ELIT
Economic Laboratory Transition
Research Podgorica

Montenegrin Journal of Economics

Valinurova, L.S., Sulimova, E.A., Guseva, T.G., Bolotina, E.A., Tumin, V.M. (2021), "Post-Crisis Modeling of Economic Development Trends in an On-Going Recession of National Economies", *Montenegrin Journal of Economics*, Vol. 17, No. 2, pp. 75-82.

Post-Crisis Modeling of Economic Development Trends in an On-Going Recession of National Economies

LILIYA S. VALINUROVA[1], ELENA A. SULIMOVA[2], TATYANA G. GUSEVA[3], EVGENIYA A. BOLOTINA[4], and VALERY M. TUMIN[5]

[1] Bashkir State University, Ufa, Russian Federation,
E-mail: valinurovalilia@mail.ru, ORCID 0000-0002-6771-9728
[3] Plekhanov Russian University of Economics, Moscow, Russian Federation,
E-mail: lena-s-l@yandex.ru, ORCID 0000-0003-3975-6799
[3] D. Mendeleyev University of Chemical Technology of Russia, Moscow, Russian Federation, E-mail: vmp2010@mail.ru, ORCID 0000-0002-1259-1384
[4] Russian Academy of National Economy and Public Administration under the President of Russian Federation (RANEPA), Moscow, Russian Federation,
E-mail: finfss@mail.ru, ORCID 0000-0003-3704-4376
[5] Moscow Polytechnic University, Moscow, Russian Federation,
E-mail: vm@tumin.net, ORCID 0000-0003-4651-0359

ARTICLE INFO

Received July 29, 2020
Revised from August 26, 2020
Accepted September 28, 2020
Available online June 15, 2021

JEL classification: D21, D22, E27

DOI: 10.14254/1800-5845/2021.17-2.6

Keywords:

Economy,
development,
structure,
trend,
crisis

ABSTRACT

Within the structure of the development trends of the global economy, crisis phenomena determine, first of all, the possibility of further development of global industries, which require significant external assistance in the formation of development strategies. The aim of the research is to build a trend of global economic recovery in terms of stimulating the increase in the value of production assets and an overall assessment of the development potential of the research program. Budgeting of the process should be considered in terms of formation of the development model not only on the basis of factual assessment, but on the level of forecasted economic growth as well. In the course of the research, mainly prognostic and extrapolation methods were used basing on the actual data collected with the growing economy prior to the crisis. The main results of the study are presented in the form of a model for reducing the consequences of the liquidation of crisis phenomena. The model reflects the close relationship between the gross output of goods and services in the industrial sector during the crisis and shows the possibility of changes in the value of fixed assets and the number of people employed in the industrial sector. The formation of this form of sustainable economic functioning allows for full implementation of development projects and technical improvement of industrial assets.

INTRODUCTION

The current stage of the development of the global economy can be referred to as an epoch of bifurcation in which qualitative deep transformations are taking place in economies practically all over

the world (Delibasic, 2019; Iacobuta et al., 2019). Economists have defined this process as a global transition period, during which transformation processes take place under the influence of large-scale, long-term processes of global development, the so-called megatrends. Of these, globalization is the main one.

1. LITERATURE REVIEW

Globalization, according to M.B. Konashev, in turn, generates transformations, the research of which has allowed identification of five transformational megatrends [Konashev, M.B., (2019)]: the transformation of the value base of development; changes in the priorities of the model of economic development; changes in the ways of building social ties; concentration on the solution of global problems of human development and the organic combination of global processes with the processes of other levels. A. Buzgalin and A. Kolganov (2009) speak in terms of the classical theory of political economy, which associates globalization with the entry of states and society into a new phase of interaction characterized by the infinity and universality. It is the process of globalization since the early 1990s that, according to T. Sayakbayev, et al. (2019) has become the prevailing theoretical scheme used to explain the world order.

Globalization processes are aimed at spreading political, economic and cultural influence of any country or several countries on the whole of the world. Specifically, this is shown by the authors A.T. Uskelenova et al. (2017), who use regional social transformation in Kazakhstan as an example, that takes place under the influence of globalization. M. Amal (2016) does the same thing using the example of Brazil. In the late 20th century, a separate branch of knowledge was formed in science, the subject of which was, on the one hand, globalization and anti-globalistic struggle, according to W. Gong (2003) and Z. Fu (2010), and, on the other hand, globalism and anti-globalism, which W. Huang and L. Jiang (2018) generally refer to as *Globalistics,* a separate scientific branch of knowledge.

