MECHANISMS AND METHODS OF THE STATISTICAL ANALYSIS AND ACCOUNTING FOR PHASE SHIFTS IN CYCLIC DEVELOPMENT OF ECONOMY IN THE CONDITIONS OF THE INCREASED UNCERTAINTY OF THE INSTITUTIONAL AND CONJUNCTURAL ENVIRONMENT

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ABSTRACT

Subject. Modern development of social and economic systems is characterized by cyclic dynamic changes occurring in them. These changes affect the various aspects and levels of the economic system, and its structure forming a variety of relationships. Increased processes of economy globalization and at the same time its regionalization, formation of complex and versatile dynamic structures forming crisis developments actualize the problem of modern regulation of cyclic economic development which solution becomes difficult within the framework of schemes of the classical methods of cyclism theory.

Objectives. Development of scientific basis (verification) and testing the model of cyclical changes built on the basis of factors that would have a high level of sensitivity to changes in the external and internal environment of an economic system.

Methodology. This study applied a methodology based on the use of the factor approach to influence of target indicators on trends in cyclical economic development, also in the course of work we have used methods of statistical and econometric analysis and forecasting.

Results. Diagnostic algorithm for cyclical changes has been developed that allows identification of upward and downward phases of the economic cycle regardless of their "entry" into a positive or negative zone of emerging indices of rapid development on the basis of which it is possible to perform short-term forecasts with advancing in 1 - 2 years from the current trajectory of economic development of the national economy.

Conclusions. The analysis results show that the short-term cycles of the Russian economy are somewhat different from the classic short-term Kitchin cycles which periodicity dates within the range of 2 - 4 years. The revealed duration of the Russian economy cycles varies within a wide range depending on the corrective actions of public authorities, as well as on existing high volatility of conjunctural parameters.

Keywords: cycles, forecasting, phase shifts, leading indicators, cycles of rapid economic development

KURUMSAL VE KONSERVASYON ORTAMININ ARTTIRILMIŞ BELİRTİLMESİNİN KOŞULLARINDA EKONOMİNİN SİNYAL GELİŞİMİNDE FAZ GEÇİŞİ için İSTATİSTİK ANALİZ VE MUHASEBENİN MEKANİZMALARI VE YÖNTEMLERİ

ÖZ

Konu. Toplumsal ve ekonomik sistemlerin modern gelişimi, içinde meydana gelen döngüsel dinamik değişikliklerle karakterizedir. Bu değişiklikler ekonomik sistemin çeşitli yönlerini ve düzeylerini etkiler ve yapısı çeşitli ilişkiler oluşturur. Ekonomik küreselleşmenin artan süreçleri ve aynı zamanda onun bölgeselleşmesi, kriz gelişmelerini şekillendiren karmaşık ve çok yönlü dinamik yapılar, klasik siklizma teorisi yöntemleri çerçevesinde çözümün zorlaştığı döngülü ekonomik kalkınmanın modern düzenlenmesi sorununu gerçekleştirmektedir.

Hedefler. Bir ekonomik sistemin dış ve iç ortamındaki değişikliklere karşı yüksek düzeyde hassasiyete sahip olabilecek faktörlere dayalı olarak yapılan çevrimsel değişiklik modelinin bilimsel temel (doğrulama) ve test edilmesi.

Metodoloji. Bu çalışma, hedef göstergelerin döngüsel ekonomik gelişme eğilimleri üzerindeki etkisine faktör yaklaşımının uygulanmasına dayanan bir metodoloji uyguladı ve istatistiksel ve ekonometrik analiz ve öngörme yöntemlerini kullandığımız çalışma boyunca da uyguladı.

Sonuçlar. Kısa döngülerin gerçekleştirilebilmesi için ortaya çıkan hızlı gelişme endekslerinin pozitif veya negatif bölgesine "girişi" ne bakılmaksızın ekonomik döngünün yukarı ve aşağı aşamalarını tanımlamasına izin veren çevrimsel değişiklikler için teşhis algoritması geliştirilmiştir. Ulusal ekonominin mevcut ekonomik gelişme yörüngesinden 1 - 2 yıl içinde gelişen uzun vadeli tahminler.

Sonuçlar. Analiz sonuçları, Rus ekonomisinin kısa vadeli döngülerinin, dönemlilik 2 ila 4 yıl arasında değişen klasik kısa vadeli Kitchin döngülerinden biraz farklı olduğunu göstermektedir. Rus ekonomi döngülerinin ortaya çıktığı süre, kamu makamlarının düzeltici faaliyetlerine ve mevcut konjonktürel parametrelerin aşırı oynaklığına bağlı olarak geniş bir aralıkta değişiklik göstermektedir.

