

DEVELOPMENT OF THE METHODOLOGY FOR ASSESSING THE ECONOMIC GROWTH OF THE REGIONAL ECONOMIC SYSTEM ON THE BASIS OF THE COMPATIBLE SYSTEM OF FACTORS (BY THE EXAMPLE OF THE VOLGA FEDERAL DISTRICT)

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Abstract: Development of economic growth predictive models, their improvement and adaptation to the transforming conditions of institutional factors require continuous refinement of the methodological tools. At the same time, the most important task is the search for a system of factors that would explain the trends in economic dynamics on the one hand and, on the other hand, should be unified for the entire set of regional systems, what creates the possibility of a comparative analysis of economic growth drivers. This paper is devoted to the investigation of this problem. The object of the study is unified factors of economic growth in the regions of the Volga Federal District. The subject of the study is a system for modeling the parameters of economic dynamics based on the identification of exogenous factors which are uniform for all regional systems. Economic growth models for the PFD regions are determined as a result of the implemented estimates based on econometric modeling tools and the principles presented above what allowed using cluster analysis methods to group them in accordance with the level of response and sensitivity to the changing parameters of the analyzed macroindicators.

Keywords: economic dynamics, regional system, economic growth factors, cluster analysis, factor analysis

1 Introduction

The questions of constructing prognostic models of the economic growth of regional systems with regular frequency arise and damp in the discussion space of scientific and expert research. Despite the fact that in the modern scientific space the methodological approaches to forecasting the development of the territories are viewed from various angles, the practice of regional forecasting nevertheless reveals a number of problems caused by the accuracy and validity of the prognostic estimates being developed and their comparability. Mostly, such a differentiation in the assessments obtained on the basis of the application of various methodological approaches is usually due to the appropriate selection of the research tools, as well as the choice of exogenous factors (the explanatory parameters used in the economic growth models) which differ significantly within the frameworks of a study of a particular regional system (a part of the territory of a state characterized by relative homogeneity of socio-economic indicators (Bertalanffy, 1962; Elshin & Abdukaeva, 2017; Dorzhu & Ondar, 2018). Of course, this is a very reasonable modeling mechanism, since the national

economy regions, being its structural elements, generate various parameters of their development based on various points of their economic growth. At the same time, in our opinion, such a "multifactorial" approach does not accurately allow for determining the degree of regional economic systems' reaction to the transformation of the common for all system-shaping set of traditional factors formed within the various schools of economic thought. At the same time, an understanding of the degree of homogeneous factor influence on the parameters of the economic dynamics of different subjects is a very important task. This predetermines the need to develop special methods for modeling the development of regions on the basis of a unified tool that allows them to measure the sensitivity of their responses to a "standardized" set of exogenous parameters (Ivanter et al, 2007; Bariviera et al, 2017; Villalobos Antúnez, 2016).

It should be noted that the development of unified economic growth models for regional systems should be based on relevant scientific theories that reveal the features of their economic growth. The theory of forecasting and modeling of economic dynamics, despite its seemingly extensive elaboration within the framework of various kinds of traditional and non-traditional approaches, is still far from complete and requires further improvement and refinement of the concepts of structural and logical analysis, the paradigm and patterns of comparative analysis.

2 Methodology

A sufficiently large number of scientific papers are devoted to the issues of forecasting and modeling the development of regional socio-economic systems, determination of the aggregate of the factors generating macroeconomic trends. All of them are conditionally subdivided into groups depending on the belonging of researchers to a particular economic school (neoclassical, neo-Keynesian, neo-institutional, etc.). It is important to note that one of the key differences between them is the process of selecting factors that determine macroeconomic generation.

However, despite the polarity of views between representatives of Keynesianism and neoclassicism expressed primarily in the interpretation of the expectations of economic agents that determine the paradigm of modeling economic growth, their system of identified factors that generate macroeconomic trends unites them. These include fluctuations in price indices, interest rates, money supply, employment, external conjuncture factors, etc. (Table 1).