The main research method is the Bertelsmann Index modelling. This method, based on parametric equations, makes it possible to identify growth opportunities for countries with economies in transition. Structural deformations of the economy are long-standing distortions in the sectoral, technological, and institutional structure of the economy, which lead to low efficiency in the creation of most of the gross added value by enterprises with a low level of processing of products and the use of technologies of lower technological paradigms.

Structural changes in the economy occur continuously as a reaction to various factors (conjunctural, innovative, institutional, etc.); they have a natural character and, according to the evolutionary approach, are an objective process of economical development. At the heart of the development process is the mismatch between the changes in the structure of needs and interests of economic entities and changes in the location, technology of use and distribution of economic resources, which generates uneven dynamics of the ratio of quantitative indicators of various elements within the structure. At a certain stage of economic development, the structure of the economy, which by its nature is quite inert, may be in conflict with the global conditions of functioning and the goals of state socio and economic policies. In this case, structural changes are inevitable in the form of structural transformations, which can be represented as econometric equations of the form,

$$\begin{cases} D_i = \alpha + \beta t + \gamma t^2 \\ I_{it} = \alpha + \beta I_{it+1} + \gamma D_t \\ F_{it} = \alpha + \beta F_{it-1} + \gamma I_{it} \\ Z_{it} = \alpha + \beta t \\ V_{it} = \alpha + \beta F_{it-1} + \gamma DZ_{it} \end{cases} \quad (1)$$

where D_i - budget revenues of the country; I_{it} - investment in fixed capital; F_{it} - volume of fixed assets in the i-th industry; F_{it} V_{it} - number of employees in the i-th industry; α - production of goods and services in the i-th industry; - free term of the system of econometric equations; β γ - coefficients of the system of econometric equations.

In our opinion, transformation is a complex process of the modification of an economic system, which implies quantitative and qualitative changes in the components of the system and the spheres of public life. Due to the fact that transformation is a complex, multilevel and multidimensional process, which involves a transition from one economic system to another and has its own nuances in different countries, it is necessary to examine stages of this transition, including those in the changing structure of the social environmental development (Lovanov, 2018).

Stochastic dependencies, which take into account the influence of several factors on the effective feature, are described by means of correlation analysis. Dependencies are represented as analytical equations (functions).

To describe the dependence of average budget revenues per region in 2001-2018, we will use the capabilities of the *Microsoft Office* software package, specifically, those enabling modeling of stochastic interrelationships in the *Microsoft Excel* editor.

The level of approximation of the analytical representation of the stochastic dependence of the selected type of equation is determined by the coefficient of multiple determination calculated by the formula:

$$R^2 = 1 - \frac{\sum_{i=1}^{n} l_i^2}{\sum_{i=1}^{n} (y_i - \overline{y})^2} \qquad (2)$$

where y_i - actual level of the i-th indicator; $\overline{y}$ - average value; l_i^2 - deviation of the actual level of the i-th indicator from the estimated one.

We will study the dynamics of the consolidated budget revenues in 2001-2018 and form a polynomial. The results show a significant influence of time on the level of consolidated budget revenues R^2=0.9571. Thus, the regression equation of the dependency of the aggregate budget revenues will be:

$$D_t = 121362 + 4248,3t^2 - 23803t \qquad (3)$$

This model is adequate by the criteria F, the actual value of the Fisher criterion (Table 1).

Table 1. Model quality check parameters

Criteria	D_t
R^2	0.9571
F	379.27

Source: own

Calculations for the industry will be made with regard to the data in Table 2. We study the interdependence between investments in fixed assets in the industry in 2001-2018 and the sums of revenues from the consolidated budget. Using the graphical capabilities of the *Microsoft Excel* editor, we will create a regression equation of dependence of the amount of fixed investment in the industry on the amount of consolidated budget revenues, exclusively.

Table 2. Input data for formation of models for the industry in 2001-2018.

