Econometric modeling of economic growth factors of the Russian Federation regions

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Abstract. The article focuses on the results of a statistical study of economic growth factors of the Russian Federation region. A hypothesis about the existence of socio-economic factors that are important for all Russian regions is advanced. A number of parameters of the economy that potentially have an impact on the economic growth of the regions are outlined by theoretical qualitative analysis. The system of indicators of the region economic development is considered, the estimation of the degree of their importance in the formation of the gross regional product through correlation-regression analysis is carried out. The principal component method is used to identify the most significant factors of economic growth. Conclusions about typical factors present in each Russian subject and having the most serious impact on the growth of the regional economy are made based on the results of the study.

Keywords. Economic growth of the region, Gross regional product, Econometric modeling, Factor analysis.

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J.E.L. classification. O47.

1 Introduction

Modern economic conditions, pressure from the outside world, growing competition on the world market, compel economists to search for new growth factors. The main indicator of economic growth at the macro level is GDP growth. However, an equally important aspect of the economy is the economic growth of individual regions of the country.

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The gross regional product occupies a special place among the indicators for assessing the effectiveness of the economic policy of the Russian Federation region governments. Despite the shortcomings noted by a number of economists, GRP continues to be the most universal integral macroeconomic indicator characterizing the results of economic activity within a single federal region. [5, 2, 4, 1]

The development of budgetary federalism, the search for regions of their own points of economic growth and ways to support social and economic stability, cause the intensification of research to identify factors that affect productive economic indicators. Econometric models that express the dependence of GRP on various key indicators reflecting the social and economic state of the region have been widely disseminated. These are indicators such as: demographic indicators of the birth rate and life expectancy, the level of employment of the population, the volume of investments, the volume of tax revenues of the subject, the density of transport networks, per capita income of the population , the level of crime, etc. [3, 6].

On the one hand, each region of Russia has its own unique characteristics, reflecting natural and climatic, geographical, ethnographic and other conditions, and stipulating an individual approach to the development of a strategy for the development of the region. On the other hand, there are shaping factors that are equally important for all territories, since they affect the most significant social processes that affect the socio-economic stability of the subject. The purpose of this paper is searching of typical for Russian Federation regions of economic growth using probability-statistical methods.

2 System of indicators and correlation analysis

2.1 Formation of database

The official statistics data of the Federal State Statistics Service for the 2012-2015 used as an information base of research. For calculations we used software packages: Microsoft Office Excel, StatSoft STATISTICA 12.

An array of variables that traditionally have the strongest impact on GRP (Y) for all constituent regions of the Russian Federation are selected for the study by the theoretical qualitative analysis (Table 1).

All absolute indicators were adjusted for the population of the region to ensure comparability of the data.

2.2 Correlation analysis

At the first, preliminary stage of the study, the correlation matrices of variables for the period 2012-2015 are constructed (Tables 2-5). Correlation analysis allows you to determine the list of independent variables that most strongly affect the dependent variable. The paired linear Pearson correlation coefficient is used as a measure of coupling.

Table 1. Variables for the analysis.

Variable	Characteristics of the region
Y	GRP
X_1	The volume of electricity produced
X_2	The volume of investments in fixed assets
X_3	The total length of roads
X_4	The number of employees
X_5	The number of registered crimes
X_6	The number of small enterprises
X_7	The value of fixed assets
X_8	The volume of innovative goods and services
X_9	The innovative activity of organizations
X_{10}	The depreciation of fixed assets
X_{11}	The sickness rate
X_{12}	The number of graduation of skilled workers and employees
X_{13}	The number of graduates of mid-level specialists
X_{14}	The number of graduates of bachelors, specialists, masters
X_{15}	The ratio of rural population
X_{16}	The number of unemployed
X_{17}	The retail turnover

The notation “-0” means that the correlation coefficient is negative and modulo less than 0.01.

As can be seen from the table, the presence of a strong relationship between a large number of variables is revealed, which indicates the presence of multicollinearity in the traits under study.

