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ABSTRACT

of the dissertation for the degree of Doctor of Philosophy

ECONOMETRIC METHODS FOR RESEARCHING THE CYCLICAL DEVELOPMENT OF THE AZERBAIJANI ECONOMY

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Applicant: **Esmira Mirmamed gizi Ahmadova**

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The Azerbaijan State University of Economics Department of Mathematics and Statistics is where the dissertation was finished.

Scientific supervisor: Professor, Doctor of Economic Sciences
Rovshan Rasim oghlu Guliyev

Official opponents: Professor, Doctor of Economic Sciences
Namig Faig oghlu Taghiyev

Ass.prof., Doctor of Philosophy in Economics
Shafiga Safar gizi Mammadova

Ass.prof., Doctor of Philosophy in Economics
Aytakin Telman gizi Afandiyeva

Dissertation council FD 1.11 of Supreme Attestation Commission under the President of the Republic of Azerbaijan operating at Azerbaijan State University of Economics.

Chairman of the
Dissertation council: _____ Doctor of economic sciences, Professor
signature **Yadulla Hamdulla oghlu Hasanli**

ÜMUMİ ŞÖBƏ

Scientific secretary of the
Dissertation council: _____ Doctor of philosophy in economics
signature **Rashad Aktiv oghlu Huseynov**

Chairman of the
scientific seminar: _____ Doctor of economic sciences, professor
signature **Murad Ramiz Taghiyev**

GENERAL DESCRIPTION OF THE RESEARCH

Relevance of the topic and degree of elaboration. In the current conditions of transition of developed and developing countries to the sixth technological mode with simultaneous introduction of innovations and scientific technologies of the fourth industrial revolution, new approaches, a new paradigm in determining investment and monetary policy, development of new forms, methods and tools of state regulation both at the macro and micro levels are necessary to ensure sustainable development of the economic system. Econometric research is one of such tools.

The cycle for any economic system is a constant dynamic characteristic. The economic cycl – is a recurring over a certain period fluctuation of various indicators of economic activity:growth rate of GNP,total sales, total price level, unemployment rate, capacity utilization, the amount of investment etc.

The study of cyclical development of a country, the degree and depth of cycles is of fundamental importance. Mathematical methods, economic-mathematical and econometric approaches are an integral part of any section of economic science. It is well known that the use of mathematical description of economic systems opens new opportunities for economic theory and practice.

Today the world has entered the VI technological mode (TM) - a qualitatively new stage of economic development of the world economy. Its contours can be traced in the industries of developed and developing countries. The main branches of the VI TU are biotechnology, nanotechnology, robotics, photoinformatics, new medicine, high humanitarian technologies and others. According to some experts' forecasts, the technological structural shift in the VI TU will take place until 2035. This period is extremely important. After all, it is now that those innovations are being selected and processed, under the flag of which the modern development of the world will take place until 2040-2050. It is in the transitional moments that the country can break out among the advanced developed countries. Determination of such a time is extremely important and gives Azerbaijan an opportunity to become not only a regional but also a world leader.

The relevance of the conducted research is conditioned by the following points:

1. the theory of medium-term and large cycles have a deep prognostic potential;

2. despite the huge number of publications, a general systematic theoretical and practical approach to the concept of economic cyclicality has not yet been formed, as the publications concerning the cycles of conjuncture are mainly of a local, one-sided nature;

3. certain complexity of the economic system itself, as well as its functions and tasks contribute to a more detailed and qualitative study of the practical side of this issue, using for this purpose the results of quantitative and qualitative analyses of the relevant processes;

4. in economic theory and practice, despite the progress in the development of the concept of economic cycles at the present stage, there are still a number of unresolved problems, which include ignoring the fact of existence of large cycles. It should also be noted that none of the available hypotheses can provide an accurate explanation of the mechanism of formation and development of cycles. The question of explaining long waves, as well as the characterisation of the alternation of high and low rates of economic development in the long run also requires attention;

5. existence of gaps in the study of medium- and long-term cyclical development of the economy of Azerbaijan.

In the last 20 years, research on economic dynamics has underpinned all economic processes. Thus, in 2004, the Norwegian economist Finn Erling Kydland and the US economist Edward Prescott were awarded the Nobel Prize for their contribution to the study and development of the influence of the time indicator on economic policy and research into the driving forces and factors of business cycles. This once again proves the relevance of the study of economic cyclicality in the modern world and for the economy of Azerbaijan.

The cyclical development of economy was officially established in 1801, when astronomer William Herschel proved the dependence of crop prices on the appearance of sunspots. At the same time, the

Rothschilds discovered three different cycles in British interest rates and, without disclosing them, used the results of their research to enrich themselves for more than a hundred years, until in 1912 investors in New York began to study this phenomenon, and in 1923 W. Kram and J. Kitchen officially discovered short-term cycles in the economy. Later on, the development of the problems of cyclical fluctuations in the economy and the issues of fluctuations was dealt with by famous scientists-economists and econometricians: C. Veblen, J. M. Keynes, J. M. Clark, N. Kondratiev, K. Marx, W. Mitchell, P. Samuelson, M. Tu. Samuelson, M. Tugan-Baranovsky, J. Hicks, A. Spitgoff, J. Schumpeter, C. Dougherty, F. Kidland, E. Prescott, W. Green, S. Kitchena, T. Anderson, D. Gujarati, K. Douglas, J. Timbergen, V. Valentinov, A. Gladilin, L. Yanovsky, V. Utkin, and many others.

Among the fundamental research works on the study of cyclicality using econometric methods we can highlight the works of the following scientists: S. Jevons, C. Juglar, J. Kitchin, S. Smith, R. Lucas, T. Malthus, R. Mogi, P. Samuelson, J. Sismondi, J. Say, A. Toffler, D. Ricardo, J. Hansen, R. Harrod, R. Khautry, J. Schwager and others.

A significant contribution to the development of econometric methods for modelling economic cycles was made by A. Akaev, T. Anderson, A. Burns, E. Dementieva, A. Granberg, K. Granger, V. Gubanov, S. Kapitsa, M. Kendel, A. Stewart, M. Hanataki, V. Tsvetkov and others.