Table 1. Key approaches to the interpretation of factors that generate phase shifts in economic cycles (Fedorenko et al, 1958; Goodwin, 1967).

| Theory | Key factors of economic growth |
|--|--|
| Keynesian theory of economic cycles | |
| The model of cyclical development of the Samuelson-Hicks economy | The fluctuation of prices and interest rates. Mechanisms of demand change on the part of economic agents are formed as a result of the macroeconomic effects of the multiplier and accelerator, having both positive and negative effects |
| The Kaldor Model | Savings and investments, a function of income, expressed by a non-linear (logistic) dependence |
| Model Tevez | The conjuncture development of the money market, which contributes to the change in the volume of investments in the economy |
| Fischer's imperfect competition model | Monetary policy of the state or unexpected internal conjuncture shifts |
| Neoclassical theory of economic cycles | |
| The Friedman model | Adjustments to the money supply caused by a change in political structure |
| Houghtree model | Phase shifts in cycles are formed in the financial capital markets as a result of periodic adjustments in the level of interest rates against a background of growth / decrease in the volume of lending to the real sector of the economy by the banking system |
| The Goodwin model | The main generator of phase shifts in the cycle is growth or, conversely, a reduction in the level of employment |
| The study of Charles Nelson and C. | The most important component of the emergence of cyclical fluctuations are technological |

| | |
|-----------------------------------|---|
| Plosser | innovations that generate a change in output |
| The study of Prescott and Kydland | Business cycles are a consequence of the periodically changing expectations of economic agents (firms and households) that are transformed as a result of changes in labor productivity (due to technological shifts), as well as external conjuncture factors that predetermine investment activity in the economy |

Thus, it is possible to distinguish the following set of key factors affecting macroeconomic dynamics:

- price changes;
- adjustment of interest rates;
- investment activity;
- savings;
- adjustment of the money supply
- growth / decrease in the level of employment;
- innovative activity forming the change in labor productivity;
- income of the population;

and etc.

Their combination and mixing between themselves, in fact, determines the differentiation of scientific views and approaches to building the economic growth models. Thus, it can be stated that the diversity of views and scientific approaches to the study of economic dynamics is rather multidimensional, complex and often contradictory (Nelson Charles & Plosser, 1982).

Using the identified set of factors influencing the parameters of economic growth, this study attempts to apply them in the framework of building economic growth models unified for the studied population of regions. One of the most important tasks set in the work was the cluster analysis based on the systematization of common for all regions parameters generating economic dynamics. In connection with this, an important methodological element was the definition of such a single factor that would characterize the macroeconomic dynamics applied to the entire set of studied subjects of the Russian Federation: the regions of the Volga Federal District (Safullin, 2017; Elshin & Abdukaeva, 2017).

3 Results and Discussion

Table 2. Parameters of model regression statistics

| <i>Regression statistics</i> | |
|------------------------------|-------------|
| Multiple R | 0,907896478 |
| R-square | 0,824276014 |
| Adjusted R-square | 0,771558819 |
| Standard Error | 252186.2694 |
| Observations | 14 |

Table 3. Estimated parameters of regression model coefficients and their statistical significance

| | <i>coefficients</i> | <i>Standard Error</i> | <i>t-statistics</i> | <i>P-Value</i> |
|----------------------|---------------------|-----------------------|---------------------|----------------|
| Intercept | 11045316.57 | 2534112.15 | 4,359 | 0,001 |
| CPI | -92229.66 | 23143.12 | -3,985 | 0.003 |
| Dollar exchange rate | 28847.15 | 8320.77 | 3,467 | 0.006 |
| Number of unemployed | -8315.3 | 2,905.42 | -2,862 | 0,017 |

The data presented indicate that the calculated regression substantially approximates the initial series to a significant degree. The corresponding coefficient of determination R^2 is 0.91. Consequently, the equation obtained within the framework of implementation of multi-iterative calculations and actions, adequately describes the initial data. Therefore, it seems reasonable and justified to use the constructed model in the

In the process of the task solving, based on the results of the correlation analysis, three indicators were identified: CPI - the consumer price index, NE - the number of unemployed, and K\$ - the US dollar rate which characterizes the investment activity of economic entities.

The selected factors are not related (a low value of the correlation coefficient), if there is a high connection with the dependent variable. The absence of multicollinearity of the factors is a prerequisite for regression analysis and clustering procedures.

Further, by the example of the Republic of Tatarstan, we demonstrate the process of modeling the economic growth dynamics applying a selected set of factors used in the economic growth models by various scientific schools discussed above.

As a result of the economic modeling procedures, the following regression model was obtained reflecting the impact of the analyzed set of factors on the GRP of the region:

$$GRP_{RT} = 11045316.5 - 92229.7 \text{ CPI} + 28847.2 \text{ K\$} - 8315.3 \text{ NE}$$

Where:

GRP_{RT} - gross regional product of the Republic of Tatarstan, million rubles;

CPI - consumer price index, in % to the previous year;

K\$ is the average annual value of the dollar exchange rate;

NE - number of unemployed, thousand people.

