QUID 2017, pp. 691-697, Special Issue N°1- ISSN: 1692-343X, Medellín-Colombia

SCENARIO FORECASTING OF DEVELOPMENT OF INDUSTRIAL PRODUCTION ON THE BASIS OF MODELLING OF EXPECTATIONS OF ECONOMIC AGENTS: METHODICAL APPROACHES AND THEIR APPROBATION

(Recibido el 15-06-2017. Aprobado el 04-09-2017)

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Abstract. The complexity and multidimensionality of the processes of socio-economic development provides the basis for improving the traditional theoretic approaches to modeling and forecasting economic growth. The main objective of the research is to develop based on the assessment of the expectations of economic agents the scenario-prognostic models for the evolvement of industrial production of the national economy. Based on the cross-correlation analysis of a combination of factors of the institutional and market order that affect the aggregated trends of economic growth, the parameters of their influence on the system of emerging expectations of economic agents were identified. Using the methods of econometric analysis, the values of subindexes specifying the integral estimates of the business activity index were determined and the parameters of the multiple choice model characterizing the relationship between expectations and the industrial development of the national economic system were identified. Based on the results of the approbation of the above approach, the development scenarios of industrial production in the Russian Federation for the medium-term period (until 2020) were developed subject to the programming of certain institutional and market factors. It was established that high rates of industrial development contributing to overcoming structural problems in the economy are able to be formed, mainly in the case of institutional reforms that form a stable basis for the generation of positive, stable expectations regarding the transformation of the current way of shaping the mechanisms of macroeconomic shifts. The main provisions and conclusions of the paper can be used by the scientific community, as well as representatives of business and government in developing forecasts of socio-economic growth and the rationale for development mechanisms.

Keywords: economic agents' expectations, modeling and forecasting, cross-correlation analysis, industrial development, scenario programming, business activity, institutional and market development parameters.

Citar, estilo APA: Safiullin, M., Elshin, L. (2017). Scenario forecasting of development of industrial production on the basis of modelling of expectations of economic agents: methodical approaches and their approbation. *Revista QUID (Special Issue)*, 691-697.

1. INTRODUCTION

The emerging trends in the development of socio-economic systems characterized by highly dynamic institutional transformations and the corresponding macroeconomic generations based on progressive forms of creating added value require improved approaches to methods of analyzing their development and, accordingly, methods of forecasting.

The multiplicity of factors that form the "points and quality of growth" of socio-economic systems greatly complicate the objective modeling processes, which predetermines the need to improve methodological approaches to the analysis and identification of the mechanisms of macroeconomic generation. Today, relying on mono- and micro-parametric (including a very limited set of exogenous parameters) economic growth models, as it predominantly occurs in neoclassical and neo-Keynesian concepts, means a decrease in the objectivity of the estimates obtained and the relevant conclusions.

Intensification and simultaneously regionalization of the globalization processes of the economy, the formation of complex and dynamic structures that form crisis phenomena actualizes the problem of modern regulation of economic development mechanisms, solving which becomes difficult in the framework of classical methods. Traditional approaches to modeling socio-economic processes can lead to a decrease in the quality of prognostic models built on the basis of extrapolation methods with the use of scenario forecasts for the development of the market and institutional factors. This means that the current developments of the prognostic models under consideration carry a whole range of risks associated with the accuracy of predicting and anticipating the trajectories of the economic growth. In this connection, there is a need to develop, scientifically substantiate (verify) and approbate models of economic growth, including, of course, forecasting ones, built on the basis of such factors that would have both a high level of sensitivity to changes in the external and internal environment of the economic system and predictability of trends, either emerging or nascent, at certain phases of the business cycle.