The works of domestic scientists A.B.Aliyev, Y.Hasanli, articles by Sh.Adygezalov, V.Ahmedov, S.Huseynov, F.Mammadov, N.Ismailov, F.Hasanov and others consider these problems quite extensively.

The studies, the authors of which since the mid-1980s of the last XX century rehabilitated the theoretical heritage of N.D. Kondratiev's long waves, deserve special attention. These are mainly the works of L. Abalkin, I. Abramov, E. Ageyev, V. Bessonov, Y. Davydov, V. Korolkov, L. Klimenko, V. Lapkin, G. Malinetsky, S. Menshikov, V. Pantin, Y. Yakovets, Y. Hasanli and others.

The analysis of the studied scientific economic literature on the causes, peculiarities, influence and identification of economic cycles has shown that despite the presence of a large amount of theoretical literature on this topic, it has shown the existence of gaps, insufficient coverage of this concept, due to differences of interpretation up to denial and lack of a single, generally accepted theory. In the present period of economic development, in the conditions of the 6th technological mode and the 4th industrial revolution, when mankind has actually entered a new digital reality, a new paradigm of development with its own approaches, theories of comprehension and modelling is required, in which the modified cyclical approach is seen as fundamental. In addition, the market economy, which is constantly evolving through the change of phases, creates the need for a constant dynamic study of this problem.

The object and subject of the study. The object of the study is economic cycles in the socio-economic development of Azerbaijan. The subject of the study is the socio-economic development of Azerbaijan, arising as a result of the functioning of economic cycles of different duration.

Aims and objectives of the research. The aim of this dissertation is to systematise and reveal econometric methods and models to identify cyclical dynamics in the socio-economic development of Azerbaijan, to develop a systematic scientific approach to assess the cyclical development of the economy of our country.

The main tasks of this study are:

1) system-complex scientific econometric study of the problem of analysing the cyclical nature of the development of quantitative characteristics of economic cycles in the short, medium and long term;
2) to determine the place and position of Azerbaijan economy in the system of economic cycles;
3) study of trends, dynamics and depth of development and main characteristics of different types and kinds of economic cycles;
4) comparative analysis of leading indicators of economic cycles of Azerbaijan and other countries. Determination of “indicators

inherent directly to the economy of Azerbaijan, capable of predicting, regulating the phases of the beginning and end of the economic cycle;

5) synchronisation of economic cycles, conducting singular spectral analysis (SSA) and other methods in the study of macroeconomic fluctuations on the example of Azerbaijan
6) development of "Programme - proposal for the development of economic system in terms of cyclical paradigm of socio-economic development of Azerbaijan" and determine its characteristic features;
7) diagnose the sustainability of the country's economy in the conditions of cyclical development and determine the main indicators and inhibitors of sustainability;
8) to develop the possibility of forecasting economic cycles for the economy of Azerbaijan;
9) to determine the specifics of cyclicality of economic development of the Republic of Azerbaijan.

Research methods. The methodological basis of the research includes fundamental research in the field of mathematical and statistical tools and econometric modeling of economic cycles. Basic research methods:

1. The method of smoothing by a moving polynomial (simple and centered moving average);

2. The method of structural analysis with the implementation of the index method;

3. Adaptive methods: Box-Jenkins models - Autoregression and moving average models and the Tail-Wage model;

4. SSA method (Singular spectrum analysis or Singular spectrum analysis)

5. The method of production dependencies;

6. The time series decomposition and the dummy variable method.

The main provisions of the defense. The research work puts forward the following as the main points for defence:

1. The main statistical and econometric approaches of complex assessment of the onset of short-term, medium-term and long-term

economic cycles have been systematised and the chronology of short-term, medium-term and long-term economic cycles of the economy of Azerbaijan has been revealed.

2.A block diagram of the methodology for analysing structural shifts (SS) on the basis of empirical data of socio-economic development of the economic system, reflecting fluctuations in the GDP structure of Azerbaijan has been developed.

3.The methodology of step-by-step construction of the production function (PF) of the Azerbaijan economy (MPPPF) is given, which in its turn is reduced to the successive complication of the used PFs with subsequent identification of cyclicity based on production dependencies.

4.Application of adaptive econometric methods and models in analysing cyclical dynamics of economic development.

5.Development of the foundations (base) of indicator methodology in the study of economic cycles in Azerbaijan.

6.The place of Azerbaijan's economy in the system of long-term technological cycles - N. Kondratiev's patterns was determined.

7.Application of singular spectrum analysis (SSA or SSA) algorithm with implementation of time series decomposition for the economy of Azerbaijan.

The scientific novelty of the research. The scientific novelty of the dissertation research is:

1. The methodology of the structural shift (SS) analysis scheme on the basis of empirical data of socio-economic development of the economic system, reflecting fluctuations in the GDP structure of Azerbaijan has been developed. By the method of experiment the Chain Structural Index of structural shift dating determination was systematised and methodologically refined. The directions of structural shifts allowing to ensure effective economic structure of Azerbaijan's GDP are established. At this stage qualitative indicators of accumulated quantitative changes are analysed.
2. The basics of indicator methodology of cyclical development of the economy based on a group of leading, acyclical, pro-cyclical and counter-cyclical indicators for the economy of Azerbaijan, which are markers of the onset of the next phase of the economic cycle. The

indicator research methodology proposed by the author on the basis of 20 indicators will allow to carry out diagnostics of cyclical development of Azerbaijan's economy as a current observation. The introduction of a new approach based on the developed indicator method can prevent undesirable losses and improve crisis management, which allows assessing the effectiveness of the management process at different levels of socio-economic management.

