Analysis of the Interrelations of Economic Indicators as a Tool for Predicting Regional Financial Instability

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Abstract. One of instruments of forecasting of financial instability of regions of Russia is quantitative and qualitative estimates of interrelations between regional macroeconomic indicators.

Research objective is selection of the most adequate models of establishment of interrelations between indicators of regional financial stability, their specification, assessment of parameters, quality check of models and interpretation of the received results.

For carrying out the analysis financial performance of regional statistics is clusted on federal to districts and is investigated as panel structure of data.

The principal component method which allowed to generate a new regressor in the form of the first main components is applied to elimination of multicollinearity between economic indicators in models.

1. Introduction

Volatility (variability) of financial performance of regional macroeconomic statistics, is the most important characteristic of stability of social and economic development of regions.

Calculation of a cost measure of risk of variability of economic indicators and also quantitative and quality standard of interrelations of indicators are instruments of forecasting of financial and economic recession in the region.

The techniques of the analysis of variability of indicators of activity of regions, ways of assessment of interrelations offered by researchers and approved by us between volatile economic indicators are presented in table 1. The presented tools make a basis of forecasting of financial stability of regional structures.

Table 1. Tools for forecasting of a financial position of the region.

The Tool	Appointment
Regression model of dependence of the economic indicator from time	Forecast of values of economic indicators. Assessment of a confidential interval of the forecast of values of economic indicators
Assessment of a cost measure of risk [1]	
One-dimensional model of a temporary row - ARIMA model	
Regression model of dependence of economic indicators with preliminary elimination of false correlation	The analysis of interrelations between separate economic indicators by least square method
Angle-Granger Cointegration Model	
Koyck transformation	Determination of significant interrelations between economic indicators of activity of the region, their quantitative assessment and definition of the period during which such quantitative influence should be expected
logistic regression models [2]	Determination of significant interrelations between economic indicators of activity of the region, their quantitative assessment by method of maximum likelihood decoding

2. Problem definition

Heterogeneity of social and economic development is characteristic of any region of the Russian Federation and is generated by a geographical location, climatic features, security with natural resources, proximity to sales markets, level of production and other factors.

The prevailing part of economists-researchers considers the region as independent subject managing [3,4, 5, 6,7]

Let's cluster regional macroeconomic indicators on federal districts. The analysis of interrelations between economic indicators

let's carry out concerning each federal district as a separate economic system, thereby we will emphasize existence of a number of features inherent in each district.

The models of the analysis of panel data giving the chance to receive more effective estimates of parameters in comparison with models of spatial data and also to estimate the effects of separate objects of selection which are not changing in time (the fixed effects) allow to be convinced in existence of individual regional effects.

Theoretical part. We investigate a number of economic indicators of activity of eight federal districts of Russia from 2004 for 2017.

We chose a number of statistical macroeconomic indicators of activity of districts: a gross regional product per capita (VRP), the average per capita income (ACI), a central government debt (GD), investments into fixed capital (INV), overdue accounts payable on the salary (EO), balanced financial result (BFR), consumer price index (CP), a level of unemployment (U), budget revenues (BR).

Data for the analysis were taken from the websites of the Ministry of Finance of the Russian Federation of URL: https://www.minfin.ru/ru/perfomance/public_debt/subdbt/2010/, State committee of

statistics of the Russian Federation URL:http://www.gks.ru/wps/wcm/connect/rosstat_main/rosstat/ru/statistics/publications/catalog/doc_1 138623506156.

About whether it is expedient to perceive data as panel we will do a conclusion on the basis of assessment of linear model where the fixed effects will be considered as fictitious variables (formula 1)

$$Yit = b_0 + \sum_{j=1}^{k} b_j * x_{it}^j + a_2 * D_2 + \cdots + a_n * D_{ni} + \varepsilon_{it} \qquad (1)$$

If our assumption that the individual fixed effects are absent truly, then coefficients at the D_n variables are equal to zero (formula 1)

Let's check this hypothesis. Processing of statistical data we will provide in an econometric package of an open entry Gretl.