Years	D_t, *million dollars*	I_t, *million dollars*	F_{it}, *million dollars*	Z_{it}, *thousand people*	V_{it}, *million dollars*
2001	54,934.6	12,127.9	311,089.0	4,390.3	222,045.0
2002	61,954.3	13,989.7	339,259.0	4,220.4	241,694.0
2003	75,285.8	18,246.8	362,598.0	4,123.2	289,599.0
2004	91,529.4	28,190.8	420,080.0	4,077.1	388,838.0
2005	134,183.2	3,5031.1	456,738.0	4,072.4	479,402.0
2006	171,812.0	44,803.7	525,222.0	4,036.9	553,519.0
2007	219,937.0	64,341.4	660,369.0	3,973.0	710,209.0
2008	297,844.0	76,617.7	760,194.0	3,871.4	925,453.0
2009	272,967.0	57,657.6	970,942.0	3,546.9	799,496.0
2010	314,506.3	58,558.2	1,101,199.0	3,461.5	1,004,608.0
2011	398,553.6	86,312.8	1,116,367.0	3,352.7	1,228,141.0
2012	445,525.3	58,558.2	1,603,646.0	3,236.7	1,242,188.0
2013	442,788.7	101,858.0	1,749,110.0	3,170.0	1,171,899.0
2014	456,067.3	8,2743.8	1,937,821.0	2,898.2	1,280,275.0
2015	652,031.0	84,168.0	3,842,517.0	2,573.9	1,569,009.0
2016	782,748.5	108,635.2	3,072,954.0	2,494.8	1,954,792.0
2017	1,016,788.3	136,490.1	2,454,483.0	2,440.6	2,433,239.0
2018	1,184,278.1	65,901.1	2,916,938.9	2,411.3	2,423,918.7
R^2	0.9571	0.7463	0.7648	0.9615	0.9258
F	379.27	50.01	55.28	424.56	212.11

Source: own

Let us impose a regression line on the line for the distribution of investments in fixed assets in the industry in 2001-2018 and the sums of revenues of the consolidated budget of the country, so that this line would correspond to the maximum value of the determination coefficient. We get the equation of investment in fixed assets of the industry as a linear function:

$$I_{it} = 0,078Dt + 32308,6 \qquad (4)$$

The obtained regression equation balances the oscillations and determines the main trend with the multiple determination coefficient equal to R^2=0.7491.

A generalization can be made, according to which in case the previous conditions of development are preserved, the variation of investments in industrial fixed assets in 2001-2018 can be presented by 74.91% in the form of a linear function of dependence on the sum of revenues of the consolidated budget. Using the graphical capabilities of the *Microsoft Excel* editor, we will create a regression equation of the dependence of the value of industrial fixed assets on the sum of return on investment in the industrial fixed capital and the cost flow of industrial fixed assets for the period t-1. As a result of regression analysis, a model was specified:

$$y = a_0 + a_1x_1 + a_2x_2 + a_3x_3 \qquad (5)$$

Using the method of least squares for multiple regression, the following values of unknown parameters of the equation of the dependence of the value of industrial fixed assets on the sum of return on investment in industrial fixed capital and the cost flow of industrial fixed assets for the period t-1 were obtained:

$$F_{it} = 237957,4 + 0,502I_{it} + 0,899F_{it-1} \qquad (6)$$

Adequacy check of the model allowed calculation of its certain characteristics (Table 3).

Table 3. Model Features

Model Features	*Meanings*	*Model Features*	*Meanings*
Multiple correlation coefficient (R_{xy})	0.875	Matching correlation coefficients including	
Determination factor (*d*)	0.765	1) Investments in fixed capital of the industry (r_{x1y})	0.765
F-criterion for distribution (*Frsp*)	55.28	2) cost flow of industrial fixed assets for the period t-1 (r_{x2y})	0.875

Source: own

It can be concluded that the dependence between the factors under study is most fully described by the following factor model:

$$V_{it} = 5800427 - 0,203F_{it} - 1290,89Z_{it} \qquad (7)$$

The equation coefficients show the quantitative impact of each factor on the resultant while the other values are unchanged. The cost of output of goods and services in the industry will decrease by 0.203 points, while the cost of fixed assets in the industry will increase by 1 point, and the number of those employed in the industry will decrease by 1,290.89 points. The next step is to evaluate the reliability of the obtained model, the result of which is presented in Table 4.

Table 4. Assessment of the reliability of the econometric model of industrial output of goods and services

Regression statistics	
Correlation coefficient (multiple R)	0.9622
Determination coefficient R^2	0.9258
Normal R^2	0.9159
Standard error	200,717
Observation	18

Source: own

That is, the results of the *Microsoft Excel* calculations provide the greatest number of characteristics of close relationships. The determination coefficient for the linear model shows that the variation of the output of goods and services in the industry is determined by 92.58% by the variation of the factors under study. The correlation coefficient shows that there is a very close relationship between the cost of producing goods and services in industry, on the one hand, and the cost of industrial fixed assets and the number of people employed in the industry, on the other hand. In order to estimate the reliability of the econometric model as a whole, let us calculate the Fisher criterion (F-criterion) using the formula:

$$F = \frac{\frac{R^2}{m-1}}{\frac{1-R^2}{n-m}} \qquad (8)$$

The evaluation results are summarized in Table 8.