3. The basic statistical and econometric approaches (conceptual, statistical indicator, adaptive) of complex assessment of the onset of short-term, medium-term and long-term economic cycles have been systematised and investigated and the chronology of short-term and medium-term economic cycles of the economy of Azerbaijan of the corresponding phases of cycles has been revealed, which are based mainly on the use of economic-mathematical and statistical methods, with the subsequent use of modern computer processing technologies e On the basis of the conducted researches the distinctive specific features of cyclic development of the economy of Azerbaijan were revealed, which allows to develop theoretical and practical bases for the construction of the basic system of information support of effective anti-crisis management both at the macro level and at the micro level of the economic system;
4. The econometric model of synchronisation of short- and medium-term economic cycles with a focus on seasonality, with the implementation of singular spectrum analysis (SSA) and other methods in the study of macroeconomic fluctuations in the economy of Azerbaijan has been developed.

Theoretical and practical significance of the research results. Theoretical and methodological basis of the research includes fundamental studies in the field of mathematical and statistical tools and econometric modelling of economic cycles, monographs and articles of Azerbaijani and foreign scientists on methodological, theoretical and applied problems related to cyclical fluctuations in the economy.

The empirical and information base of the study was made up of monthly, quarterly and annual statistical data of the State Committee of the Republic of Azerbaijan from 1997 to 2022, statistical bulletins of the Central Bank of Azerbaijan, data of the Bureau of Economic

Analysis (USA), data of reports of the Global Innovation Index, UN, OECD, UNIDO and the World Bank and others. More than 24 economic indicators and their derivatives were studied. The dialectical method was used as a methodological basis. The implementation of the system approach was carried out in the form of structural-logical and economic-statistical analysis, as well as using graphical methods of information presentation.

The methods of system, economic, statistical and econometric analyses were used to solve the tasks set in the thesis.

For data processing the following applied software packages were used: "Excel", "Statistica", "R", "Gretl".

The practical significance of the dissertation research is determined by the possibility of using the models of short-term, medium-term economic cycle and long-term K-wave in improving the mechanism of state anti-cyclical policy. The proposed developed econometric methods and models can be used to forecast the dynamics of a number of important macroeconomic indicators in the long and short term. The knowledge obtained in the study can also be used to monitor economic dynamics in the short, medium and long term and be taken into account in the investment, budgetary and monetary policy of the country

Approval and application. The main provisions of the dissertation research were presented at international scientific conferences, scientific seminars and published in scientific journals of the Higher Attestation Commission of the Republic of Azerbaijan, Turkey, Germany, Spain, Belarus and the Russian Federation**.**

Name of the organisation in which the dissertation work is carried out. The dissertation work is carried out at the chair of "Mathematics and Statistics" of Azerbaijan State Economic University.

Structure and volume of the dissertation. The dissertation work consists of introduction, three chapters, conclusion, appendices, 19 figures and 22 tables. The work contains 219 pages of typewritten text and the list of used literature from 213 names of literary sources.

CONTENTS

MAIN PROVISIONS OF THE THESIS RESEARCH

The research work puts forward the following as the main points for defence:

1. The main statistical and econometric approaches of complex assessment of the onset of short-term, medium-term and long-term economic cycles have been systematised and the chronology of short-term, medium-term and long-term economic cycles of the economy of Azerbaijan has been revealed.

The economic cycle is the volatility or fluctuations in the level of employment, price levels and output. The price level includes the price level of producers, consumers and the GDP deflator. To identify the cyclical dynamics, the dynamics of the consumer price index, the dynamics of the producer price index of Azerbaijan, the dynamics of the Paasche index (GDP deflator) and the moving average of the actual growth rate of officially registered unemployed in Azerbaijan were initially studied.

By smoothing the macroeconomic time series, using moving average (a=5), the short-term economic cycles in the dynamics of Azerbaijan's GDP were dated.

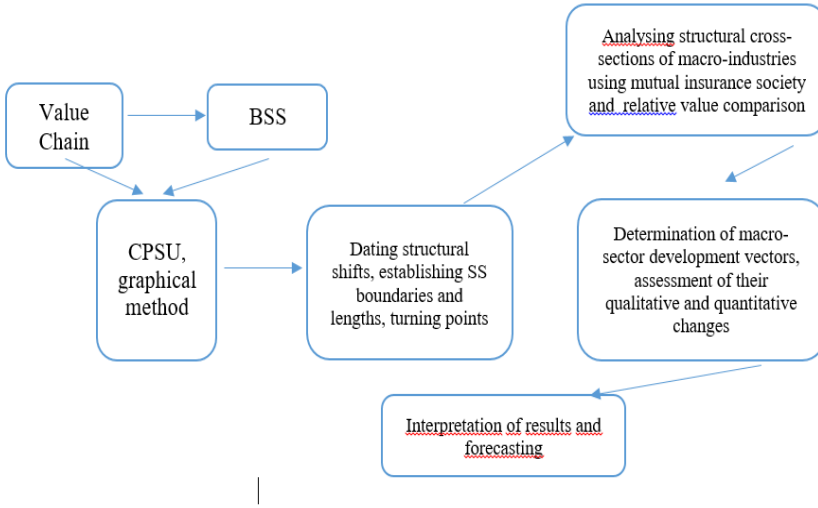
Table 1. Chronology of short-term economic cycles in the economy of Azerbaijan

No. cycle	Business cycle	Deep tough	Cycle duration
1	Up to now	March 1999	Up to now
2	November 2000	March 2002	36 months
3	December 2002	January 2005	34 months
4	April 2006	January 2009	48 months
5	November 2009	January 2012	36 months
6	November 2013	March 2014	26 months
7	July 2015	November 2016	34 months
8	March 2019	November 2020	48 months
9	March 2022	November 2023 *	36 months*
10	March 2024 *	Up to now	Up to now

Up to now – no data, * forecast data

Source: complied by the author

2. **A block diagram of the methodology for analysing structural shifts (SS) on the basis of empirical data of socio-economic development of the economic system, reflecting fluctuations in the GDP structure of Azerbaijan has been developed.** The problem of interindustry structural shifts is most interestingly reflected in the works of Kantorovich V. Kantorovich, Nemchinov V.S., Clark J.B., Marx K., Leontiev V. and others. Using mathematical methods, scientists have been able to construct multi-sectoral models of economic growth and inter-sectoral balance to depict structural shifts in the economy. The problem of the relationship between structural shifts and cyclical development of the economy is presented in the works of Y. Hasanly, S. M. Menshikov, R. Solow, N. D. Kondratiev, G. Mensch, Y. V. Yakovets, J. Schumpeter, A. Carter, and others.



