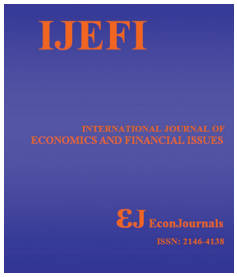

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Methodological Approaches to the Diagnosis and Forecast of the Long-Wave Fluctuations in the Economy

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ABSTRACT

Evolutionary development of economic systems demonstrates the cyclical nature in time. In such a case these cyclical fluctuations comprise all facets of economic relations, starting from the production sector and ending the sphere of services, focused on ensuring the interaction effectiveness of economic relations. As the modern world experience shows the cyclical dynamics has a number of its individual features depending on a wide range of factors, such as the type of economic system (planned or market), market type, forms and methods of state or other effects on the regulation of cycles within smoothing process, etc. The knowledge of these factors, the nature of their origin and the impact on the long-term cyclical fluctuations is not a trivial matter and requires a comprehensive system analysis, based on a synthesis and a dialectic of the established approaches.

Keywords: Long-term Cycles, Phase Shifts, Advanced Development Cycles, Technological Modes
JEL Classifications: C10, C53, E37, F17, O10

1. INTRODUCTION

Questions on cyclical development of the economy by regular intervals appear and fade in the discussion area of the scientific theories. The theory of cyclical development is still far from complete and requires further improvement and refinement for the concepts of structural and logical analysis, paradigms and patterns for the phase shift (Matveev and Semenov, 2013).

Now, the scientific community has identified more than 1300 economic cycles different in nature. In this case, there are three main areas of research (Dubovitsky, 2005):

1. Conventional, based on classical and Keynesian approaches for diagnosis of cyclical fluctuations (Keynes, 1973)
2. Evolutionary-institutional, theoretical positions, which are based on the institutional nature of the cyclical development in the economy (Hicks, 1988) value and capital
3. Synergistic, revealing methodological approaches of the cyclical fluctuations, formed because of the interaction process for various factors and different levels of the system.

Each of them operates with its own set of tools and factors, revealing the specifics for generation of cyclic development. In this case, the entire set of factors is divided into external and internal. Their matching and combination with each other, in fact, determines the differentiation of scientific views. A very important aspect that divides scientific theories of cyclical development is the fact that, the factors used in their models and concepts are different in speed of the sync with the overall dynamics. In connection with it there are highlighted the advanced, delayed and synchronized indicators of the economic cycle.

Thus it can be stated that the existing diversity of views and scientific approaches to the study of cyclical development of economic systems are multiple enough, complex and often contradictory (Barr, 1997).

Identification of the influence logics of the factors on the long-wave fluctuations and so far is the most difficult task in the cyclical development theory for which there are a number of unresolved and controversial issues. As noted in the work of Glazyev (2011) "generalization of the theory for long-waves requires an interdisciplinary approach, for which is necessary the common methodological basis, allowing to combine the results of research in the technological, economic, institutional, managerial and sociological fields." Really, understanding of the logics for long-term cyclical fluctuations is impossible without a comprehensive analysis of the institutional and market factors that encourage this process. Moreover, the analysis of these factors should not be limited to purely economic parameters due to the fact that the long-wave fluctuations present a complex multidimensional process that includes "multi-bit" and a multi-level complex of factors, evaluating the general condition of the evolving system. As rightly, in our view, it is seen in the work of Perez (1987) "the concept of techno-economic paradigm reflects the interaction of technological way to the socio-economic environment, mediating the formation processes of growth and replacement." Developed in this study methodological apparatus for diagnosing of the cyclical fluctuations completely fits in the defined research paradigm. In its base there are laid the mechanisms diagnosing not only tactical but also institutional factors, not only economic parameters, but the parameters that assess the social component of the system development (Center for Economic and Social Studies of the Republic of Tatarstan at the Cabinet of Ministers in the Tatarstan, 2009).

2. MATERIALS AND METHODS

The methodological approaches used in this study are based on the factorial approach, that is, identifying a set of factors affecting the economic expectations of the agents, and hence an economic system activity in general (Shekhin, 1991). By this approach, first the analyzed factors are combined into sub-indices, which present the sum of a plurality for average weighted estimates on the analyzed components. Based on this system of indicators characterizing certain kinds of activities, and on the index method there is calculated integral (composite) or a composite index - "index for advanced development cycles." (Matveev and Semenov, 2015).