Anahtar kelimeler: döngüler, tahmin, faz kaymaları, önde gelen göstergeler, hızlı ekonomik kalkınma döngüleri

INTRODUCTION.

The modern market design has a very wide range of uncertainties and transforming macro-generating processes. Particularly relevant the above-stated arguments are represented in the context of the studying cycles in the Russian economy characterized by congestion of the administrative methods of regulation and, accordingly, the special nature of economic cycles. Thus the use of traditional methods of forecasting the change of cycle phases that are based mainly on the static and linear extrapolation methods would not fully meet the requirements of high prognostic properties. This causes the need to develop the improved and adapted to the new realities mechanisms and methods of cyclical changes diagnostic. At the same time these methods must necessarily take into account the totality of macroeconomic factors affecting the change of cyclic phases. These include, for example, the dynamics of growth of the world and national economy, investment activity in this considered sector of the economy, changes in the pricing environment for the products, and so on. However, inclusion in the model of a large number of predictors can generate a number of known problems [1]. Proceeding from this, the development of the model should be formed on the basis of a limited number of exogenous factors that characterize, in the first place, the dynamics of the expectations of economic agents as the most important indicator of the phase shift in the cyclical development, and evaluating almost fully trends in economic activity - the main drivers of a phase shift in the cyclical development.

Importance of the use of valuation techniques for the indicators characterizing the expectations of economic agents increases significantly in a period of uncertainty. In these circumstances a discrepancy between economic policy measures and the actual situation can significantly increase the depth of a cyclical downturn and "hold" economic recovery. In this regard, the interest in this tool extremely increased and its role in adoption of economic solutions has essentially increased.

The technique applied in this research is based on usage of the factor approach, i.e. detection of a set of factors affecting the expectations of economic agents, and hence an economic system activity in general. Upon this approach, firstly the analyzed factors are combined into sub-indices which are the sum of a set of average weighted estimates by the analyzed components. An integral or a composite index ("index of rapid development cycles") is calculated on the basis of this system of indicators characterizing certain activities, and the index method.

In this paper, we mean rapid development cycles as changes in economic agents' expectations caused by a change of short-, medium- and long-term institutional and conjunctural factors and forming conditions for phase generations of cyclic development of the economic system. Upon that, rapid development cycles are divided into short, medium and long term, depending on the composition of the lagged variables having signs of rapid development, and included in the analytic base for modeling the cyclical changes [2, 3].

As the basis for the study of cyclical development is the expectations theory, the simulated cycles will have a significant prognostic properties predicting turning points in the cycle depending on the composition of the factors used and the size of their lagged values [4].

Structurally-logic diagram for rapid development cycles simulation is shown in Figure 1.
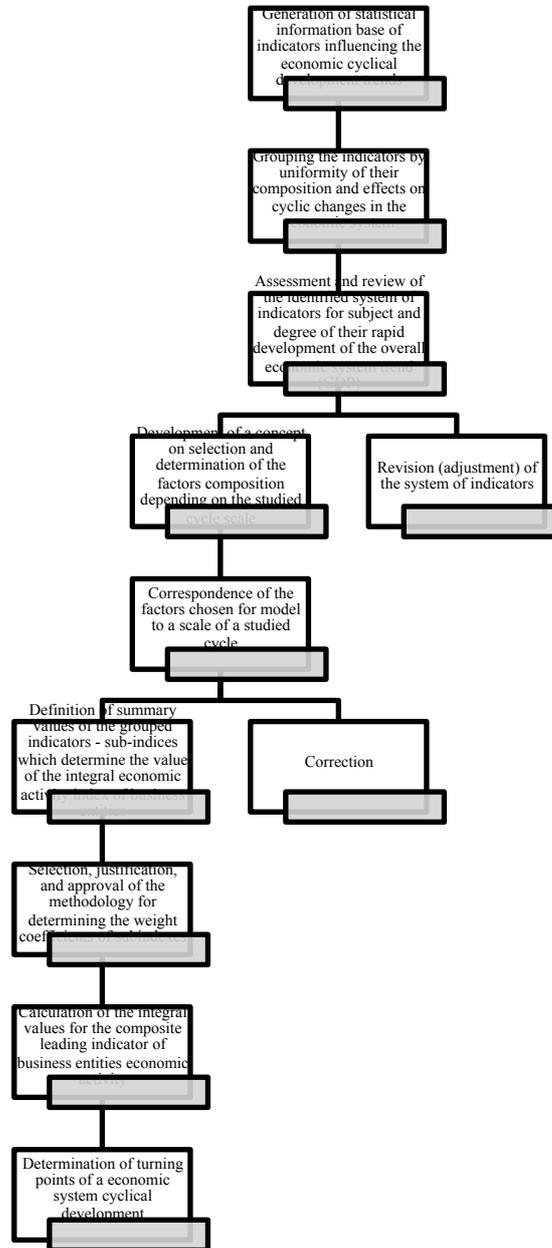