Thus, it is impossible to determine the impact of a single indicator on GRP. In such conditions it is advisable to carry out factorial or component analysis.

3 Component analysis and econometric modeling of economic growth factors of the Russian Federation regions

3.1 Determination of the number of components

At the next stage of the study, the principal component method is used to reduce the dimensionality of the data. The component analysis was carried out by the method of principal components using the Varimax rotation of the factor axes.

The number of factors for each year of the study period is determined using the Scree plot criterion. Graphs of scree plot for 2012-2015 are presented in Fig. 1.

Thus, in 2012, six factors were identified, in 2013-2014 years - 5, and in 2015 - 6 factors. Then, the verification of the determination of the number of factors was carried out by the Kaiser criterion.

Table 2. Correlation matrix for 2012 year.

	Y	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}	X_{13}	X_{14}	X_{15}	X_{16}	X_{17}
Y	1,00	0,31	0,39	0,00	0,57	0,24	0,38	0,91	0,56	0,21	-0,11	0,26	0,07	-0,18	0,08	-0,44	-0,22	0,36
X_1	0,31	1,00	0,05	0,05	0,30	0,29	0,12	0,40	0,00	0,00	-0,09	0,06	0,15	0,11	-0,04	-0,31	-0,17	0,00
X_2	0,39	0,05	1,00	0,51	0,34	0,07	-0,03	0,26	0,07	0,24	-0,05	0,29	0,44	-0,25	-0,31	-0,01	-0,03	-0,11
X_3	0,00	0,05	0,51	1,00	0,18	0,16	-0,21	-0,03	-0,10	0,02	-0,08	0,26	0,43	0,07	-0,42	0,28	-0,02	-0,40
X_4	0,57	0,30	0,34	0,18	1,00	0,46	0,50	0,52	0,23	0,53	-0,09	0,34	0,08	0,17	0,25	-0,69	-0,69	0,13
X_5	0,24	0,29	0,07	0,16	0,46	1,00	0,17	0,31	0,11	0,13	-0,32	0,28	0,34	0,35	0,00	-0,37	-0,23	-0,02
X_6	0,38	0,12	-0,03	-0,21	0,50	0,17	1,00	0,28	0,16	0,43	-0,11	0,24	-0,16	-0,04	0,48	-0,66	-0,41	0,29
X_7	0,91	0,40	0,26	-0,03	0,52	0,31	0,28	1,00	0,36	0,12	-0,07	0,22	0,04	-0,14	0,03	-0,41	-0,18	0,27
X_8	0,56	0,00	0,07	-0,10	0,23	0,11	0,16	0,36	1,00	-0,05	-0,12	0,12	-0,02	-0,02	-0,04	-0,19	-0,03	0,04
X_9	0,21	0,00	0,24	0,02	0,53	0,13	0,43	0,12	-0,05	1,00	0,05	0,18	0,07	0,01	0,38	-0,36	-0,46	0,25
X_{10}	-0,11	-0,09	-0,05	-0,08	-0,09	-0,32	-0,11	-0,07	-0,12	0,05	1,00	0,05	-0,11	0,07	0,13	0,07	0,05	-0,03
X_{11}	0,26	0,06	0,29	0,26	0,34	0,28	0,24	0,22	0,12	0,18	0,05	1,00	0,18	0,09	-0,08	-0,24	-0,02	-0,08
X_{12}	0,07	0,15	0,44	0,43	0,08	0,34	-0,16	0,04	-0,02	0,07	-0,11	0,18	1,00	0,23	-0,32	0,13	0,16	-0,37
X_{13}	-0,18	0,11	-0,25	0,07	0,17	0,35	-0,04	-0,14	-0,02	0,01	0,07	0,09	0,23	1,00	0,09	0,06	-0,20	-0,17
X_{14}	0,08	-0,04	-0,31	-0,42	0,25	0,00	0,48	0,03	-0,04	0,38	0,13	-0,08	-0,32	0,09	1,00	-0,44	-0,31	0,51
X_{15}	-0,44	-0,31	-0,01	0,28	-0,69	-0,37	-0,66	-0,41	-0,19	-0,36	0,07	-0,24	0,13	0,06	-0,44	1,00	0,52	-0,37
X_{16}	-0,22	-0,17	-0,03	-0,02	-0,69	-0,23	-0,41	-0,18	-0,03	-0,46	0,05	-0,02	0,16	-0,20	-0,31	0,52	1,00	-0,25
X_{17}	0,36	0,00	-0,11	-0,40	0,13	-0,02	0,29	0,27	0,04	0,25	-0,03	-0,08	-0,37	-0,17	0,51	-0,37	-0,25	1,00