Table 8. Assessing the reliability of the model of output of goods and services in the industry by the Fisher criterion

Dispersion analysis	*df*	*SS*	*MS*	*F*	*F significance*
Regression	2	7.5E+12	3.8E+12	9.4E+01	3.4E-09
Remainder	15	6.0E+11	4.0E+10		
Total	17	8.1E+12			

Source: own

Since F=9.4E+01 and the significance of F=3.4E-09, the model as a whole is significant. Since $F_{fact} > F_{tabl}$, the hypothesis of the importance of relationship is accepted and the model of output of goods and services in the industry is statistically significant. It should be noted that the reliability of an econometric model can be achieved only at the expense of individual parameters, while the other parameters may not be reliable, so it is reasonable to assess the significance of each parameter of the models. To do this, let us calculate the t-test (Student's criterion) using the formula (9):

$$t_{aj} = \frac{|a_j|}{S_{aj}} \qquad (9)$$

where a_j is the estimation of the model parameter; $S_{aj}$is the standard parameter error.

The results of the t-criterion calculation for a specific econometric model of the output of goods and services in the industry are summarized in Table 9.

Table 9. Credibility assessment of the model of the output of goods and services in the industry by Student's criterion

	Coefficients	*Standard error*	*t-statistics*	*P-values*
Y- crossing	5,800,427.30	952,022.00	6.09	0.00
-F_{it} Variable	0.20	0.14	-1.47	0.16 (61)
Z_{it} Variable	-1,290.89	222.26	-5.81	0.00

Source: own

We will test the model in forecasting the growth of agricultural output. We will make calculations on the development of a system of econometric models on agriculture to forecast the structure of the economy per types of economic activities. Output data for regression analysis for agriculture are presented in Table 10.

Table 10. Input data for the formation of the agricultural model in 2021-2038.

Years	*D_t, million dollars*	*I_t, million dollars*	*F_{it}, million dollars*	*Z_{it}, thousand people*	*V_{it}, million dollars*
2021	54,934.6	1,471.0	93,392.0	4,148.1	66,788.0
2022	61,954.3	1,969.4	86,192.0	4,135.8	66,902.0
2023	75,285.8	2,999.2	77,979.0	4,105.7	66,602.0
2024	91,529.4	3,419.2	75,447.0	3,998.3	86,216.0
2025	134,183.2	4,931.5	76,034.0	4,005.5	95,520.0
2026	171,812.0	7,364.3	75,511.0	3,652.6	99,154.0
2027	219,937.0	9,554.9	78,978.0	3,484.5	114,031.0
2028	297,844.0	12,469.1	95,880.0	3,322.1	157,208.0
2029	272,967.0	5,324.9	103,187.0	3,152.2	159,187.0
2030	314,506.3	12,296.8	113,388.0	3,115.6	189,373.0
2031	398,553.6	18,319.7	118,019.0	3,410.3	253,485.0
2032	445,525.3	12,296.8	137,640.0	3,308.5	261,707.0
2033	442,788.7	16,526.9	156,013.0	3,389.0	306,998.0
2034	456,067.3	1,7137.3	171,392.0	3,091.4	381,227.0
2035	652,031.0	27,900.0	210,169.0	2,870.6	558,788.0
2036	782,748.5	4,5042.4	270,467.0	2,866.5	655,569.0
2037	1,016,788.3	57,804.7	341,622.0	2,860.7	727,352.0
2038	1,184,278.1	65,901.1	247,809.2	2,694.1	757,896.0
R^2	0.9571	0.9043	0.9040	0.8921	0.9548
F	379.27	160.64	160.08	140.55	359.11

Source: own

Thus, the following changes in the model of economic development took place during the analyzed period:

- there is a small change in the structure of the economy by types of economic activities;
- the general ratio of specific weight in the output of goods and services in market prices by types of economic activities is preserved;
- structural shifts in the sectoral structure have not changed significantly.

On the basis of the forecast data related to the structural transformation of the model of economic development, the state develops measures of state policy on stabilization of the economy from consequences of possible structural transformation.

CONCLUSION

The article provides the layout of the global economic recovery trend in terms of stimulating an increase in the value of production assets and an overall assessment of the development potential of the research program. Budgeting of the process should be considered in terms of formation of the development model not only on the basis of factual assessment, but on the level of forecasted economic growth as well. In the course of the research, prognostic and extrapolation methods were mainly used, based on the actual data collected in the context of growing economy prior to the crisis.