The results of calculation of the statistical significance parameters for the obtained model are presented in Tables 2, 3.

process of developing scenarios for modeling and forecasting the region's economic growth.

Similarly, using the multi-iterative calculation methods, the assessments of the influence of the considered factors' set on the GRP dynamics for other regions of the Volga Federal District have been implemented (Table 4).

Table 4. Parameters of the regression equation and their statistical significance

| Regions | CPI | Number of unemployed | Dollar exchange rate | R-square | Adjusted R-square |
|---------------------------|-----------|----------------------|----------------------|----------|-------------------|
| Republic of Bashkortostan | -79016.24 | -6095.13 | 20858.17 | 0.8 | 0.74 |
| Nizhny Novgorod Region | -47483.22 | -5314.04 | 12845.99 | 0.77 | 0.71 |
| Mari El Republic | -2714.38 | -2945.09 | 1972.94 | 0.84 | 0.79 |
| The Republic of Mordovia | -3825.89 | -3527.67 | 3458.56 | 0.76 | 0.69 |
| Udmurt republic | -20029.87 | -2636.79 | 7162.15 | 0.83 | 0.69 |
| Chuvash Republic | -8382.06 | -3159.17 | 1699.96 | 0.86 | 0.74 |
| Perm Region | -37047.46 | -5364.17 | 13594.18 | 0.81 | 0.66 |
| Kirov region | -14582.99 | -2380.78 | 3254.36 | 0.86 | 0.74 |
| Orenburg region | -19597.42 | -7070.88 | 6521.543 | 0.92 | 0.90 |
| Penza region | -8556.65 | -4855.52 | 4768.356 | 0.8 | 0.74 |
| Saratov region | -12063.96 | -4943.65 | 4696.11 | 0.86 | 0.81 |
| Ulyanovsk region | -13470.36 | -2653.00 | 5,064.43 | 0.88 | 0.78 |
| Republic of Tatarstan | -92229.66 | -8315.30 | 28847.15 | 0.82 | 0.77 |
| Samara Region | -46435.70 | -7654.70 | 19184.48 | 0.79 | 0.73 |

The obtained values of the regression equations on the basis of a unified set of exogenous factors made it possible to realize a cluster analysis of the PFD regions in terms of the degree of impact from the analyzed set of parameters on the gross regional product.

A hierarchical cluster analysis was chosen in the capacity of the main tool for grouping regions by selected features. In the process of calculations and evaluations, the information-

automated package SPSS was used. Preliminary results of calculations allowed determining the number of enlarged groups (clusters) with similar drivers of GRP growth within the limits of the analyzed set of factors (Rand, 1971).

To assess the proximity of individual objects and clusters, as well as to demonstrate the sequence of regions merging into homogeneous groups, a dendrogram was constructed based on the results of hierarchical clustering (Fig 1).