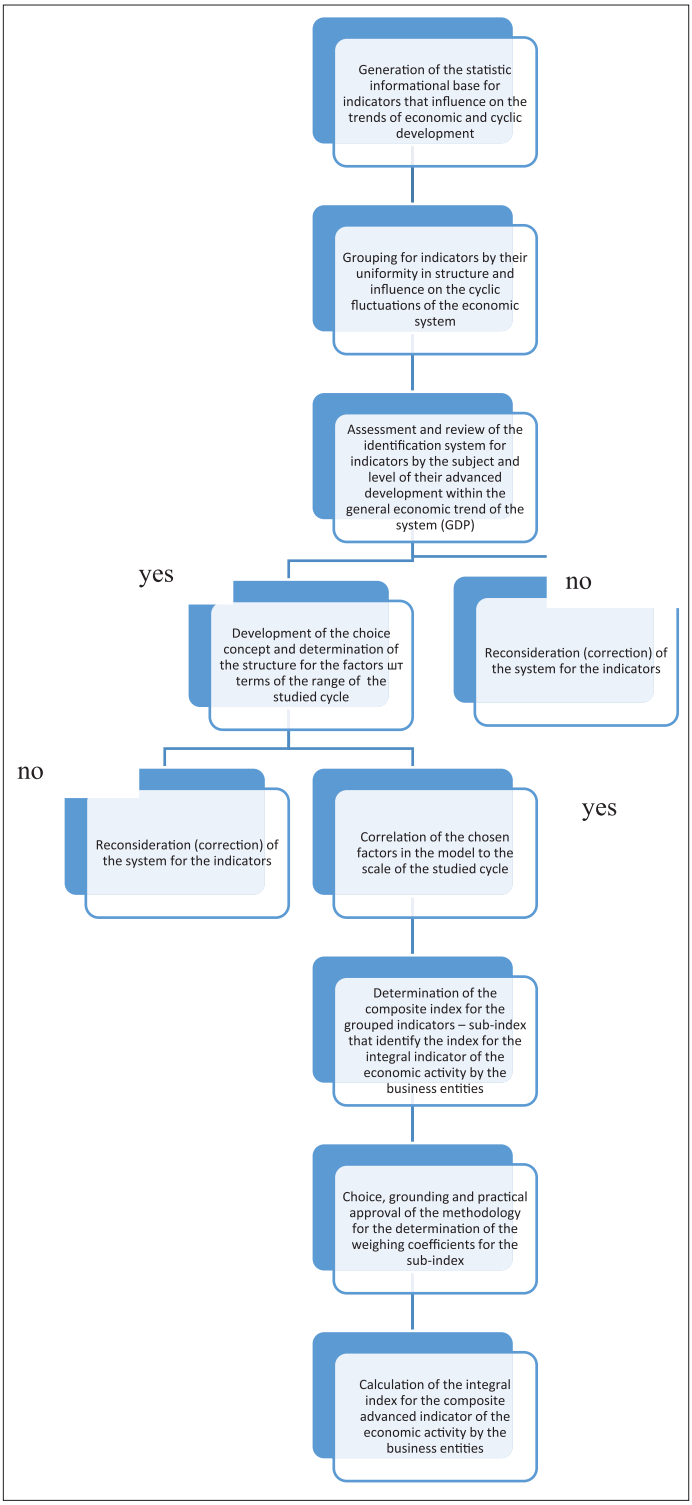
Under advanced development cycles we understand fluctuations in expectations by the economic agents, obeying a change of short-, medium- and long-term institutional and conjunctural factors and shaping the conditions for phase generations of cyclic development in the economic system. In this case, the cycles of advanced development are divided into short, medium and long-term, depending on the composition of the lagged variables with signs of advanced development, within the analytical framework of modeling by cyclical fluctuations (Safiullin et al., 2015).

As the basis for the study on cyclical development is the theory of expectations, the simulated cycles will have significant prognostic properties predicting turning points in the cycle, depending on the composition of the used factors and the size of their lagged values (Abalkin et al., 2002).

Structurally-logical scheme for modelling the long-term cycles of advanced development is shown in Figure 1.