Originally for modeling we use absolute values of economic indicators.

As a resultant dependent variable we will define the average per capita income.

When using absolute values essential indicators are the level of unemployment, a central government debt, a gross regional product per capita; the determination coefficient in this case makes 0.97

The null hypothesis that all regions have the general constants is not confirmed as the p-value is 0.0027, that is it is less than any reasonable significance value; thus, we draw a conclusion about existence of individual regional effects.

At the following stage we will define effects are accidental or fixed, for this purpose we carry out the Hausman test in which it is supposed that estimates of coefficients in model with random effects are well-founded.

In our case the null hypothesis is not confirmed, thus, for forecasting the model with the fixed effects has to be used, however, the remains in model are not distributed under the normal law, and besides, at model there is heteroscedasticity

Now we use growth rates of economic indicators and the standardized values of indicators calculated on formula 2 for modeling

$$\text{Standart ind} = \frac{(\text{ind} - \overline{\text{ind}})}{\sigma_{ind}} \qquad (2)$$

Transition to the relative and standardized sizes allows to separate volatility from a trend that does temporary ranks of data stationary [8]

When modeling with use of growth rates of economic indicators the null hypothesis that the allocated clusters have the general constants was confirmed, that is it is necessary to analyze data as spatial selection and to build usual regression model.

The lack of significant differentiation between economic indicators of federal districts is confirmed also by the researches containing a conclusion about that, in recent years is observed trends of rapprochement of regions of the Russian Federation on nominal and real average per capita VRP, the income of the population, labor productivity, level of investments and so forth [9,10,11, 12] and also the values of Gini coefficient calculated by us and coefficients of a variation weighed on a population share according to the technique described in M.Yu. Malkina's articles [9, 13, 14]. Dynamics of coefficients is presented in fig. 1, 2.
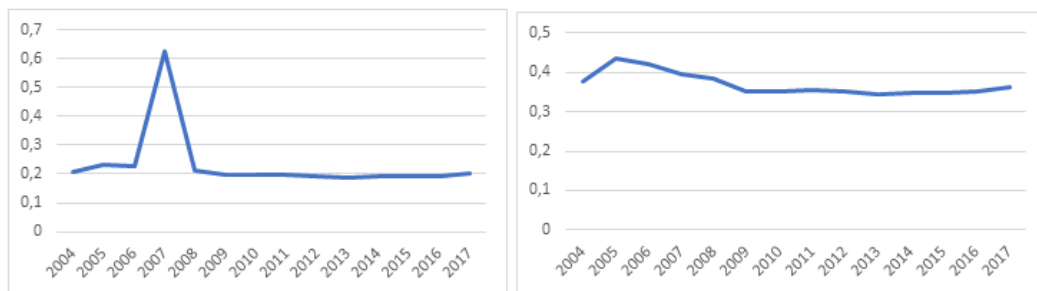

Figure 1. Dynamics of Gini coefficient on VRP and the average per capita income.
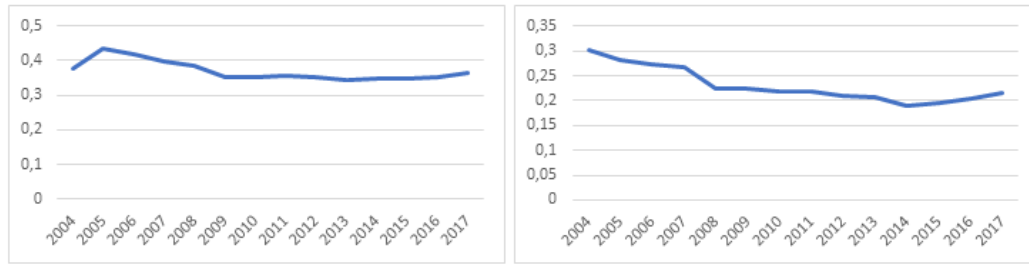
Figure 2. Dynamics of variation coefficient on the VRP and the average per capita income.