2. METHODS

Methodological approaches to the development of predictive models for the evolvement of socio-economic systems that consider the multifactor system of views towards the construction of forecasting functions, based also on the expectations of economic agents, generating cyclical fluctuations in the economy, became the subjects of the works by Russian scientists Granberg (2006), Ivanter (2007), Kondratiev (1989), Suslov (2008), Smirnov (2016) and others. At the same time, these studies differ in their methodological approaches, including the choice of explanatory factors. In our opinion, it is necessary to develop universal approaches to modeling of the economic development using a limited system of indicators that express promising transformations in a concentrated form. The use of an integral indicator, which estimates the expectations of economic agents, blends seamlessly into this approach. In this connection, the methodological approaches to the empirical evaluation of these expectations, generating future transformations in the social and economic environment in a concentrated form, and triggering, in turn, the mechanisms of phase shifts in the system of cyclical development of economic systems, must be clarified.

The use of more factors and explanatory variables in the model of determining and identifying economic development can lead to a number of known problems that reduce the quality of statistical estimates (Davis, Hecht, & Perkins, 2003). Thus, there arises the need to select a very limited set of such exogenous factors that would completely correspond to the solution of the problem posed. In our opinion, the optimal solution to the problem is to use an integrated indicator in the model, which in concentrated form represents the expression of the whole set of parameters characterizing the mechanisms of macroeconomic, social, institutional and other types of generation. Such an integrated indicator can be a quantitative assessment of the expectations of economic agents – the main drivers of the macroeconomic generations. In this case, the expectations of economic agents need to be modeled as an integral function of weighted components characterized by advanced dynamics in relation to trends in economic dynamics and expressing the institutional and market parameters of the socio-economic environment.

Cross-correlation analysis serves as an effective tool for factors filtering by the criterion of their advanced development (Fischer, 1977). For this purpose, the cross-correlation functions of the effective factor (the reference series) are modeled, depending on the predefined variables (leading economic components).

As a result of numerous iterations and implemented measures of quantitative analysis,

processing of public statistics, a system of institutional and market factors was identified that satisfied the fundamental criterion for their selection, as well as the lagged values of these factors. Having grouped them according to the criterion of homogeneity, we obtained a system of subindexes, which forms the basis for modeling the index of business activity of the economic system, calculated as the sum of average weighted subindex values, characterizing its institutional and market potential (I1,..., I6).

Having identified the initial database of factors used to determine the integral values of the index of business activity, assessing the expectations of economic agents in a concentrated form, a sequence of actions aimed at quantifying the values of subindexes (I1,..., I6) was implemented.

The algorithm for determining the integral values of subindexes is shown in general terms in Figure 1.

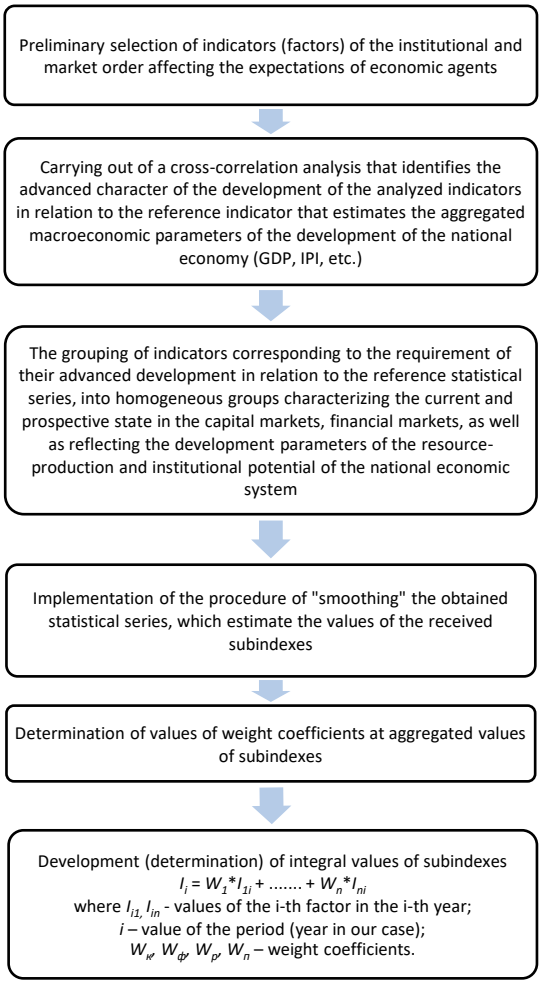

Figure 1. Algorithm for the determination of integral values of business activity indices in the region