Table 3. Correlation matrix for 2015 year.

	Y	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}	X_{13}	X_{14}	X_{15}	X_{16}	X_{17}
Y	1,00	0,45	0,97	-0,16	0,78	0,11	0,03	0,95	0,13	-0,01	0,09	0,49	-0,03	0,03	-0,31	-0,28	-0,11	0,42
X_1	0,45	1,00	0,37	0,00	0,43	0,21	0,07	0,42	-0,05	-0,12	0,09	0,23	0,05	-0,03	-0,22	-0,32	-0,16	0,23
X_2	0,97	0,37	1,00	-0,13	0,67	0,09	-0,07	0,90	0,04	-0,06	0,06	0,47	-0,04	0,12	-0,36	-0,16	-0,03	0,28
X_3	-0,16	0,00	-0,13	1,00	-0,15	0,19	-0,24	-0,20	-0,16	0,04	-0,11	0,17	0,49	0,10	-0,27	0,31	0,04	-0,33
X_4	0,78	0,43	0,67	-0,15	1,00	0,15	0,40	0,72	0,32	0,32	0,05	0,40	-0,04	-0,10	0,01	-0,63	-0,50	0,63
X_5	0,11	0,21	0,09	0,19	0,15	1,00	0,27	0,13	0,06	-0,16	-0,25	0,24	0,44	0,16	-0,17	-0,32	-0,07	0,08
X_6	0,03	0,07	-0,07	-0,24	0,40	0,27	1,00	-0,03	0,32	0,29	-0,08	0,13	-0,14	-0,01	0,43	-0,63	-0,39	0,42
X_7	0,95	0,42	0,90	-0,20	0,72	0,13	-0,03	1,00	0,11	-0,07	0,15	0,44	-0,05	-0,02	-0,35	-0,26	-0,10	0,41
X_8	0,13	-0,05	0,04	-0,16	0,32	0,06	0,32	0,11	1,00	0,25	-0,03	0,03	-0,09	0,02	0,19	-0,32	-0,26	0,45
X_9	-0,01	-0,12	-0,06	0,04	0,32	-0,16	0,29	-0,07	0,25	1,00	0,07	0,07	-0,02	0,05	0,39	-0,17	-0,43	0,24
X_{10}	0,09	0,09	0,06	-0,11	0,05	-0,25	-0,08	0,15	-0,03	0,07	1,00	0,10	-0,08	0,08	-0,02	0,00	-0,10	-0,10
X_{11}	0,49	0,23	0,47	0,17	0,40	0,24	0,13	0,44	0,03	0,07	0,10	1,00	0,22	0,15	-0,27	-0,23	-0,08	0,09
X_{12}	-0,03	0,05	-0,04	0,49	-0,04	0,44	-0,14	-0,05	-0,09	-0,02	-0,08	0,22	1,00	0,05	-0,27	0,04	0,17	-0,33
X_{13}	0,03	-0,03	0,12	0,10	-0,10	0,16	-0,01	-0,02	0,02	0,05	0,08	0,15	0,05	1,00	0,19	0,24	-0,03	-0,09
X_{14}	-0,31	-0,22	-0,36	-0,27	0,01	-0,17	0,43	-0,35	0,19	0,39	-0,02	-0,27	-0,27	0,19	1,00	-0,21	-0,27	0,25
X_{15}	-0,28	-0,32	-0,16	0,31	-0,63	-0,32	-0,63	-0,26	-0,32	-0,17	0,00	-0,23	0,04	0,24	-0,21	1,00	0,51	-0,53
X_{16}	-0,11	-0,16	-0,03	0,04	-0,50	-0,07	-0,39	-0,10	-0,26	-0,43	-0,10	-0,08	0,17	-0,03	-0,27	0,51	1,00	-0,51
X_{17}	0,42	0,23	0,28	-0,33	0,63	0,08	0,42	0,41	0,45	0,24	-0,10	0,09	-0,33	-0,09	0,25	-0,53	-0,51	1,00

