same conclusion can be made out of the analysis of Moran's glow irises of dispersion on which the standardized values of the space log of a variable are plotted on an axis of ordinates, and on an axis of abscissae are plotted the standardized values of the variable itself, and also the regression line, the angle of inclination of witch matches to magnitude of Moran's I estimation.

In fig. 2 Moran's glow iris (for the space matrix of distance) for average rates of GRP growth per capita is presented.

The first and third quadrants of the glow iris are characterized by positive space autocorrelation. The upper right (lower left) quadrant reflects clusterization of regions with rather high (low) values of average rates of growth in an environment of relatively fast-growing (slightly-growing) neighbours. It is important to note, that the observed space clusterization of regions as far as the rates of growth is concerned is moderate enough because of a considerable number of the regions which are marked in the upper left and lower right quadrants of the glow iris that matches to negative space correlation. These quadrants represent, in the first case, clusters of regions with rather low values of average rates of the growth, enclosed by regions with rather high values, and, on the contrary, clusters of regions with rather high values, enclosed by regions with rather low values, in the second. The considerable number of the regions characterized by negative space correlation, testifies, in our opinion, to prematurity of conclusions about a long-term trend of clusterization of regions at average rates of growth. At the same time, even if a short period of time is regarded it is possible to speak about the presence of significant space inhomogeneity in economic development of regions of Russia

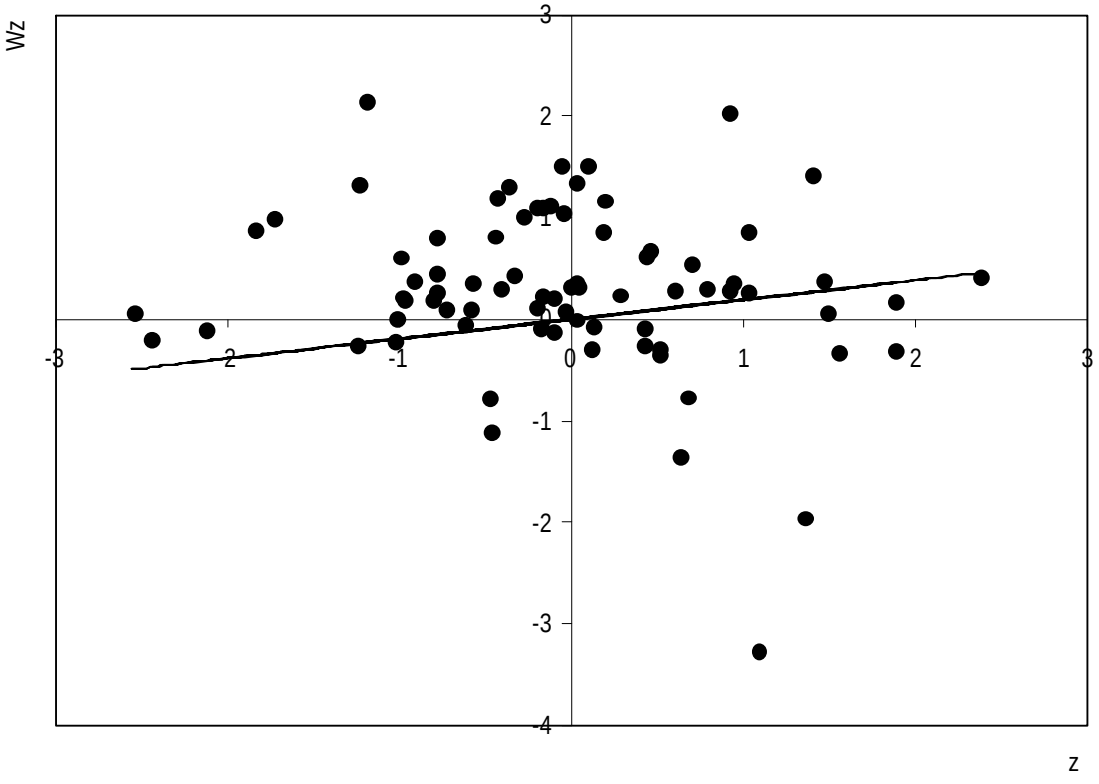

Fig. 2. **The Moran's glow iris of dispersion for the log of average Rates of GRP growth per capita during 2001-2006 yrs (Moran's I=0,192)**

which, apparently, should be taken into consideration in empirical researches of regional growth.

In the works devoted to the analysis of the European regional growth, the Moran's glow iris of dispersion is used for detection of so-called "the space clubs" convergence. The clusterization of clubs is made according to the per capita income at the initial period of time. The regions hitting in the first and third quadrants of the glow iris are determined then the hypothesis of unconditional convergence is mustered for each of the clubs selected: relatively poor in an environment of relatively poor and of relatively rich in an environment of relatively rich regions.

$$g_T = 0{,}967 - 0{,}069 y_{bogat};$$

$$(0{,}263)\quad (0{,}024)$$

$$hl = 11{,}696;\quad \delta = 5{,}926$$

- Model of unconditional β-convergence on sample from rather rich in an environment concerning rich regions (OLS estimations)

As a result, the estimation of the equation of unconditional convergence on sample from rather poor in an environment concerning poor regions has not given statistically significant estimation of factor of convergence β, as well as on complete sample of 79 regions. Thus, we can confirm neither presence, nor lack of convergence of economic development for such regions. However, if we leave in sample rather rich regions only in an environment concerning rich convergence of regions on the level of economic development nevertheless is observed. Thus, the null hypothesis about lack of convergence is rejected. At other equal, in regions with low original GRP values per capita for a considered period higher average rate of growth are observed. For passing a half of the distance separating the economics of the region from its stable state of growth, 12 years are required to average region, that matches to a convergence velocity approximately 6% a year (see the equation (7)).

From the point of view of new economic geography and the convergence analysis a special interest is represented by regions with rather high original values per capita GRP and, with simultaneously, rather high values of average rates of growth. The regions of European part apply to such regions (St.-Petersburg (61), Leningrad region (26), Moscow (29), the Moscow area (30), the Arkhangelsk area (3), Murmansk area (31), the Vologda area (9), Lipetsk area (27)), and as some regions of the Urals (Republic Bashkortostan (44), Orenburg (36), Tyumen (71), Sverdlovsk (64) and Chelyabinsk (75) areas), Western Siberia (Kemerovo (19) and Tomsk (69) areas) and the south of the Far East (the Sakhalin area (63)) in the core. The specified regions, except for Lipetsk and Sakhalin areas shape small groups of regions with the common boundaries, simultaneously characterized by rather high average rates of growth and GRP values per capita in starting 2001 If to consider Moscow and the Moscow area as one region it is also an exclusion, i.e. has no common boundaries with regions simultaneously characterized by rather high average rates of growth and GRP values per capita in starting 2001. Thus it is possible to state, that the nearness to the capital of Russian Federation negatively affects economic growth of regions.

It is also necessary to note, that calculation of indexes of space correlation is only a preliminary stage of the space econometric analysis. The specified indexes testify the presence, but do not explain reasons of regions clusterization in space. For a test of hypothesis about reasons of such clusterization, explained on the whole, the new economic geography and theories of endogenic growth, and hypotheses about space inhomogeneity influence on dynamics of economic development as well, the space econometric models are used.

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