Calculation of weight coefficients for the obtained standardized data includes a sequence of actions based on the determination of the correlation coefficients between the analyzed series characterizing the values of the included factors on the one hand and the statistical series, which numerical expressions for each analyzed year are the arithmetic mean of the standardized factors. This tool allows assessing the influence of each factor on the change in the average value of their aggregate impact for each year, which is the basis for determining the weight coefficients.

Projecting the presented methodological toolkit to the assessment of the values of all subindexes that define the composite value of the integral index of business activity allowed us to obtain data presented in Table 1.

Table 1: Integral values of subindices of the business activity index

	I1	I2	I3	I4	I5	I6
1996	2.090	-1.300	-0.880	0.421	0.782	-0.259
1997	1.173	-0.566	-0.851	-0.486	-0.337	-0.453
1998	0.406	-0.712	-0.169	0.606	-0.147	-1.036
1999	-0.017	0.566	-0.552	0.470	-0.040	0.160
2000	-0.150	1.130	0.828	0.476	-0.381	0.626
2001	-0.038	0.610	0.730	0.308	-0.375	-0.402
2002	-0.134	1.005	0.529	-0.014	-0.257	0.662
2003	-0.364	0.751	0.539	0.464	0.332	0.701
2004	-0.443	1.362	0.837	0.979	0.169	0.781
2005	-0.798	1.584	0.734	-0.399	0.289	0.353
2006	-0.243	0.731	0.563	0.360	-0.169	0.241
2007	0.084	0.260	0.442	0.173	-0.060	-0.705
2008	-0.074	0.118	0.636	-0.732	0.052	-0.034
2009	0.078	-0.390	-0.208	-0.925	0.052	0.135
2010	-0.475	0.647	-0.770	-0.275	-0.252	0.361
2011	-0.442	-0.212	1.115	0.168	0.166	-0.105
2012	-0.190	-0.582	0.668	-0.417	-0.221	0.632
2013	-0.188	-1.085	0.598	0.277	-0.507	-0.252
2014	-0.197	-1.141	0.185	0.210	-0.150	-0.093
2015	-0.078	-1.064	0.141	-0.133	-0.040	0.464

Source: *compiled by the author.*

3. RESULTS

The implementation of procedures for the identification of the integral values of subindexes allows us to proceed to the final stage of modeling the index of business activity, based on the previously stated algorithm. Formally, the process

of assessing the values of the business activity index is presented in Equation 4.

$$I_i = W1 \cdot I_1 + W2 \cdot I2 + W3 \cdot I_3 + W4 \cdot I4 + W5 \cdot I5 + W6 \cdot I6, \quad (1)$$

where I_i - BAI value;

i – value of the period (year in our case);

I_{1i} – urban development index in year i;

I_{2i} – human assets index in year i;

I_{3i} – production and resource development index in year i;

I_{4i} – institutional and cultural development index in year i;

I_{5i} – economic activity development index in year i;

I_{6i} – scientific and research potential index in year i;

$W_1, W_2, W_3, W_4, W_5, W_6$ – Weight coefficients of the corresponding indices.

Based on the data for 1996-2015, the calculated dynamics of the business activity index in the Russian Federation, based on the expectations of economic agents about the changes in institutional and market factors, is presented in Figure 2.

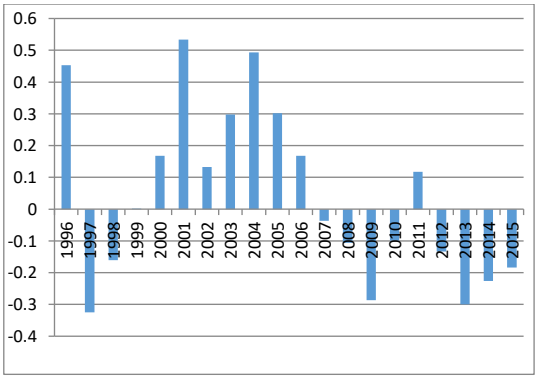

Figure 2. Business activity index assessing the expectations of economic agents in a concentrated form.