Significant variables at creation of model of linear regression are the gross regional product, a central government debt, balanced financial result, consumer price index and deposits. At assessment of quality of model we found out that the coefficient of determination made only 0.62, the remains are distributed under the normal law, at model there is heteroscedasticity.

Work with the standardized data also showed existence of the general group constants, at creation of regression model with the subsequent exception of excess variables the following significant indicators of VRP on one-percentage significance value, arrears on the salary - on ten-percentage significance value the index of consumer prices - on five-percent significance value are allocated; the determination coefficient in this case makes 0.98. The remains in model are distributed under the normal law, heteroscedasticity is absent, however, at model there is a multicollinearity between regressors.

Let's try to fix a problem having applied to the analysis of interrelations between financial performance of activity of regions a method main a component.

Use of this method for the analysis of financial stability of micro and macroeconomic systems finds reflection in works of modern researchers [15,16,17,18,19,20].

For carrying out calculations we will use data in two forms - growth rates of economic indicators and the standardized values of indicators calculated on formula 2. Results are presented in table 2.

Table 2. The factorial analysis with application of a principal component method.

	Growth rates of indicators		Standardized indicators	
	The equation for the first principal components	The explained dispersion, %	The equation for the first principal components	The explained dispersio, %
Far East (FEFD) Federal district	0,387*VRP+0,386*ACI+0,362*GD-0,022*U+0,206*INV+0,385*BFR-0,260*CP-0,115*EO+0,384*BR+0,388*D	65	0,373*VRP+0,372*ACI+0,313*GD-0,213*U+0,371*INV+0,260*BFR-0,291*CP-0,175*EO+0,382*BR+0,388*D	63
Central (CFD)	0,447*VRP+0,280*ACI+0,150*GD-0,248*U+0,451*INV-0,092*BFR-0,201*CP+0,143*EO+0,383*BR+0,399*D	44	0,390*VRP+0,385*ACI+0,336*GD+0,078*U+0,286*INV+0,295*BFR-0,207*CP-0,237*EO+0,374*BR+0,367*D	69

District	Formula	%	Formula	%
Volga (VFD)	0,410*VRP+0,363*ACI+0,128*GD-0,243*U+0,420*INV+0,285*BFR+0,178*CP+0,099*EO+0,434*BR+0,443*D	53	0,364*VRP+0,360*ACI+0,360*GD-0,308*U+0,358*INV+0,238*BFR-0,218*CP+0,159*EO+0,355*BR+0,361*D	75
Northwest (NWFD)	0,402*VRP+0,270*ACI-0,290*GD-0,290*U+0,426*INV+0,097*BFR+0,110*CP-0,197*EO+0,435*BR+0,408*D	46	0,376*VRP+0,373*ACI+0,364*GD-0,089*U+0,370*INV+0,328*BFR-0,232*CP+0,079*EO+0,368*BR+0,373*D	70
North Caucasian (NCFD)	0,416*VRP+0,424*ACI-0,177*GD-0,111*U+0,482*INV+0,064*BFR+0,297*CP-0,149*EO+0,334*BR+0,380*D	37	0,355*VRP+0,354*ACI+0,347*GD-0,331*U+0,347*INV-0,027*BFR-0,198*CP+0,343*EO+0,352*BR+0,349*D	79
Siberian (SFO)	0,403*VRP+0,406*ACI-0,240*GD-0,199*U+0,440*INV-0,136*BFR+0,174*CP+0,030*EO+0,408*BR+0,408*D	48	0,355*VRP+0,352*ACI+0,320*GD-0,280*U+0,342*INV+0,280*BFR-0,234*CP-0,272*EO+0,341*BR+0,352*D	78
Ural (UFD)	0,393*VRP+0,377*ACI-0,341*GD-0,302*U+0,392*INV-0,104*BFR+0,168*CP+0,029*EO+0,396*BR+0,380*D	45	0,363*VRP+0,359*ACI+0,331*GD-0,163*U+0,361*INV+0,37*BFR-0,219*CP-0,234*EO+0,357*BR+0,359*D	75
Southern (SOFD)	0,450*VRP+0,419*ACI-0,136*GD-0,172*U+0,455*INV-0,044*BFR+0,310*CP+0,079*EO+0,275*BR+0,433*D	36	0,376*VRP+0,370*ACI+0,356*GD-0,339*U+0,342*INV+0,236*BFR-0,234*CP-0,052*EO+0,333*BR+0,372*D	70