Flowchart 1. Methodology for determining the SS of socio-economic development of Azerbaijan's economy

The developed methodology for determining the SS and its turning points is based on statistical sequential analysis, which is a section of mathematical statistics that studies statistical methods based on a sequential sample formed during a statistical experiment.

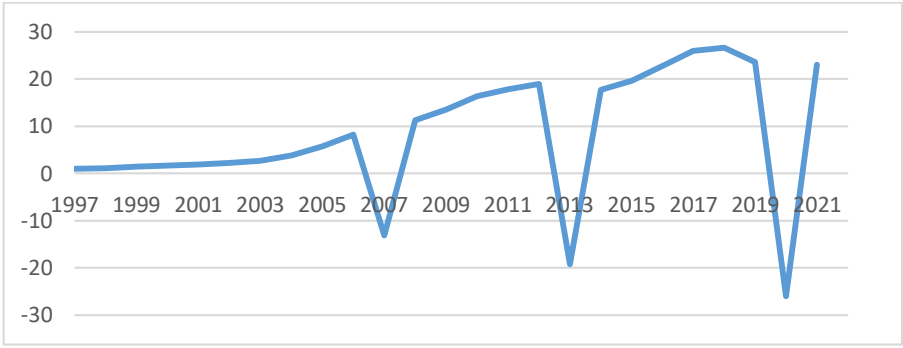


Figure 1. Coefficient of consistency of structural shift (CPSS) of Azerbaijan's GDP from 1997 to 2022.

The studies of economic cycles by V.A. Tsvetkov show three indicators of structural shift of macroindustries, which describe structural cyclical fluctuations of macroeconomic dynamics of the country as a whole quite well. These are:

Structural chain shift

$$S^{\frac{t}{t-1}} = \frac{1}{2} \cdot \sum_{i=1}^{n} \frac{\left|x_i^t - x_i^{t-1}\right|}{x_i^{t-1}}$$

where $S^{\frac{t}{t-1}}$ – an indicator of structural change per year. This indicator shows the intensity or frequency of quantitative structural inversions: when rapid structural transformations or distortions are observed, the value of the indicator increases.

$$S^{\frac{t}{t-1}} = \frac{1}{2^k} \cdot \sum_{i=1}^{n} \frac{\left|x_i^t - x_i^{t-1}\right|}{x_i^{t-1}}$$

The indicator shows the intensity of structural changes visually more accurately: the faster the structural changes occur, the higher the value of the indicator. The >k, the more precise is the transformation point. At k>=3 the changes become constant

K = 1,2,3. The maximum value of the denominator can be 8. In this case, the standard deviation decreases from 8.3 to 2.3, i.e. 3.6 times (Fig.2).

Basic structural shift

$$S^{\frac{t}{t_0}} = \frac{1}{2}\sum_{i=0}^{n} \frac{\left|x_i^t - x_i^{t_0}\right|}{x_i^{t_0}}$$

The baseline structural shift indicator $S^{\frac{t}{t_0}}$ presents an accumulated quantitative frequency measure of the accumulated structural shift over the observed time period (t-t0).

- Structural shift sequence factor

$$Q_t = \frac{S^{\frac{t}{t_0}} - S^{\frac{t-1}{t_0}}}{S^{\frac{t}{t-1}}}$$

Where Q_t – structural shift consistency coefficient, a structural indicator that is used to measure and reveal the nature of the direction of movement of the structure vector.

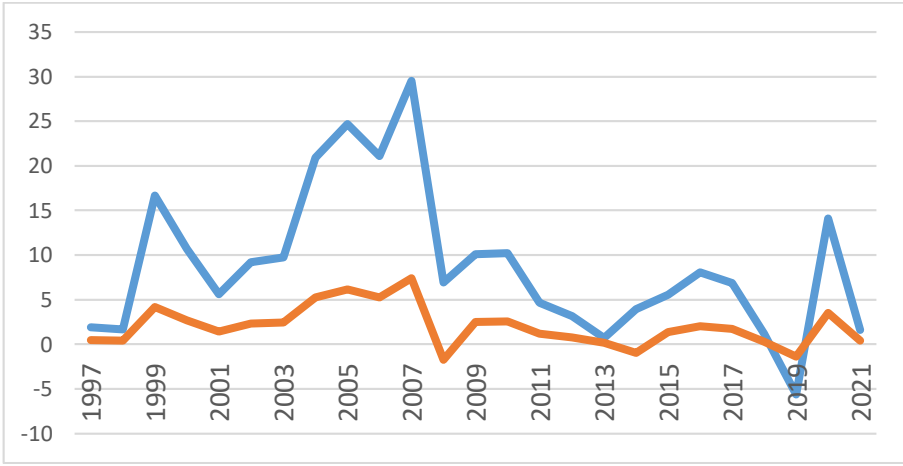


Figure 2. Visualisation of the improvement of the developed Chained Structural Shift of Azerbaijan GDP, 1997-2022.

A key condition for analysing CSS ıin index of structural shifts is the clear identification of time intervals and turning points.

3. The methodology of step-by-step construction of the production function (PF) of the Azerbaijan economy (MPPPF) is given, which in its turn is reduced to the successive complication of the used PFs with subsequent identification of cyclicity based on production

dependencies. The purpose of the methodology is to analyse socio-economic development and dating of medium-term Juglar cycles. Methodology is a set of methods and techniques of research, the order of their application and interpretation of the results obtained with their help. This methodology is capable of solving the problems of estimating the parameters of more complex classes of PFs, which most fully represent complex economic processes. The methods of Cobb and Douglas, Cobb-Douglas-Tinbergen production functions and the following techniques are used as research methods:

- dependance of average labour productivity in Azerbaijan on average capital intensity
- dependance of average labour productivity in Azerbaijan on average labour productivity
- dependance of average labour intensity in Azerbaijan on average stock intensity
- dependance of average labour productivity and average stock return in Azerbaijan

The following results were obtained from the application of the MPPPF of production dependencies.