Figure 1.Structurally-Logic Diagram For Rapid Development Cycles Simulation

In determining and justifying the choice of a combination of factors we proceeded, firstly, from the theory of rational expectations by R. Lucas who was awarded a Nobel prize in 1995. The sources of disturbances in the expectations of economic agents, according to this theory, are two groups of factors: monetary (price changes, fluctuations in interest rates, changes in the money supply, etc.) and material (appearance of technological innovation, changing in consumer preferences as a result of innovation in the consumer sphere, etc.). In addition, based on the selection and validation of the factors we have used the approach developed by A. Pigou, when there are allocated, as previously noted, three groups of factors that influence the expectations of economic agents [5]:

1. Monetary

2. Material agreed with the Lucas theory

2.Psychological factors.

METHODS
With reference to the theory developed by us on rapid development cycles based on the expectations of economic agents, all the factors must be subdivided into material and monetary with one hand and psychological, on the other. However, we understand in this paper the psychological factors as the reality in institutional forms that configure representations and cognitive models of business entities what have a decisive impact on directivity in the dynamics of national management models. In this connection, instead of the term "psychological" factors we propose to use the term "cultural and institutional factors". [6]

By the results of evaluations based on economic and mathematical modeling, seven main groups of factors have been identified that have advancing influence on the expectations and appropriate models of behavior of business entities.

The first group included the factors that characterize changes in the demographic frame of a territory and has formed the urban development index (I1).

The second group of factors has formed the so-called human capital assets index (I2).

The production and resource index includes factors which reflect the quantitative and qualitative characteristics of the emerging resource and production base of the national economy such as commodity stock, freight turnover, mining operation, etc. (I3)

The fourth group of factors is focused on the definition of the composite institutional and cultural development quality index of the system and includes a set of indicators which include indicators evaluating the level of social infrastructure development, the quality of developing mental models of society (I4).

The fifth group of factors has formed a so-called index of economic activity of business entities (I5). It includes such indicators as cash incomes, investment in fixed assets, consumer price index, and others.

The sixth group of factors has formed the so-called index of research capacity. This characterizes an internal reserve of innovation development of economy (I6).

The seventh group of factors determines the index of changes in equity (I7) that shows the reaction of the general economic trends to changes and adjustments of price indexes for the cost of capital.

The search for solutions aimed at the identification of a system of indicators on the subject and degree of their rapid development with respect to the overall economic trend of the system (GDP) has been carried out through the use of econometric tools.

Calculation algorithm had the following sequence:

1. Cross-correlation functions of a resulting factor (reference series) and preset factors (leading components) are constructed on the basis of the linear correlation coefficients. In accordance with the methodology of statistical analysis, a cross-correlation function expresses the closeness of the relationship between the levels of the time series y_t to the measured at the point of time t, and levels of another time series x_{t-}, being at a distance τ time units from one another:

$$r_{(y_t, x_{t-\tau})} = \frac{\sum (y_t - \overline{y_t}) * (x_{t-\tau} - \overline{x_{t-\tau}})}{(n - 1 - \tau) * \sigma_{x-\tau} * \sigma_y} \qquad (1)$$

Cross-correlation is a necessary condition for determining the period of advance, or the so-called lag.

2. It is necessary to compare the correlation with $r_{crit.}$

$$r_{\text{крит}} = \frac{t_{\text{кр}}}{\sqrt{t_{\text{кр}} + n - 2 - \tau}} \quad (2)$$

n - sample size, τ - lag.

t $_{cr}$ - Student distribution (5%; n-2- τ);

n - sample size, τ - lag.

If $r_{(y_t, x_{t-\tau})} > r_{\text{крит}}$, the presence of significant correlation coefficients indicates the relationship between the dynamics of the corresponding indicator with the reference series index and determines its inclusion in the system of indicators for calculation of the rapid development indexes.

The results of cross-correlation analysis of the considered statistical series which are on the one hand an efficiency factor (reference series), and on the other, the studied time series of analyzed factors are presented in Table 1.