Source: *compiled by the author.*

The obtained during approbation of presented methodological approaches results of business activity assessment based on the change of both market and institutional parameters of the social and economic environment allow us to turn to the development of prognostic models. It is important that these models will have a significant potential in terms of their forecasting of the explained variables as a result of their high "sensitivity" to the transforming multilevel parameters that characterize the expectations of economic agents.

The implemented economic and mathematical analysis of the influence of the business activity index on the dynamics of *IPI* with the use of probit-, logit- models and models of multiple choice (Bonabeau, 2002) (Kydland, & Prescott, 1986) (Prescott, 1986), the following equation was obtained. Equation 2.

$$ИПП = 0{,}053 + 2{,}462 \cdot \mathrm{I} + 1{,}62 \cdot f_1 + 1{,}03 \cdot f_2 \quad (2)$$

.

Where

IPI – industrial production index;

I – business activity index;

f1, f2 – dummy variables.

The dynamics of calculated and observed *IPI* values is shown in Figure 3

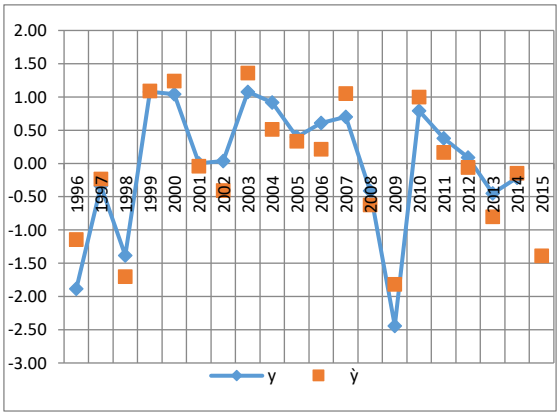

Figure 3. Results of the ratio of normalized IPI values predicted by the model and their actual level

Source: *compiled by the author.*

Thus, a model was obtained that verifies the convergence of two dynamic standardized series and allows us to relate with a high degree of reliability the dynamics of the real *IPI* to the dynamics of the calculated composite index

acting as a business activity assessment tool form expressing the expectations of economic agents in a concentrated.

4. SUMMARY

The implemented approach forms a significant potential for the performance of activities aimed at developing scenario-prognostic models for the development of socio-economic systems. Approbation of the above algorithms is presented in the form of developed scenario models for the development of the Russian economy up to 2020. Three possible scenarios for medium-term development are identified:

- A pessimistic scenario of development (the scenario of hard resource constraints) is focused primarily on overcoming the most acute phases of economic and social development.

- A basic scenario of development (the scenario of moderate resource constraints) is based on the fact that necessary measures will be implemented aimed at stimulating new forms of macroeconomic processes organization;

- An optimistic scenario (a scenario of mild resource constraints). This scenario characterizes the maximum possible rates of socio-economic development based on achieving high competitiveness and ensuring high-quality social and economic growth.

The difference in scenarios arises from the possible transformation of the factors involved in the BAI model. Scenario parameters for changing the factors are presented in Table 2.

Based on the results of the preliminary design of the regression model explaining the dynamics of the change in the standardized values of *IPI* depending on the change in the business activity index (BAI), the changes in *IPI* by 2020 as a result of the transformation of the system of institutional and market factors were prognostically estimated.

The results of the scenario modeling of the business activity index for the period up to 2020, as well as the calculated parameters of the statistical series characterizing the real values of the industrial production index (*IPI*) and the business activity index (BAI), are shown in Figure 4. The predictive growth rates of *IPI* by 2020 were obtained by inverse transformation of standardized data obtained in the framework of the application of the regression Equation 5.