The coefficients at indicators representing factorial load of components specify a contribution of each indicator to the general dispersion.

The analysis of the standardized values of indicators is more informative, than the analysis of growth rates as the first a component of the standardized values explains on average 70% of dispersion of indicators.

Let's offer a scale of factorial loadings, having defined the following gradation (table 3).

Let's note that for all districts there are general indicators which are characterized by the high level of factorial loading in table 4 they are highlighted in bold type.

The level of unemployment has high factorial loading for Volga, North Caucasian and Southern and low for Northwest, Central and Ural federal districts.

Values of factorial loading of balanced financial result are polarized for the Ural and North Caucasian federal districts.

Table 3. The level of factorial loading on the principal component.

Value of the coefficient of factorial loading	Level of factorial loading	Rank
0,35 and above	very high	6
от 0,3 от 0,35	high	5
от 0,25 до 0,3	average	4
от 0,2 до 0,25	below an average	3
от 0,1 до 0,2	low	2
lower than 0,1	very low	1

The maximum value of factorial loading concerning overdue wage arrears is characteristic of North Caucasian and Northwest, and minimum – of the Southern Federal District

Table 4. Ranging of factorial loadings of economic indicators.

	Federal districts							
1	2	3	4	5	6	7	8	9
Indicators	FEFD	VFD	NWFD	NCFD	SFD	CFD	UFD	SOFD
VRP	6	6	6	6	6	6	6	6
ACI	6	6	6	6	6	6	6	6
GD	5	6	6	5	5	5	5	6
U	3	5	1	5	4	1	2	5
INV	6	6	6	5	5	4	6	5
BFR	4	3	5	1	4	4	6	3
CP	4	3	3	2	3	3	3	3
EO	2	2	1	5	4	3	3	1
BR	6	6	6	6	5	6	6	5
D	6	6	6	5	6	6	6	6

Let's choose the main components as the explaining variables now and we will construct regression model. Still we leave to a dependent variable the average per capita income. As we came to a conclusion, that individual effects are absent, we will determine the main components by all data set without distribution on districts.

The 3rd is allocated principal components which own values it is not less than unit. In our situation these three components explain dispersion of indicators for 87%.

Having constructed a correlation matrix chosen main a component and a dependent variable we were convinced that components are among themselves not connected, the coefficient of correlation of the first and a dependent variable made components 0,97, the second and third components are connected with a dependent variable poorly.

Let's construct now regression model where as a regressor there will be the first principal component. In the equation the constant is very small and is not significant therefore having excluded it from model we will receive the following equation:ACI = 0,39*PC1

ACI = 0,39*(0,412*VRP+0,381*GD-0,247*U+0,388*INV+0,280*BFR-0,261*CP-0,040*EO+0,398*BR+0,409*D)

3. Conclusions

The research conducted by us allows to draw the following conclusions:

1.The data of regional macroeconomic statistics clustered in a section of federal districts have to be considered as spatial selection, and it is expedient to estimate interrelation between macroeconomic indicators for assessment of financial stability (instability) of regional systems by means of regression model.

2.The principal component method allowed to allocate the general for all districts the economic indicators making the greatest contribution to the general dispersion of financial performance and to emphasize individual effects for each district

3.By means of the principal component method was succeeded to create the new complex variable allowing to establish interrelation between volatile indicators of financial stability.

4. Acknowledgments

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