In the process of determining and justifying the choice for a combination of factors, we started in the first place from the theory of rational expectations by Robert Lucas, the holder of the Nobel Prize in the year 1995 (Petrosyan, 2002). The sources of disturbances in the expectations of economic agents, according

Figure 1: Structurally-logical scheme of simulation for cycles of advanced development



to this theory, are two groups of factors-money (price changes, fluctuations in interest rates, changes in the money supply, etc.) and real (the appearance of technological innovation, changing consumer preferences because of innovation in the consumer sphere, etc.). In addition, in the base of the selection system and validation of the factors we used the Pigou's approach, releasing, as previously was noted, three groups of factors that influence the expectations by the economic agents (Barr, 1997):

1. Money
2. Real ones that are synchronized with Lucas's theory
3. Psychological factors, reflecting institutionally formalized reality, constructing representations and cognitive models for the business entities, which have a decisive impact on the direction in the dynamics of national management models. In this connection, instead of the term "psychological" factors we suggest to use the term "cultural and institutional factors" (Babetska-Kukharchuk and Morel, 2004).

According to the results of the carried out evaluations, based on economic-mathematical modeling, seven major subgroups of factors have been identified that affected in advanced manner on the expectations and appropriate behavior models of the business entities. Each of these subgroups refers to one or another enlarged group that have been discussed above (Glazyev and Kharitonov, 2009).

The first subgroup included the factors that characterize the changes in the area of demographic frame and shaped urban development index (I_1).

The second subgroup factors formed the so-called human assets index (I_2).

The production and the resource index included factors that reflect the quantitative and qualitative characteristics of the emerging resource and production base of the national economy, such as inventory, turnover of motor vehicles, mining, etc. (I_3)

The fourth subgroup of factors is focused on the determination of the composite index of the quality for the institutional and cultural system development and includes a set of indicators, including the indicators that evaluate the level of development in the social infrastructure, the quality of forming mental models of society (I_4).

The fifth subgroup of factors formed the so-called index of economic activity of business entities (I_5). It included such indicators as cash incomes, investments in fixed assets, the consumer price index and others.

The sixth subgroup factors formed the so-called index of scientific research capacity. It characterizes an internal reserve of innovation development in the economy (I_6).

The search of the solutions aimed at the identification of a system of indicators by the subject and the degree of their advanced development with respect to the overall economic trend system (gross domestic product) has been carried out with econometric tools.

The calculation of the algorithm had the following order:

1. On the basis of the linear coefficients of correlation there were built the cross-correlation functions for the resultant factor (the reference number) and predetermined factors (advanced component). In accordance with the methodology of the statistical analysis, cross-correlation function expresses the closeness of connection between the levels of the time series y_t measured at the moment t, and the levels of the different time series $x_{t-\tau}$, spaced from each other at T time units:

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

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}.

$$r_{crit} = \frac{t_{cr}}{\sqrt{t_{cr} + n - 2 - \tau}} \quad (2)$$

n is the sample size, τ is the lag.
t_{cr} is the Student's distribution (5%; n-2-τ);
n is the sample size, τ is the lag.

If $r_{(y_t,x_{t-\tau})} > r_{crit}$, the presence of significant coefficients for correlation indicates the dynamics connection of the corresponding index with the index of the reference range and determines its inclusion into the system of indicators for the calculation of advanced development indices.

3. RESULTS AND DISCUSSION

The results of the cross-correlation analysis of the considered data series by way of a productive factor (reference number) performs on the one hand, on the other one-the studied time series for analyzed factors that are presented in Table 1.

As a result of the cross-correlation analysis in the final composition of factors, from the originally defined list in the amount of 34 units there were included 19 units (Figure 2).

Upon receiving the generalized statistical indicators, there is always a need to choose the appropriate determination method for the values of the weighting coefficients (Kij). The calculation basis of the weighted sub-indices of the coefficients that determine the value of the composite index for advanced development, presents a taxonomic method (Kovaleva, 1991). It is based on determining the distance between the points of the multidimensional space whose dimension is calculated by the number of factors involved in the model. Distances between the factors are calculated by the formula:

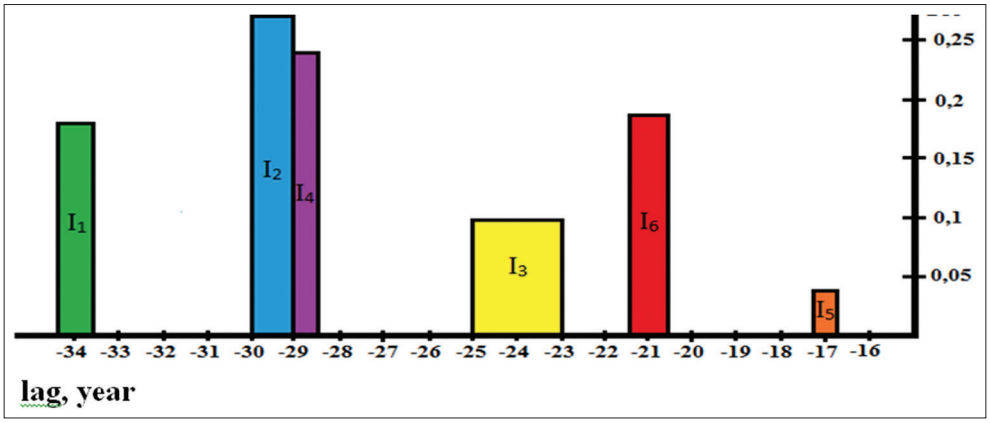
$$a_{rs} = \frac{1}{m}\sum_{i=1}^{m}|b_{ir} - b_{is}|, \quad r,s = \overline{1,n} \quad (3)$$

Where a_{rs} is the distance between factors r and s.

Table 1: Results of the cross-correlation analysis

No	Factors	Lag, year		
		Short-term cyclical	Medium-term cyclical	Long-term cyclical
I. Index of urban development (I1)				
1.	Number of a rural population	1, 2	3, 4	
Index of human capital (I2)				
2.	Issued from average institutions		3	12
3.	Issued from the highest institutions	2		
III. Index of production and resource development				
4.	Stocks commodity	1		
5.	Cargo turnover	1		
6.	Mining	1, 2	3	
7.	Goods carried by rail	1,2		
IV. Index of institutional and cultural development				
8.	Number of medical institutions			11
9.	Number of theaters	2		
10.	Number of organizations of cultural and leisure type	1, 2	3, 4	
V. Index of economic activity of business entities				
11.	Consumer price index			8, 9
12.	Cash incomes of the population	1, 2	3	
13.	Consumer price index	2		
VI. Index of scientific research capacity				
14.	Number of scientists	1, 2	4	
15.	Number of research institutions	1, 2		
16.	The number of the arrived offers in the field of research and development			9
17.	Internal costs on researches and developments	3		12
VII. Index of shift in capital				
18.	Oil price			9
19.	Level of an interest rate of refinancing	1	3	

Figure 2: Effect of consolidated advanced development indicators (sub-indices) on the nature and dynamics of long-term cyclical development in the economy of the USSR during the period from 1940 to 1990



The final form of the matrix for distances between the factors will be the following:

$$\begin{bmatrix} 0 & a_{12} & \dots & a_{1n} \\ a_{21} & 0 & & a_{2n} \\ \dots & & 0 & \dots \\ a_{n1} & \dots & & 0 \end{bmatrix} \quad (4)$$

After determining the distance matrix there is calculated the so-called critical distance that characterizes the maximum distance between the two factors (Center for Economic and Social Studies of the Republic of Tatarstan at the Cabinet of Ministers in the Republic of Tatarstan, 2009):

$$a_{crit} = \max_{r} \min_{s} a_{rs} \quad (5)$$

Next to each feature there is found the sum of all the distances that do not exceed the critical distance:

$$p_j = \sum_{s=1}^{m} a_{js}, \quad для\ a_{js} \le a_{crit} \tag{6}$$

Then the weight coefficients are calculated according to the formula:

$$w_j = \frac{p_j}{\sum_j p_j} \tag{7}$$

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

The formula for the calculation of the composite index for the advanced development is as follows:

$$I_i = W_1 * I_1 + W_2 * I_2 + W_3 * I_3 + W_4 * I_4 + W_5 * I_5 + W_6 * I_6 + W_7 * I_7 \tag{8}$$

Where I_i is the value of the composite index for the advanced development;
i is the periodic value (year in this case);
I_1 (i) the index of urban development in the i^{th} year;
I_2 (i) the index of human capital in the i^{th} year;
I_3 (i) the index of production and resource development in the i^{th} year;
I_4 (i) the index of institutional and cultural development in the i^{th} year;
I_5 (i) the index of economic activity development in the i^{th} year;
I_6 (i) the index of scientific research capacity in the i^{th} year;
I_7 (i) the index of shift in capital in the i^{th} year.
W_1, W_2, W_3, W_4, W_5, W_6, W_7 are the weighting coefficients for the corresponding sub-indices.