Table 2: Scenario parameters of the development trend of key factors of business activity model for the period up to 2020, in %, by 2015

Factors	Scenario 1	Scenario 2	Scenario 3
Number of rural population	100	99	98
Number of graduates of secondary schools	98	99	102
Number of graduates of higher educational institutions	98	99	102
Commodity stocks	95	100	110
Motor vehicle freight turnover	95	100	110
Mining index	95	100	105
Total freight transported by rail	95	100	105
Number of theaters	100	101	102
Number of clubs	100	101	102
Consumer price index	110	105	103
Monetary income	100	110	120
Researchers	100	101	102
Research institutes	100	102	105
R&D domestic expenditures	100	105	110

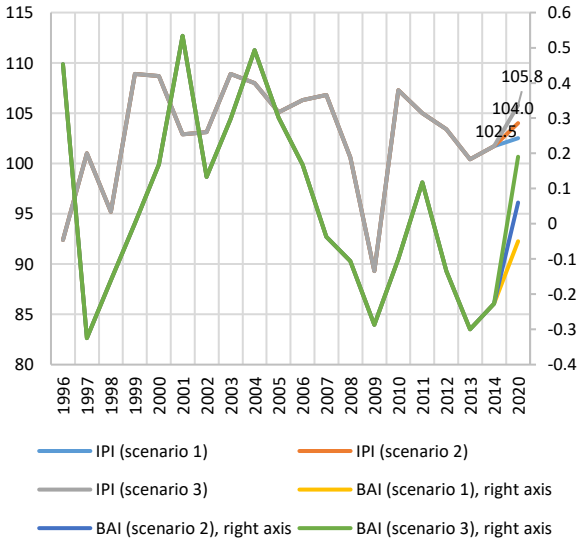

Figure 4. Prognostic trend of the industrial production index of the Russian Federation for the period up to 2020, in growth rates

Source: compiled by the author.

5. CONCLUSION

The toolkit for programming the expectations of economic agents and assessing their impact on the industrial production index presented in this paper allows implementing scenario-prognostic assessments of the development of key economic parameters. The results of the conducted research established that in case of preservation of the institutional and market trends formed in 2014-2015 for the period up to 2020, a quite moderate growth in industrial production, comparable to the dynamics of 2012-2013, that is, the period of aggravation of structural problems in the Russian economy, is expected. This scenario will not contribute to their overcoming, which will significantly complicate the transition of the national economy to the transformation of macroeconomic generations based on increasing labor productivity and restructuring the inefficient development tools that have developed in recent years based on the prevailing development of rental mechanisms (Safiullin, Elshin & Prygunova, 2015).

The third scenario, considered in this paper and based on activation of the processes of institutional and market order, on the contrary, presupposes a significant growth in business activity and the transition of the Russian economy to high rates of growth in industrial production (about 106% per year by 2020).

An important aspect in programming the expectations of economic agents and their impact on the dynamics of industrial growth is that it is initially built on a high predictive potential, based on the use of factors outrunning the overall dynamics. It is also important that the composition of factors integrated into enlarged groups includes both institutional and market parameters of the development of economic systems. At the same time, based on their membership in a particular group and the identified advanced dynamics (lagged component), the approaches to the estimation and forecasting of industrial growth have been formed. The developed forecasting mechanism is largely methodically based on the principles of AR and ARMA models. There are also conceptual points of contact with "agent-oriented" (AOM) models, which are based on the hypothesis of the presence of a large number of interacting agents in the studied system according to a given set of rules. However, the main distinctive feature is the conceptual approach based on the "programming" of institutional and market factors that generate shifts in the expectations of economic agents.

ACKNOWLEDGEMENTS

The work is performed according to the Russian Government Program of Competitive Growth of Kazan Federal University (26.8732.2017/8.9).

The publication was prepared within the framework of a research project No. 16-06-00062 supported by the Russian Foundation for Basic Research.

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