Table 1.Composition of the factors characterized by advancing dynamics of the relative reference series (GDP) with a breakdown to integrated leading indexes

	Factor name	Lag value, number of years
I. Urban development change index		
1	Rural population	1, 2
II. Human capital assets index		
2	Number of graduates from secondary schools	-
3	Number of graduates from higher institutions	2
III. Production index		
4	Commodity stock	1
5	Freight turnover	1
6	Mining operations	1, 2
7	Freights carried by rail	1,2
IV. Social well-being index		
8	Number of hospitals	-
9	Number of theaters	2
10	Number of cultural and leisure institutions	1, 2
V. Economic activity index		
11	Investments in fixed assets	-
12	Consumer price index	1, 2
13	Incomes of the population	2
VI. Research capacity index		

14	Number of scientific workers	1, 2
15	Number of research institutes	1, 2
16	Number of R & D proposals	-
17	Gross domestic R & D expenditures	3
VII. Changes in equity index		
18	Price of oil	-
19	Refinancing rate level	1

The following table shows the values of the lag for factors that satisfy our requirements with respect to their rapid development dynamics relative to the reference series. Factors with a lag of 3 years and more can no longer be used in the simulation of short-term rapid development cycles. Since the phase shifts in short cycles are determined by impacts of operational level factors, that is, by those which adjustments result in the reference series shifts in the shortest prospect.

Thus, by the results of a cross-correlation analysis, the factors that have a short term impact to the economic agents behavior model are classified as those that are fully consistent with the existing theoretical and methodological approaches to the modeling of the so-called Kitchin cycles. However, the rather unexpected result was that the rapid development hallmarks are borne by the factors which characterize the institutional and cultural potential of the system. The observed phenomenon certainly requires appropriate explanations and substantiations.

The basis of calculation of weighted coefficients for sub-indices which determine the value of the rapid development composite index is a taxonomic method. It is grounded on determination of the distance between points of the multidimensional space which dimension is determined by the number of factors involved in the model.

A value of the composite index estimating expectations of economic agents is the sum of the calculated series of indicators or sub-indices. Accordingly, each component of the indicator is weighed.

Calculation in the formula form of the rapid development composite index is as follows:

$$I_i = W_k * I_{ki} + W_{\phi} * I_{\phi i} + W_p * I_{pi} + W_n * I_{ni} \text{,} \quad (8).$$

Where Ii - the composite (integrated) index value;

i - period value (year in this case);

I1 (i) the index of urban development in the i-th year;

I2 (i) - the human capital assets index in the i-th year;

I3 (i) - the production and resource development index in the i-th year;

I4 (i) - the institutional and cultural development index in the i-th year;

I5 (i) - the economic activity index in the i-th year;

I6 (i) - the research capacity index in the i-th year;

W1, W2, W3, W4, W5, W6, W7 - weighting coefficients of corresponding indices.

RESULTS

The results of calculations for the short-term rapid development cycles in relation to the Russian economy for the period of 1991-2015 is presented in Figure 2.
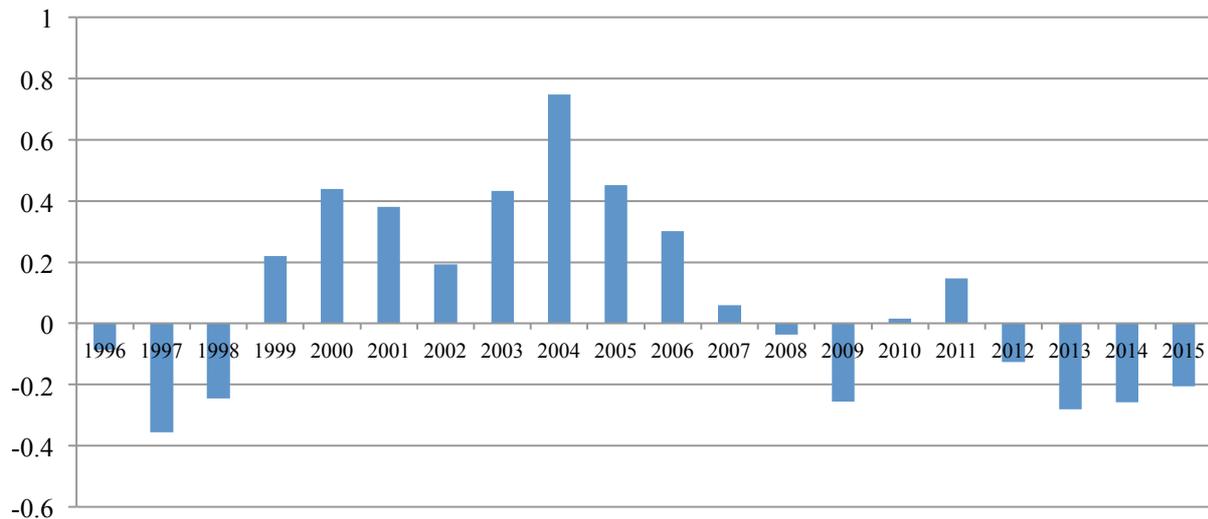

Figure 2.The rapid development cycles of the Russian economy in the period from 1996 to 2015.