Thus, the results of the carried assessments and experimental calculations based on simulation of the advanced development cycles, revealed the contribution of each of the six considered indicators in the nature and dynamics of the composite index for the advanced development (Figures 2 and 3).

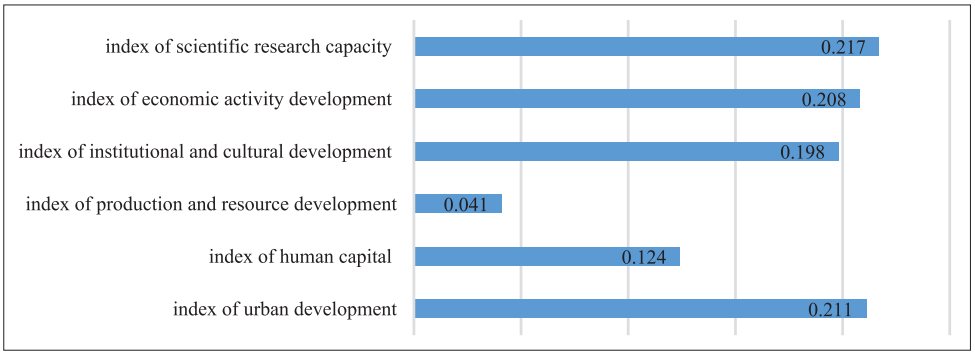
An important part of the modeling for the advanced development index is to determine the weight coefficients for the considered sub-indices. At the same time in the given stage of the simulation there were methods for taxonomic analysis (Yakovets, 1999).

In terms of assessing the significance of each of the six sub-indices used in the model based on indicators characterizing the values of weighting coefficients, the greatest contribution to the long-wave fluctuations makes the sub-index, which forms the scientific research capacity of the system (I_6 = 0.217). The second by significance indicator, which measures the impact of factors on the phase shift of the long-term cycles, is the index for change of urban development (I_1 = 0.211). It describes the institutional changes in the demographic profile of the national economy, the effectiveness of which cannot be based on the understanding of current and forecasted urban trends that largely determine the potential of the institutional changes. By solving the organizational and economic problems of diagnosing and predicting for cyclical fluctuations, we should take into account a whole range of characteristics of the demographic trends. These must be regarded, primarily, in the context of the studied research subject, formed and forming type and structure of urban and rural settlements, as well as its inherent positive or negative trends.

Notable participation to the long-wave macroeconomic generations also contribute the indicators characterizing social health system (I_4 = 0.198), as well as the economic activity of business entities (I_5 = 0,208).

Assessment of the significance of the studied factors for the long-term cycles in the economy from the perspective of the speed for occurring changes because of their exposure generates a slightly different view on the strength of influence by the considered indicators (Abramov, 1990). The values of integral indices that assess the impact level of the target set of the sub-indices on the dynamics of the composite index advanced development were defined as the product of their weight coefficients and the corresponding parameters characterizing lagged parameters for the given sub-indexes. In such a case as an axiom there is accepted the hypothesis that the smaller the lag value is the higher level of impact on the rate of phase transformations in a cycle has the sub-index. Moreover, therefore, higher level of importance is given to this sub-index. Thus, while determining the integrated indicators by the significance of sub-indexes the values of the

Figure 3: The values of the weighting sub-indexes of the coefficients for composite index advanced development in the USSR economy during the period from 1940 to 1990 (long-term cycles)



lagged variables are attributed to the variables in accordance with the reverse scale regarding the established lagged values (Mkhitaryan et al., 2008).

The greatest level of impact on the transformation of the phase processes for long-term cycle has human assets index (I_2), the lag, the a head value of which is 11 years. The second in the list of important for consideration criteria is the index of social well-being (I_4). The speed of the ongoing inner-cycled transformations because of the impact of a group of factors that determine the value of the index under consideration is 13 years.

According to the presented above methodological approaches the final level of the influence by the group of factors is determined based on evaluation of the integral values (Figure 4).