Table 2. Chronology of turning points of medium-term Juglar cycles of the economy of Azerbaijan based on the results of the analysis of production dependencies

No.	Turning points (year)	Duration (years)
1	2002	6
2	2008	6
3	2014	6
4	2020	6
5	2005	6
6	2009	6
7	2015	6
8	2021	6
9*	2027*	6*

* forecasted values of turning points

source: author's calculations

4. Application of adaptive econometric methods and models in analysing cyclical dynamics of economic development. Among the adaptive methods of statistical and econometric analysis and forecasting of time series are highlighted:

- exponential smoothing, moving average;
- Autoregressive integrated moving average (ARIMA (p,d,q), ARIMA(p,d,q,)(Ps,Ds,Qs),and others, where p – ist the order of autoregression, d – is the order of difference, q – is the order of moving average, Ps – is the order of seasonal difference, Ds – ist he order of seasonal difference, Qs – is the seasonal moving average parameter;;
- The Theil-Wage method and Theil-Wage model decomposition.

Adaptive methods belong to one of the modern directions of statistical analysis and forecasting of time series. The beginning of the development of adaptive forecasting methods was laid by the work of C. Holt. This issue has been studied most fully by R.G. Brown, Y.P. Lukashin, S. Fan, R. Hinden and others, autoregression - moving average models developed by J. Box and G. Jenkins, models of the ARCH, GARCH, ETS, ETS, SARIMA family and others. Among these publications, the most in-depth consideration of this topic is in the works of Enders (2004) and Tsay (2005). The results of Amemiya (1985), Mann (Mann), Wald (1943), Makarov D., Saprykin K. and Anderson (1971) cover most of the known structures of autocorrelation models.

The econometric modelling results in the following adaptive Theil-Wage model:

$$\hat{a}_{1,t} = 0{,}2 \times (x_t - \hat{g}_{t-l}) + 0{,}8 \times (\hat{a}_{1,t-1} + \hat{a}_{2,t-1}),$$
$$\hat{a}_{2,t} = 0{,}01 \times \left(\hat{a}_{1,t} - \hat{a}_{1,t-1}\right) + 0{,}99 \times \hat{a}_{2,t-1},$$
$$\hat{g}_t = 0{,}25 \times \left(x_t - \hat{a}_{1,t}\right) + 0{,}75 \times \hat{g}_{t-l},$$

5. Development of the foundations (base) of indicator methodology in the study of economic cycles in Azerbaijan. The method is based on the development of a system for recognising cyclical signals on the basis of clustering of 22 indicators - precursors of economic cycles: acyclical, counter-cyclical, pro-cyclical and others. By researching the best group of indicators that adequately describe business

Table 3. Results of determining the impact of the indicators on the economy of Azerbaijan

Counter-cyclical	Acyclical	Pro-cyclical
V Oil Crime Unempl Interest rates on loans for legal entities with terms from 1 to 3 months, from 5 to 10 years	CPI PPI Interest rates on loans to legal entities for more than 10 years	GDP P Monetary aggregates C I Interest rates on loans for legal entities with terms from 3 to 5 years
Lags	Leads	Coincident
Tx Ex	CPI PPI M3 Bud M0 Interest rates on loans for legal entities with maturity up to 1 month	-

source: author's calculation

As a result of the study, the indicators under consideration were divided into three categories: 1. Indicators that have an impact on cyclical fluctuations in the economy of Azerbaijan. These include: retail turnover, monetary aggregates M0, M2, M3 and the level of monetization of the economy. 2. Indicators that have an ambiguous effect on cyclical fluctuations in the Azerbaijani economy. These include: the M1 monetary aggregate, taxes, the volume of industrial production, the speed of money circulation in the economy. 3. Indicators that do not affect cyclical fluctuations in the Azerbaijani economy. These are investments, exports, imports, consumer price index, crime rate and deflator.

6. The place of Azerbaijan's economy in the system of long-term technological cycles - N. Kondratiev's patterns was determined. The problem of studying the essence of technological patterns and technological dynamics is the subject of a significant number of works, in which the causes of long waves are highlighted in different ways: Mandel E., Forrester J. U., W. Gleisman H, Walter F, Akaev A.A. and others.

The explanation of long waves linking K - cycles with cycles of technological innovation became popular at the turn of the XX-XXI centuries.

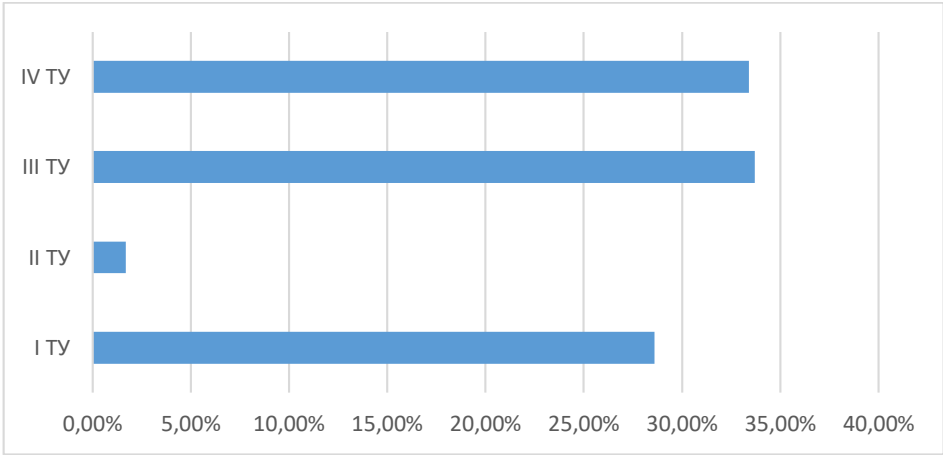


Figure 3. Technological structure of Azerbaijan industry in 1985, in % of industry

source: author's calculation

Technological waves are widely developed in the studies of Schumpeter J.A., Mensch N., Dixon F., Glazyev M., Hiroko and others.