Important thing in the results obtained is that the cyclical changes here are short term in view of the fact that the lagged values of the factors under study make 1-2 years on average. In this regard, the forecasting horizon for future changes of economic conditions will also be limited to 1-2 years. Thus, we can say that the implemented approach has allowed to simulate the processes of generating the so-called business cycles (Kitchin's short cycles) of the Russian economy in the range of 1991-2015 years developed in advance of 1 -. 2 years from the current trajectory of the national economy development.

The main feature of the diagnosing the rapid development indices is that the taxonomic method is used in the process of normalization of the absolute values of the indicators which define values of the corresponding sub-indices. It is based on the principle of the ratio of a difference between the individual series value and the average value to the standard deviation. Thus, depending on the current growth rate of the absolute values of the investigated indicators set their totals normalized according to the taxonomic method would fall either to a positive or to a negative zone. If, for example, the indicator value has fallen into negative zone, this will mean that growth rates were in the current year under analysis lower than the average series value. And the sheer number of the indicator means in how many times this deviation is higher / lower than the standard deviation of the series under study. The higher the modulus level of this value, the higher volatility was characteristic to this year [9]. With respect to the rapid development composite index, a negative value of the series will mean a decrease in optimism of economic agents with respect to the further development of socio-economic and institutional environment and market environment, and vice versa, if the value of the indicator was in the positive zone, this means reducing the overall level of pessimism. It is important to note that fluctuations in the composite index are tracked relative to the RMS value of the series that will demonstrate the scattering of series points with respect to a number of its dispersion. According to the terminology of R. Lucas [10] fluctuations in the rapid development composite index are seen as a result of a deviation of the real level of economic agents' expectations from its long-term trend. In a case of exceeding the composite index value over zero (neutral) level we can talk about the cycle growth, otherwise about its decline.

At the same time, shifting the upward phase to the downward and vice versa can be observed both in positive and in negative zone of the series. That is, the phase shift does not have to occur exclusively in the logic of "the downward phase is in the negative zone of the series, and the upward in positive". Phase shift process can only take place in one zone (positive or negative). Moreover, if all phases of the cycle are observed, for example, in the negative zone, it means that the change of pessimism to optimism happens to be, but even improving economic agents' expectations does not lead to reliance on institutional and conjunctural environment in the future, but only could mean some improvement in sentiments continuing at the same time below the formed level of the standard deviation of the series.

The dynamics of rapid development short-term cycles of the Russian Federation consisting of two phases is presented in Table 2.

Table 2. Short cycles of rapid development of the Russian economy in the period from 1994-2015.

Rapid development cycle	Downward phase	Upward phase
1994 – 1997	1994 - 1995	1996 - 1997
1998 – 2002	1998 - 2000	2000 – 2002
2002 – 2009	2002-2004	2004-2009
2009 – 2013	2009 - 2011	2011 – 2013
2013-2018,2019*	2013-2017*	2017-2019*

* Estimation

CONCLUSION.

It is necessary to have in view the fact that the Russian economy, as has been previously noted, simultaneously combines the principles of market and planned economy what, of course, affects the arrhythmy and duration of the observed cyclical changes. In process of reduction of the share in the economic regulation mechanisms of the tools that are attributable to the administrative-command system, observed arrhythmia will decrease, and the classic mechanisms of cyclical development become more common.

The analysis results show that the short-term cycles of the Russian economy are somewhat different from the classic Kitchin's short cycles, the frequency of which dates is 2 - 4 years. The revealed duration of the Russian economy cycles varies within a wide range depending on the corrective actions of public authorities, as well as on existing high volatility of conjunctural parameters. In addition, it is necessary to bear in mind the fact that the Russian economy, as has been previously noted, simultaneously combines the principles of market and planned economy what, of course, affects the arrhythmy and duration of the observed cyclical changes. In process of reduction of the share in the economic regulation mechanisms of the tools that are attributable to the administrative-command system, observed arrhythmia will decrease, and the classic mechanisms of cyclical development become more common [11].

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