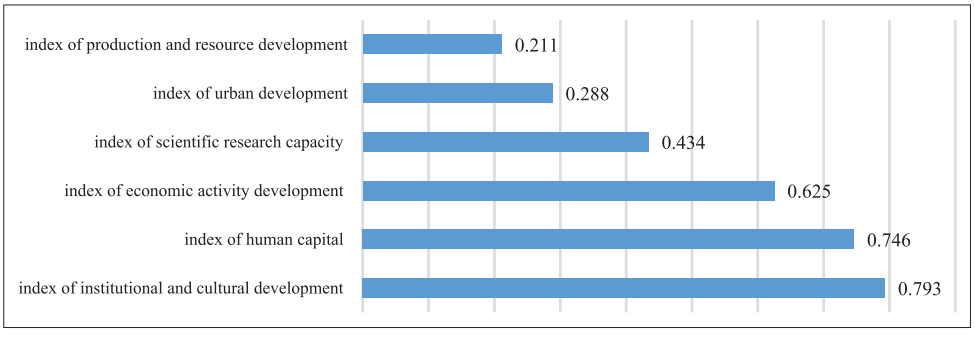
The results of the experimental evaluations show that on the dynamics and speed of phase transformations in the long-term cycles for the advanced development the greatest impact has the index of social well-being, taking into account the qualitative characteristics of the development of the institutional and cultural environment, determining the formation of mental models of society behavior, predisposing to the relevant "matrices of strategic self-development." The second most important index, forming long-term institutional changes in the cyclical development of the economy, has become an index that identifies the quality of human potential (the integral index value is 0.746). This substantially goes with the generally accepted approaches in science, used in the theory of long-waves, and found on the fact that as the basis for generating long-term economic development there is concept about the technological structures. The basic idea of this concept is that technological conjugation creates synchronicity in the evolution of productions formed a reproducing integrity, which creates the material basis for cyclical fluctuations. Development and expansion by each of the process is due to the development of the entire group of conjugate technology systems (Safiullin et al., 2015). Accepting that these shifts are formed largely because of improving the quality of labor resource, the last act as a key element in the evolution process of technological structures and hence long-term cyclical fluctuations.

In keeping with traditional ideas about the impact on the long-wave fluctuations of economic activity, which trends are formed because of adjustments in energy prices and investment activity there is found a similar pattern for the long-term cycles, formed under the conditions within the administrative-command system. For example, in Marcheti's work there is shown an evident relationship for the considered economic phenomena (Dyakonov, 1994). Similar conclusions were also stated by Glazyev ".... sharp spikes in energy prices, taking place in the maturity phase of the dominant technological order, plunge a large part of its component industries in the unprofitable zone, the only way out of which is mediated by the introduction of new technological order.... and, although later energy prices rapidly declining, the price shock will start the mechanism of irreversible structural changes in the economy" (Glazyev, 2011). As a result, we obtained estimates based on the methodological approach of diagnosing advanced development cycles, it was found that the influence level of the factor for economic activity in business entities (formed on the basis of adjustments to price indices, as well as investment activity indices) on the formation of long-waves in the Russian economy is very significant. Thus, it is possible to assert that there is evidence of the convergence effect of this factor for various types of economic systems (administrative-command and market).

Hardly less important, but in the meantime extremely actual and heavy impact on the long-term cycles of the phase shifts in the planned economy has an index that reflects the research capacity of the system. Really, it is so hard to imagine a change of technological structures, generating long-wave oscillations, without the development and implementation in the real sector of new technologies that activate mechanisms for the generation of product, process and technological innovation. Conditions for formation of new technological structures are created in the process of implementing appropriate groundwork for scientific research discoveries and structural developments. As the available technological possibilities of the capital increase are depleted due to the reduce of their impact in the form of marginal performance indicators, the stated conditions have a powerful impetus to the implementation that is expressed in the form of technological shifts in the evolution of economic systems. It is important to note that the stated impact in terms of the planned economy of the research capacity index on the processes of long-macroeconomic generations brings together theoretical approaches to the interpretation of the key factors shaping the cyclic changes in administrative-command and market types of economic systems (Perez, 1987).

The use of the set in the methodological model of advanced development cycles, diagnostics mechanisms of their development let us reveal the contribution of each factor in the path of the composite index advanced development. The results of the held

Figure 4: The values of integral indices of influence sub-indexes onto the path of long-term advanced development cycles (in descending order)



estimates and calculations, as to the outlined methodological approaches (Glazyev, 2011), the obtained results determined the nature and trends of long-term cyclical development in the Russian economy (Figure 5).