In Azerbaijan, the theoretical development of the theory of long waves received in the studies of Y.H. Hasanli, A. Aliyev, A. Huseynova, E.E. Alekbarov, G.I. Abbasov, A. Aliyev, A. Shekeraliyev and others. At the same time, practical issues related to the study of the development and formation of technological patterns in the economy of Azerbaijan remain insufficiently studied. The insufficient level of development of this problem determined the significance and relevance of the research topic.

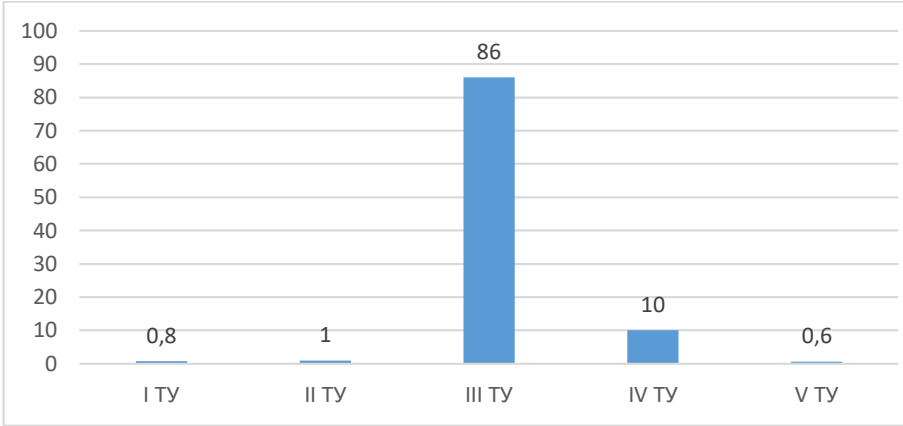


Figure 4. Technological structure of Azerbaijan industry in 1985, in % of industry

source: author's calculation

The results of diagnostics of the innovative development of the Azerbaijani industry. As a result of multi-stage econometric modelling using regression linear analysis, ANC method with robust standard errors and adjustments for heteroscedasticity, the following 3 models were obtained, the econometric characteristics of which are presented in the table:

Model 1

GDP = 4,49e+03 + 0,2597* Develop_4 + 0,1566* Design_4 + 0,0947* Technologies + 0,8551* Software_3

Model 2

Prof = 2,27e+03 + 0,608*Research + 9,05*Software_3 + 0,374*Technologies

Model 3

Total = 2,11e+03 + 0,618*Research + 7,49*Software_3 + 0,378*Technologies

Source: author's calculation

7. Application of singular spectrum analysis (SSA or SSA) algorithm with implementation of time series decomposition for the economy of Azerbaijan.

The purpose of spectral analysis is to recognise seasonal and cyclic components with specific wavelengths, detecting somewhat

repetitive cycles of different lengths in a time series that at first glance may look like random noise. Spectral analysis techniques include periodogram construction, spectral density estimation and are important for detecting hidden periodicities in the data.

Thus, it can be concluded that the above three groups of factors directly affect the levels of time series dynamics, which can be described as the following function:

$$Y(t) = f(T, R, S, E),$$

where Y – dependent variable is GDP of Azerbaijan;
T – independent variable, GDP trend;
R - independent variable, representing cyclicality;
S - independent variable, certain seasonal fluctuations;
E - random fluctuations.

Thus, the model of Azerbaijan's GDP with separation of the cyclical component has the following form:

for 1997-2004:

$$Y1 = 0{,}1846 * \mathrm{t} - 6385{,}1 + \begin{cases} -67{,}3, \text{if } I \text{ quarter} \\ -31{,}7, \text{if } II \text{ quarter} \\ 34{,}6, if\ III \text{ quarter} \\ 64{,}4, \text{if } IV \text{ quarter} \end{cases} + 71{,}7 * (0{,}3693 * L_3 + 0{,}2167 * L_{43-44} + 0{,}0015);$$

for 2005-2014:

$$\mathrm{Y2} = 1{,}2555 * \mathrm{t} - 47150 + \begin{cases} -67{,}3, \text{if } I \text{ quarter} \\ -31{,}7, \text{if } II \text{ quarter} \\ 34{,}6, \text{if } III \text{ quarter} \\ 64{,}4, \text{if } IV \text{ quarter} \end{cases} + 630{,}1 * (0{,}3693 * \mathrm{L}_3 + 0{,}2167 * L_{43-44} + 0{,}0015);$$

for 2014-2022:

$$\mathrm{Y3} = 1{,}5027 * \mathrm{t} - 58856 + \begin{cases} -315{,}99, \text{if } I \text{ quarter} \\ -270{,}45, \text{if } II \text{ quarter} \\ 67{,}93, \text{if } III \text{ quarter} \\ 599{,}77 \text{ if } IV \text{ quarter} \end{cases} + 965{,}8 * (0{,}3693 * \mathrm{L}_3 + 0{,}2167 * L_{43-44} + 0{,}0015);$$

As a result of the study of the application of econometric methods in the study of cyclical development of the economy of the Azerbaijan Republic, the author proposes the following programme of management and forecasting of cyclical development, including the management of crisis phases in the economic system at the present stage.

The program is an application for the development of the economic system from the point of view of the cyclical paradigm of socio-economic development:

1. The implementation of the identified important and relevant cycling algorithms should be carried out at the micro, meso and macro levels;

2. Investment and fiscal policy, as well as projects that need to be analyzed and monitored from the point of view of cyclicity for a period of at least 4 years, with subsequent adjustments if necessary;

3. It is necessary to clearly separate short-term, medium-term and long-term planning and forecasting;

4. Monitoring of indicators of economic stability to ensure the smoothing of volatility and diagnostics of the main indicators of the cyclical development of the economic system;

5. Consideration of seasonal factors with subsequent regulation of the appropriate pricing policy;

6. Increasing the monetization of the economy to the level of developed countries;

7. Assessment of indicators of diversification and import substitution depending on the location of the Azerbaijani economy in the system of cycles;

8. Implementation of the Innovation model – Education and science – Labor market – Investments – The State.

MAIN SCIENTIFIC RESULTS OF THE WORK

The results of the study gave grounds to conclude that it is possible to carry out diagnostics and forecasting of Azerbaijan's GDP in the short, medium and long term with scientifically grounded reliability. All the tasks set for the research gave grounds to come to the following scientifically grounded conclusions:

1. The dissertation study presents theoretical and practical econometric approaches in modelling the cyclical perspective of the development of the economy of Azerbaijan. The identical results obtained by comparative methods confirm the scientific validity and adequacy of the application of scientific approaches in solving this problem.