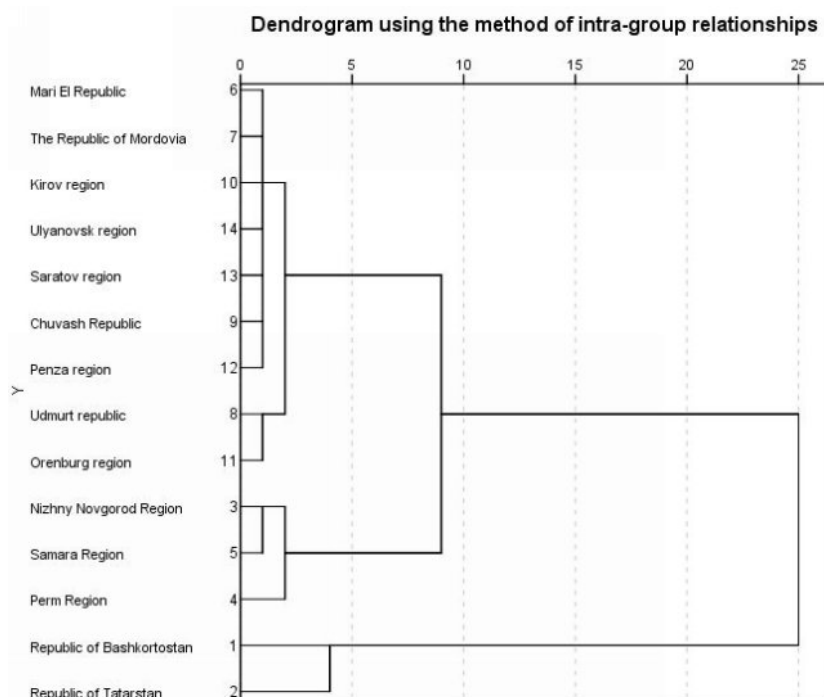


Fig 1. Dendrogram using the intra-group relationships method

The data presented on the dendrogram show the main regularities in the formation of clusters located at a relatively large distance from each other. Interpretation of the results of the hierarchical analysis demonstrates the presence of three clusters.

After completing the final stage of cluster analysis using the k-means method, the values for the final cluster centers were obtained (Table 5).

Table 5. Cluster final centers

| | CPI | Dollar exchange rate | Number of unemployed |
|-----------|------------|----------------------|----------------------|
| Cluster 1 | - 85622.96 | 43655.47 | -11469.29 |
| Cluster 2 | 24852.67 | 15208.22 | 4288.72 |
| Cluster 3 | -7205.22 | 6110.98 | -3796.96 |

The evaluation of the clustering reliability (the coefficient of explanatory ability) is estimated at 92.2%.

4 Summary

So, the analysis results made it possible to identify the features of the GRP formation for the regions of the Volga Federal District within the framework of the concept of using a unified system of statistically significant factors. This opens up new opportunities for interpreting the drivers of their economic growth in a unified system of coordinates and for developing relevant proposals aimed at optimizing and improving the mechanisms for their development, both in the crisis conditions and in the growth phases of the economic cycle.

So, for example, based on the received estimates, it should be noted that the most "sensitive" regions to the fluctuations in the consumer price index are the regions of the first cluster. The CPI growth there by 1% forms the prerequisites for reducing GRP by 0.04-0.06% in monetary terms (low values of elasticity coefficients are due to the fact that the exogenous and endogenous parameters in the developed models of economic growth used indicators in the absolute value scale).

The Cluster 3 regions demonstrate the response to the changes in the factors considered, which is very similar but has a slightly lower level; those regions are characterized with a higher level of reaction to the growth of unemployment in the economy (the elasticity coefficient is of the order of 0.02%), as well as fluctuations in the external economic situation reflected in concentrated form in the volatility of the national currency.

Regions of the second cluster are less susceptible to fluctuations of the studied set of factors as evidenced by lower values of the elasticity coefficients. Such a reaction may be due to a number of reasons, the main ones being expressed, apparently, in a lower level of integration of business processes into a system of global reproductive processes. The existing organization of socio-economic processes forms a special way of evolutionary trends expressed in a lower level of sensitivity to the external conjuncture and, as a consequence, in a weaker response to corrective macroindicators.

Thus, it can be stated that the algorithm put in a research toolkit for determining the sensitivity of regional economic systems to a unified system of factors forms stable bases for the development of adapted state policy measures. Its adaptability is expressed, first of all, in understanding the degree of regional response to the transforming parameters of fundamental factors and in the possibility of developing on this basis specific targeted measures aimed at "smoothing out" the negative effects that arise as a result of the crisis phases in the economic dynamics. The received estimates which determine the reaction of regional economic systems to the "standardized" set of exogenous factors point to the need to implement a differentiated state policy in the sphere of regional development. It seems absolutely expedient to apply the adapted measures and mechanisms of state regulation to the regions of the respective clusters. For example, based on the survey, it is clear that regions that are inherently referred to the category of "donors" (regions of the 1st and 2nd clusters) need more "tough" measures of state regulation in the face of crisis processes in the Russian national economy. This is due to their more acute "sensitivity" to changes occurring in the market and institutional environment. At the same time, this "rigidity" should be expressed, first of all, in the increased level of state support measures in the crisis phases of their cyclical development with the aim of smoothing the negative effects. On

the contrary, under conditions of economic revival and growth, attention should be shifted to the regions of the second cluster, characterized by intensification of economic growth due to inadequate response to positive impulses generated in the external and internal environment.

5 Conclusions

In conclusion, it should be noted that the findings are largely based on the conceptual approaches proposed in the study, based on the use of the so-called "standardized" set of factors in the process of building regional models of economic growth. This allows, as the study showed, to more accurately look at the degree of response of the analyzed subjects to the macroeconomic indicators that are transformed in time and represented in a single system of coordinates.

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