These simulation results demonstrate the "butt" of the two long-term cycles of the advanced development in the Russian economy (Petrosyan, 2002). The beginning of the first of them has been presumably formed in the 30-ies of XX century due to the identified trend dynamics. The end of the cycle is marked at the beginning of the 1970s. Taking into account the advanced nature of the considered cycle with the lag for about 10 years the real values and parameters of the cyclical development in the USSR economy are dated at the year 1940 - the beginning of the years 1980 (Figure 6). It is from this time period that the economy plunged into a long phase of depression, thereby forming a path to transition into a new long-term cycle of development, based on the structural transformation and technological shifts.

It is worth noting that according to the findings about the development pathway of the composite index for the advanced growth probable break-point of depressive state in the economy dates in the period 1997-2000 years from the theory of long-waves perspective (and this, despite the default in 1998 that was in the Russian economy). Thus we can assume (by projecting information about advanced development on the real time trend) that the formation phase of a new long-term cycle in the Russian economy, characterized by the revival and development of new technologies, according to the sixth technological order, entered into "possession" at the end of the 2000s - the beginning of the 2010s. Taking into account that this period of change in technological structures (embryonic phase in the terminology by Glazyev) lasts about 10-15 years, the growth phase in the Russian economy will come no earlier than 2020-2025.

An interesting fact is that, in the scientific and cognitive plan there are shifts of the long-term cycles in the Russian economy (including the administrative-command and market) that show arrhythmia relative to the periods of change in technological structures for the developed countries (Matveev and Semenov, 2015). Traditionally, it is believed that in modern economic history there have been five long-waves, which follow each other in quick successions (Figure 7).

4. CONCLUSIONS

Projecting discussed trends of the evolution in technological structures, on the revealed by us nature of the change in the long-term cyclical development in the Russian economy we can clearly observe a noticeable lag in the time shift of the fourth technological order to the fifth. So, if for the developed economies the beginning of the fifth technological structure gained momentum in its development in the early 1970s (digital technology), then for the command economy of the USSR such a transition has occurred within 10-15 years in the period 1980-1985 (Figure 3). However, the trajectory of the composite index of advanced development at the turn of the late 1990s - early 2000s shows a marked recovery that according to the submitted methodological approaches of forecasting (Dubovitsky, 2005) determines the transition from the depression phase into a revival phase of the real cycle in the period 2010-2015. Thus with high chances it could be assumed that in case of the retaining during 1997-2000 years (Figure 2) for the marked

Figure 5: Long-term cycles of advanced economic development in the period from 1951 to 1999

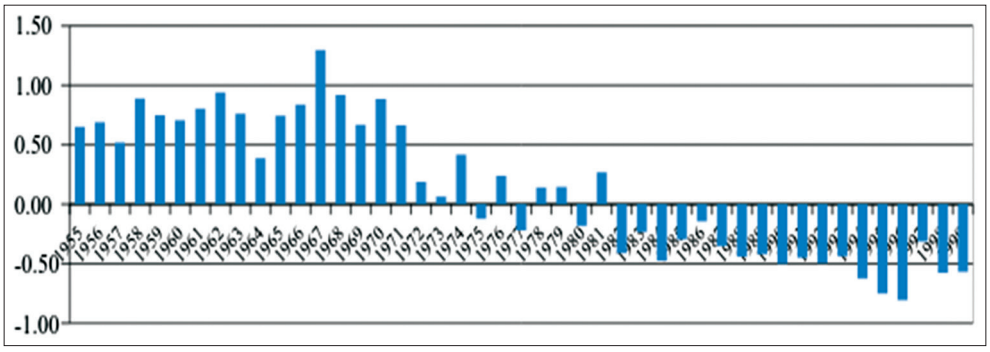


Figure 6: Long-term cycles of the Soviet Union's economy in the period from 1965 to 2009