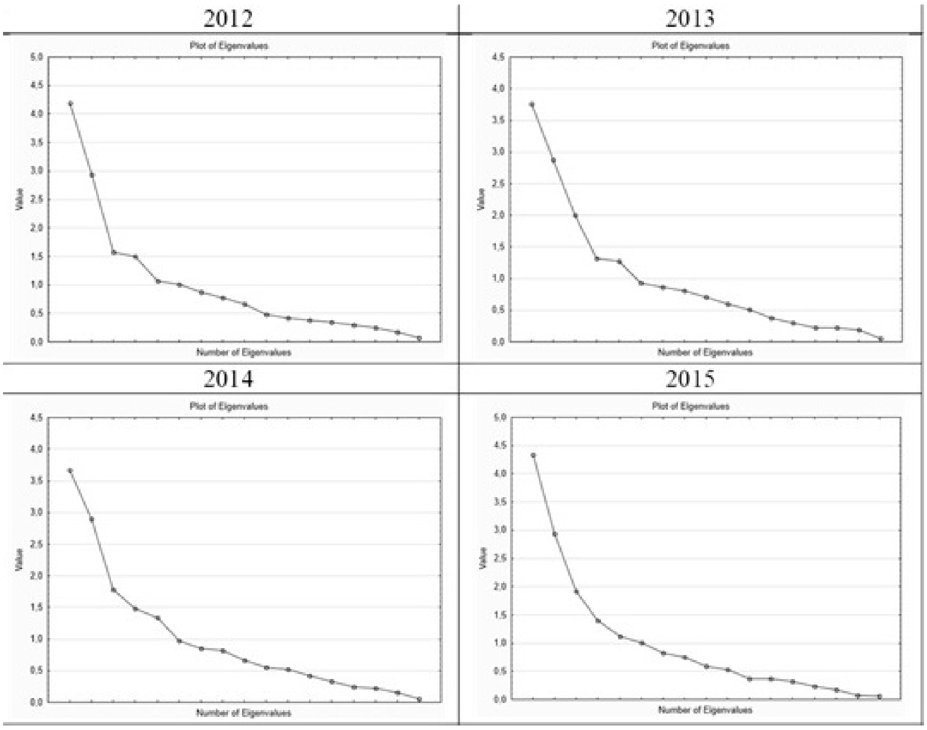

Fig. 1. Screen plot of Eigenvalues of components in 2012-2015 years.

3.2 Determination of components and econometric modeling

After determining the number of the principal components for each year, specific factors of economic growth were identified. Matrix of factor loadings of principal components was constructed. If the factor loading of the main components on variable exceeded 0.7, then it was considered that this variable is included in the component.

The most significant signs are revealed, and equations of regression of the influence of factors on GRP for each year are constructed.

For 2012, the regression equation looks like this:

$$y = 290399,2 + 79058,1f_1 + 27131,1f_2 - 67156,9f_3- \\ -126537,8f_4 + 14399,5f_5 + 103295,1f_6; R^2 = 0,88; \quad (1)$$

f_1 – factor of productive forces, which includes the number of employees (X_4), the number of small enterprises (X6), the innovative activity of organizations (X_9), the ratio of rural population (X_{15}), the number of unemployed (X_{16});

f_2 – infrastructure potential: the volume of investments in fixed assets (X_2), the total length of roads (X_3);

f_3 – staff qualification factor the number of graduates of mid-level specialists (X_{13});

f_4 – factor of innovative economy the volume of innovative goods and services (X_8);

f_5 – infrastructure condition factor the depreciation of fixed assets (X_{10});

f_6 – factor of energy supply of production the volume of electricity produced (X_1).