2. The dissertation developed a scheme of application of econometric models and methods designed to calculate specific turning points of a particular economic cycle, which allows making correct conclusions on the choice of means and directions of monetary, investment, monetary policy both at the macro level and at the micro level of the economy.

3. On the basis of research in the dynamics of GDP fluctuations in Azerbaijan from 1997 to 2022, seven complete short-term economic cycles and two incomplete ones, due to the interruption of the time series, which are defined as Kitchen cycles; three complete and two incomplete medium-term Jouglar cycles; the position of Azerbaijan's economy in the system of long-term K-waves is determined; the dates of the future phases of cycles are predicted and the characteristics of each economic cycle are analysed.

4. The scientific research conducted during the 25 years under consideration has shown that the economy of Azerbaijan has undergone three structural shifts, three structural levels of socio-economic development and is on the fourth. The nature of structural shifts has been revealed, which are both the cause and consequence of cyclical fluctuations. With the help of indicators of improved structural shifts of macroindustries, structural cyclical fluctuations of macroeconomic dynamics of the country as a whole have been described, which gives grounds to assert that shifts in the structure of

Azerbaijan's economy are not only an effective result of economic development, but also a very important factor in the steady development and progress of the economy.

5. In the dissertation study, using econometric methods, a system of macroeconomic indicators was formed, which provide an opportunity to monitor economic fluctuations in the economic sphere of Azerbaijan. According to the results of qualitative analysis, hypotheses were formulated, which were tested in the course of subsequent research using econometric and statistical methods. Within the framework of scientific research, a system of indicators directly affecting economic development was proposed.

6. The link between the signs of economic sustainability and cyclicality is shown and proposed for application. The optimal structure of the Gross Domestic Product (GDP) is the foundation on which the economic sustainability of the country is formed. The introduction and use of a set of econometric methods and approaches is shown as an aid to scientific and technical justification, creation and development of favourable domestic opportunities of the country . Such a scientific approach as knowledge of the place of Azerbaijan's economy in the system of economic cycles will reduce the level of uncertainty and increase the sustainability of the economic system as a whole.

7. The study of production dependencies revealed turning points in the dynamics of economic development of Azerbaijan, medium-term cycles, phases, periods of expansion and contraction of the economy, which alternate with the same time intervals-6 years. The level of influence of production factors on output was determined. Such scientific results provide an information base for forecasting turning points in the economic development of Azerbaijan. The nature of the dynamics of dependencies of such important qualitative indicators - measures of the economy as average labour productivity, average labour intensity, average fund intensity, production efficiency and average fund efficiency of production factors in the economy of Azerbaijan is revealed as cyclical. The new knowledge of economic and technical indicators obtained as a result of the dissertation research allows to determine the time of the onset of contraction and expansion

of the economic system, accounting in fiscal policy, planning, regulation of financial policy of medium and large enterprises.

The results obtained in the dissertation research are relevant and of great importance in scientific and practical application in the economy of the country and can be used both for monitoring the development of the economy of Azerbaijan as a whole and as a tool for forecasting and planning. The obtained results are of particular importance in the application of anti-cyclical regulation, diversification and import substitution policy.

Materials of the dissertation can be applied in educational process at reading of special course on preparation of national personnel on anti-crisis management and management, in statistics, econometrics in higher educational institutions of the country and at working out of the state programmes of social and economic development, investment policy and be taken into account at working out of economic plans of development in the liberated territories of Karabakh.

Main provisions of the thesis are reflected in the following scientific publications:

1. Əhmədova E.M., "Azərbaycan iqtisadiyyatının siklik inkişafında struktur dəyişikliklərinin müəyyən edilməsi", Ümummilli lider Heydər Əliyevin anadan olmasının 95-ci ildönümünə həsr edilmiş "Milli – mənəvi dəyərlər: ənənə və müasirlik" mövzusunda Beynəlxalq Elmi Konfransının materialları, стр. 41-48, 460 стр., 05.2018
2. Əhmədova E.M., "Uzun dalğalar şəraitində Azərbaycan iqtisadiyyatı haqqında" // AMEA İqtisadiyyat İnstitutunun 60 illik yubileyinə həsr olunmuş "İqtisadi artım və ictimai rifah" mövzusunda beynəlxalq elmi konfrans. Bakı, 2018.
3. Ahmadova E.M., Analysis of The Technological Structure of the Azerbaijan`s Economy. International Conference of European Academy of Sciences and Research, Bonn |Germany, 2019.
4. Məmmədov E.Ya., Əhmədova E.M., Bazar iqtisadiyyatının siklik inkişafı şəraitində turizm sahəsində idarəetmənin xüsusiyyətləri // "Turizm sənayesinin idarə edilməsi: metodologiya və VI Beynəlxalq