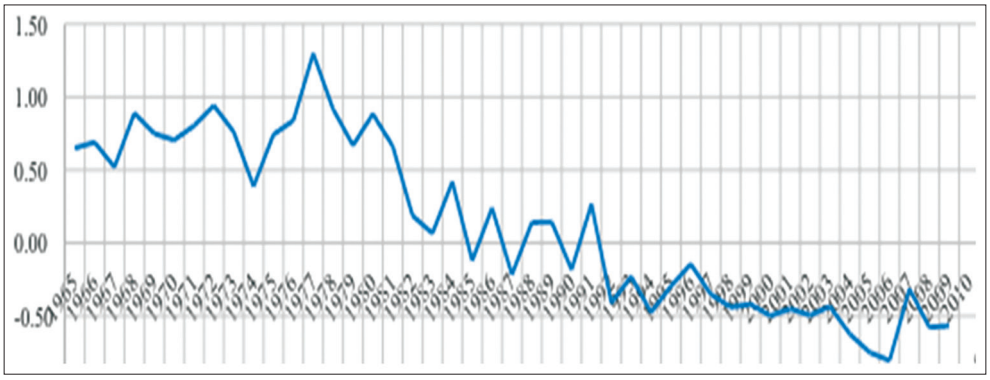
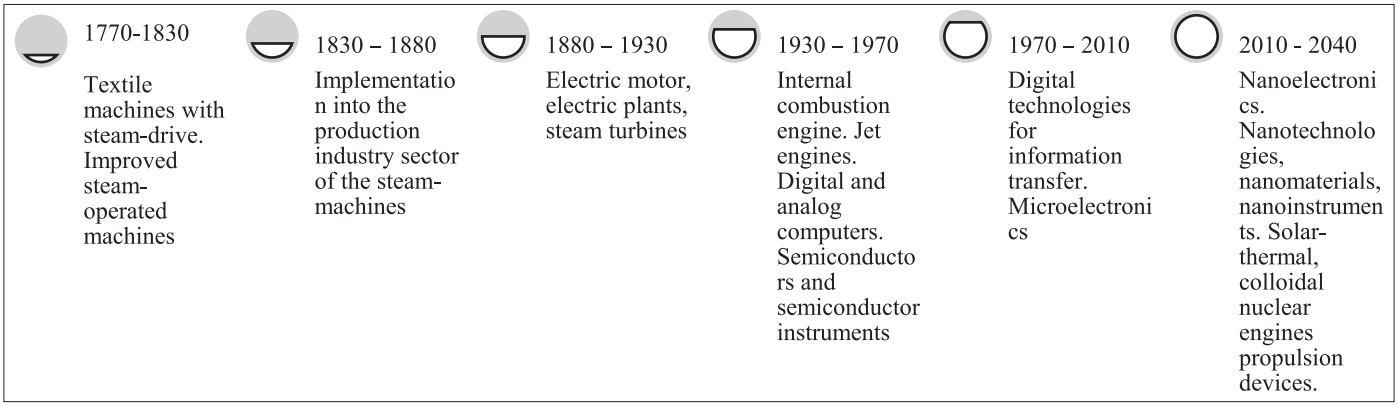


Figure 7: Evolution of the technological structures



advanced trends of the development the move in the Russian economy to the transition stage of the sixth technological order happens rather synchronous with respect to developed countries. This, in turn, means that by the end of the years 2010 energy and raw model for profit drawing was substantially exhausted in the Russian economy and the capital starts to look for new niches for self-realization that are largely launching new mechanisms of profit based on the updated business paradigms providing after all the ultimate technological shift of macroeconomic generations.

The perceived trend of the shift in the Russian Federation at the turn of the years 2010-2015 of the long-term cycles of economic development is also confirmed by the fact that one of the key indicators characterizing the effectiveness of the start of the mechanisms for such transformations, estimating the degree and quality of the advanced development in research capability, clearly demonstrates the signs of break-point in the downward trend of the composite index during the period 1996-2002 years. That, in accordance with the principles of the developed forecasting methodology, means an increase in the demand for R and D products with a lag of 10+ years. That is, the mechanisms of increased demand for innovative products, including technology, product, process innovations, received significant impetus to the development in 2006-2012. Accepting that the transition time of projects from R and D stage to the industrial stage of development is on average 10-15 years, a change in the technological structure of the Russian Federation will come, in accordance with the trend of the considered indicator, in the period from (2016-2021 years) to (2022-2027 years) (Safiullin et al., 2015).

The implemented approach has quite clearly demonstrated that the study of nature and the paradigm of the long-term cyclical fluctuations requires a comprehensive mix of theoretical and empirical methods. This approach is in demand primarily due to the fact that the use of the results of experimental calculations on the basis of multidimensional empirical research requires adequate explanation, interpretation and justification on the basis of selection and periodization of historical and evolutionary data. The carried out analysis of the cyclical development in the economy let us determine the long-wave cycles of the phase shifts based on a combination of methods of economic-mathematical processing of an array of statistics and structural logic of the historical development in the national economy.

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