The number of factors decreased in 2013:

$$y = 401865,4 + 7946,5f_1 - 487715,7f_2 - 92878,3f_3 + 29148,8f_4 + \\ +62365,9f_5; R^2 = 0,87 \quad (2)$$

f_1 – factor of productive forces: the innovative activity of organizations (X_9), the number of unemployed (X_{16});

f_2 – infrastructure potential: the volume of investments in fixed assets (X_2), the number of employees (X_4), the value of fixed assets (X_7), the sickness rate (X_{11});

f_3 – factor of development and maintenance of transport infrastructure the total length of roads (X_3), the number of graduation of skilled workers and employees (X_{12});

f_4 – safety factor the number of registered crimes (X_5),

f_5 – staff qualification factor the number of graduates of mid-level specialists (X_{13});

The number of factors remained the same in 2014, but the composition of the variables that formed the factors underwent changes:

$$y = 438188,2 - 524187,5f_1 + 112487,3f_2 - 72379,2f_3 - \\ -13866,0f_4 - 93485,3f_5; R^2 = 0,88 \quad (3)$$

f_1 – infrastructure potential: the volume of investments in fixed assets (X_2), the number of employees (X_4), the value of fixed assets (X_7).

f_2 – factor of institutional transformations in the economy the number of small enterprises (X_6), the ratio of rural population (X_{15}), the number of unemployed (X_{16}).

f_3 – factor of development and maintenance of transport infrastructure: the total length of roads (X_3), the number of graduation of skilled workers and employees (X_{12}).

f_4 – safety factor the number of registered crimes (X_5).

f_5 – staff qualification factor the number of graduates of mid-level specialists (X_{13}).

$$y = 475044,4 + 67678,8f_1 + 645776,6f_2 - 60910,5f_3 - 13957,1f_4 + \\ +43655,9f_5 - 6196,7f_6; R^2 = 0,88 \quad (4)$$

f_1 – factor of institutional transformations in the economy the number of small enterprises (X_6), the ratio of rural population (X_{15}).

f_2 – infrastructure potential: the volume of investments in fixed assets (X_2), the number of employees (X_4), the value of fixed assets (X_7).

f_3 – factor of development and maintenance of transport infrastructure: the total length of roads (X_3), the number of graduation of skilled workers and employees (X_{12}).

f_4 – factor of innovative economy the innovative activity of organizations (X_9).

f_5 – staff qualification factor the number of graduates of mid-level specialists (X_{13}).

f_6 – infrastructure condition factor the depreciation of fixed assets (X_{10})

The coefficients of determination of the constructed models are 0.88, 0.87, 0.87 and 0.95, respectively, which indicates the reliable quality of the models obtained.

4 Conclusion

Coefficients at separate factors have a sign opposite to what is supposed in theory in some cases: for example, in the regression equation for 2015, the factor with factor f_4, - the innovative activity of organizations (X_9) is negative, which means that with the other factors remaining constant with the growth of innovative activity of organizations and enterprises the volume of GRP decreases. This may indicate the presence of multicollinearity between the factors under consideration, which, however, does not affect the predicted qualities of the models obtained.

In conclusion, the following typical factors are singled out for the constituent of the Russian Federation region in 2012-2015: the infrastructure potential explaining the largest share of the GRP dispersion, and the factor of institutional changes in the economy.

Thus, when preparing regional strategies for social and economic development, all federal regions are invited to focus on renewing and modernizing fixed assets, developing a road transport network, supporting vocational education institutions, areas that have consistently contributed significantly to economic growth.

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