The main results of the research are presented in the form of a model for reducing the consequences of the liquidation of crisis phenomena.

Using the Bertelsmann Transformation Index modeling, we propose a factor model that describes the dependence between the investigated factors as fully as possible. The equation coefficients show the quantitative impact of each factor on the resultant while the other values are unchanged. This method, based on parametric equations, makes it possible to identify growth opportunities for countries with economies in transition.

Thus, in accordance with the calculated characteristics (coefficients of determination, correlation, Fisher and Student's criteria) used to assess the reliability of the model, we can conclude that the model we have built reflects the close relationship between the gross output of goods and services in the industry during the crisis and shows the possibility of changes in the value of fixed assets in the industry and the number of employees engaged in the industry after the crisis.

REFERENCES

Amal, M. (2016), *Foreign Direct Investment in Brazil: Post-Crisis Economic Development in Emerging Markets*, Academic Press.

Buzgalin, A., Kolganov, A. (2009), "World economic crisis and scenarios of post-crisis development: Marxist analysis", *Voprosy Ekonomiki*, No. 1, pp. 119–132 (in Russian).

Delibasic. M. (2019), "The Impact of Neoliberal Economic Policy on Economic Development in the Countries of Southeast Europe", *Transformations in Business & Economics*, Vol. 18, No. 2 (47), pp. 232-336.

Fu, Z. (2010), "Explore new economic growth points in the post-crisis era, on the basis of independent innovation", in *2010 International Conference on Management and Service Science, MASS 2010*. https://doi.org/10.1109/ICMSS.2010.5578167

Gong, W. (2003), "Post-crisis domestic procurement network to facilitate humanitarian assistance (a case of Sudan)" in *Proceedings of the ACM Conference on Electronic Commerce,* Vol. 5, pp. 506–570.

Huang, W., Jiang, L. (2011), "The innovation and development of network exhibition in the post-crisis era", in *2011 2nd International Conference on Artificial Intelligence, Management Science and Electronic Commerce, AIMSEC 2011 – Proceedings*, pp. 1692–1695.

Iacobuta, A-O., Mursa, G.C., Mihai, C., Cautisanu, C., Cismas, L.M. (2019), "Institutions and Sustainable Development: A Cross-Country Analysis", *Transformations in Business & Economics*, Vol. 18, No. 2A (47A), pp. 628-646.

Kievich, A.V. (2019), "Sobering reality: the global economy is going through the worst crisis ever", *Modern Aspects of Eeconomy*, Vol. 5 (261),pp. 189-194.

Konashev, M.B., Gerasimov, V.I. (ed.) (2019), "Evolutionary theory, environmental crisis and economy", *Russia: Tendencies and prospects for further development. Yearly issue,* pp. 113-118.

Lutskaya, E.E. (2019), "Global economy ten years after the crisis", *Social and human sciences. Russian and foreign literature, Series 2: Economics. Reference Journal*, No. 1, pp. 24-29.

Sayakbaev, T., Omurova, S., Alymkulova, A. (2019), "Role of an innovation economy in conditions of the world financial crisis", *Eurasian Scientific Association*, 1-5(47), pp. 278-280 (in Russian)..

Lovanov, I. (2018), "Solution of the problem of the theoretical profile of non-dimensional speed on the thickness of the boundary layer at the turbulent flow in the boundary layer based on the solution of the differential equation of Abel of the second generation with the app", *World Ecology Journal*, Vol. 8, No. 1, pp. 43-51.

Mah, J.S. (2006),. "Economic restructuring in post-crisis Korea", *Journal of Socio-Economics*, Vol. 35, No. 4, pp. 682–690.

Papava, V. (2016), "The problem of the catch-up effect and post-crises economic growth in the world leading countries", *Bulletin of the Georgian National Academy of Sciences*, Vol. 10, No. 4, pp. 97–104.

Popkova, E., Meshkova, S., Karpunina, E., Karpushko, E., Karpushko, M. (2016), "Developing countries as new growth poles of post-crisis global economy", *Contemporary Economics*, Vol. 10, No. 2, pp. 175–186.

Uskelenova, A.T., Shadiyev, K.K., Tatygulov, A.A. (2017), "Efficient model of economic growth in the conditions of post-crisis development of the society in the republic of Kazakhstan", *Journal of Advanced Research in Law and Economics*, Vol. 8, No. 2, pp. 635–643.

Vakaryov, A.A. (2019), "Multilevel nature of crises and post-crisis economic rehabilitation measures", *Forum. Series: Humanities and economic sciences*, No. 2 (17), pp.104-109 (in Russian).