elmi-praktik internet konfransının tezisləri. təcrübə". Yuri Kondratyuk adına Poltava Milli Texniki Universiteti, - Ukrayna, Poltava: - 2019, - səh.20-22, 129.
5. Əhmədova E.M., Theil-Maaş metodundan istifadə etməklə Azərbaycanın ÜDM-nin və onun dəyişkənliyinin proqnozlaşdırılması // II. İqtisadiyyat və idarəetmə sahəsində magistr və doktorantlarin beynəlxalq elmi konfransi UNEC – 90, Bakı, 2020, Xülasələr kitabı, 465, səh. 94/
6. Ahmadova E. Identification of a cyclical component in the socio-economic development of Azerbaijan // Economic and Social Development: Book of Proceedings; Varazdin, Vol. 4, (Jun 18/Jun 19, 2020). – p.460-468.
7. Mammadov E., Ahmadova E. Impact of innovations on the economic advancement of Azerbaijan // Economic and Social Development: Book of Proceedings; Varazdin, Vol. 4, (Jun 18/Jun 19, 2020) – p.680-687.
8. Ahmadova, E. (2020). Adaptive method of econometric modeling and forecasting of Azerbaijan's GDP // Economic and Social Development: Book of Proceedings; Varazdin, Vol. 3, (Jun 18/Jun 19, 2020), – p.184-193.
9. Məmmədov E.Ya., Əhmədova E.M., COVID-19 dövründə turizm sektorunun inkişafı // VII Beynəlxalq Elmi-Praktik Konfransın tezisləri: "Turizm sənayesinin idarə edilməsi: metodologiya və təcrübə". Yuri Kondratyuk adına Poltava Milli Texniki Universiteti, - Ukrayna, Poltava, 2020, səh.36-38, 149.
10. Ahmadova E. Assessment of the impact of the leading procyclical indicators on the socio–economic development of the country // Economic and Social Development (Book of Proceedings), 70th International Scientific Conference on Economic and Social. – Baku, – 25-26 June, 2021. – p.796-803.
11. Esmira Ahmadova, A. Modeling and analysis of the ecomomic development of Azerbaijan based on the production function. Proceedings of CBU in Economics and Business, 1, 11. INTERNATIONAL CONFERENCE ON INNOVATIONS IN SCIENCE AND EDUCATION (ECONOMICS AND BUSINESS), 2022, PRAGUE, CZECH REPUBLIC Vol. 3 (2022): Proceedings of CBU in Economics and Business, 2022, PRAGUE, CZECH

REPUBLIC, p. 1-5, 80/
12. Esmira Mirmammad qizi Ahmadova. "The Adaptive Method for Econometric Modeling Time Series Forecasting." 20. // ULUSLARARASI EKONOMETRİ, YÖNEYLEM ARAŞTIRMASI VE İSTATİSTİK SEMPOZYUMU TAM METİN KİTAPÇIĞI: 119. 20th International Symposium on Econometrics, Operations Research and Statistics (ISEOS 2020) to be held at Ankara Hacı Bayram Veli University, Ankara, Turkey on 12-14 February 2020
13. Mammadov Elshad, Akhmadova Esmira, INNOVATIVE MECHANISM IN THE SOCIO-ECONOMIC DEVELOPMENT OF AZERBAIJAN, Сучасні інноваційно-інвестиційні механізми розвитку національної економіки в умовах євроінтеграції: матеріали VI Міжнародної науково-практичної конференції, 30-31 жовтня 2019 р. – Полтава: ФОП Пусан А.Ф., 2019. – 194 s.
14. Əhmədova, E.M. "Azərbaycan Respublikasının dinamik inkişafında iqtisadi sikllərin müəyyən edilməsi" // – Bakı: "Statistika xəbərləri" elmi-praktik jurnal, – 2018. №1. – s. 59-67.
15. Əhmədova, E.M. "İstehsaldan asılılıq metodlarından istifadə etməklə Azərbaycanın ÜDM-in dinamikasının modelləşdirilməsi. Faktor analizi" // – Bakı: "Elmi xəbərləri" elmi-praktik jurnalı, – 2018. №08, – s.
16. Əhmədova E.M., "Statistik və ekonometrik metodlardan istifadə etməklə Azərbaycan ÜDM-nin trend komponentinin müəyyən edilməsi"// – Bakı: Azərbaycan Milli Elmlər Akademiyasının Xəbərləri, Humanitar elmlər seriyası, – 2018. №08, – s. 124-131.
17. Ахмедова, Э.М. Оценка устойчивости экономики Азербайджана // Минский Инновационный Университет, научный журнал ВАК-а «Экономика. Управление. Инновации» [Электрон. ресурс]. – 2018. – №2. – Режим доступа:
18. Əhmədova, E.M. (2019). Təhsil sektorunun ölkənin iqtisadi inkişafına təsirinin qiymətləndirilməsi // International Journal of Innovative Technologies in Economy (ISSN 2412-8368), 3(23), April 2019, стр. 41-47. doi: 10.31435/rsglobal_ijite/30042019/6455
19. Əhmədova, E.M. Siklik dinamikanın təhlilinə müasir elmi yanaşmalar prizmasından ekonometrik üsullar // Moskva İqtisadiyyat Jurnalı, – 2020. №4, стр. 232-240. doi:10.24411/2413-046X-2020-10270.
20. Məmmədov, E.Yaqub., Əhmədova, E.M. Milli iqtisadiyyat: idxalın

əvəz olunması // – Bakı: Azərbaycan Milli Elmlər Akademiyasının Xəbərləri, İqtisadiyyat seriyası, – 2020, №3 (may-iyun). – s. 5-9.
21. Mammadov, E.Я., Akhmadova, E.M. The importance of high-tech production in the stability of the economy of AZERBAIJAN // Scientific journal of National University "Yuri Kondratyuk Poltava Polytechnic" Economics and region, – 2020, №2 (77). – p. 6-10.
22. Esmira Ahmadova, ECONOMETRIC ANALYSISOF AZERBAIJAN\'S GDP USING SINGULAR SPECTRAL ANALYSIS (SSA), J. Ponte - Oct 2020 - Volume 76 - Issue 10. doi: 10.21506/j.ponte.2020.10.16
23. Əhmədova E.M. (2021) Azərbaycan iqtisadiyyatının siklik inkişafına təsir edən amillərin və göstəricilərin qiymətləndirilməsi // Qlobal transformasiyaların konturları: siyasət, iqtisadiyyat, hüquq. T. 14. № 2. C. 100–121. DOI: 10.23932/2542-0240-2021-14-2-6.
24. Mammadov, E.Y., & Ahmadova, E.M. (2021). Impact of the digital economy on the economic development of the country // Journal of Management Information and Decision Sciences, 24(S6), 1-8.

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capevi@internet.ru *Tel.: (+99455) 2012809*