Elnure Shafizada,
Ph.D., Associate professor, Azerbaijan State Economic University (ASEU), Azerbaijan
ORCID ID, 0000-0002-6473-0753
email: elnure_sh@unec.edu.az
Nigar Aslanova,
Azerbaijan State Economic University (ASEU), Azerbaijan
ORCID ID, 0000-0003-2356-7088
email: nigar.r.aslanova@unec.edu.az

Correspondence author: elnura.shafizada@gmail.com

INNOVATIVE APPROACHES TO MODEL AND FORECAST OF AZERBAIJAN'S ECONOMIC GROWTH

Abstract. *One of the indicators of the country's economic growth is the gross domestic product, and one of the factors of economic growth is capital. The main criteria and source of economic development is economic growth. Economic growth is a sustainable increasing tendency of the main indicators of national theory production. Furthermore, absolute value and growth per capita are also considered. The objective and subjective aspects and components of the processes of formation and development of economic growth are investigated. The essence and characteristics of objective and subjective factors of the country's economic growth are given. In economics and statistics, various indicators are used to measure the volume of national production. The most important of these is the gross domestic product. Gross domestic product is expressed by the monetary unit of the final products and services produced in the economy. The fact that gross domestic product comprises final products and services produced within a particular country should be considered. Moreover, the most important is the diversification of sources of gross domestic product growth and ensuring the multiplier influence of the interconnected sectors of the country's economy to increase gross domestic product growth. In this work, the dynamic model that demonstrates the dependence of gross domestic product on investments in the case of the Azerbaijan economy is created. Based on this model, it is possible to more optimally plan and predict promising sources and strategic directions for developing the national economy and ensuring its intensive growth. This approach provides an opportunity for the country's strategic planning of the gross domestic product. In this work, to achieve the desired level of gross domestic product, the volume of investment is used as the independent variable in the dynamic model. However, as indicated above, many other factors affect the amount of investment in gross domestic product. Nevertheless, the dynamic model of the optimal gross domestic product trajectory yielded good results. In modern conditions, optimal and effective modelling is essential to ensure the dynamic development of the country's economies and gross domestic product based on global changes and factors. Similar approaches create opportunities to strengthen the immunity of the national economy to counter global impacts and risks. Further research will consider the other most influential factors on gross domestic product. In this case, a dynamic model of the optimal trajectory of the gross domestic product will give even more adequate results.*

Keywords: *Azerbaijan, innovation, gross domestic product, investments, macroeconomics, forecast.*

Introduction. The main criteria and source of economic development is economic growth. Economic growth is a solid stimulant for the growth of the leading indicators of national production (GDP, GNI). Furthermore, Absolute value and growth per capita are also kept in mind. In economic theory and statistics, various indicators are used to measure the volume of national production. The most important of these is gross domestic product (GDP). GDP is an expression in the monetary unit of the final products and services produced in the economy. This refers to the final products and services produced

within the borders of a particular country.

Three main methods are used to calculate GDP: 1) Added value method (production method). With this method, GDP is determined by the sum of added values on the cost, wages and income generated in the production process and characterised by the actual share in the final product in this enterprise for all sectors and types of production; 2) By expenses. Using this method, the GDP is calculated as the sum of all expenses in society (daily expenses of the population, investments of producers, expenses of the government on goods and services), net exports (balance of imports and exports of the country); 3) Calculation of GDP by income - the total amount of all income in the company (excluding the wages of workers being paid from the state budget, as long as their wages are paid from the state budget), property income, income, interest on capital, depreciation, rent payments.

The timeliness of the topic is brought about by the global threats and new challenges in the field of effectiveness, increase of the economic mechanisms taking into account the innovatization of the national economy and the intensification of the use of high technologies, including 'smart technologies'. Under these conditions, it is especially necessary to deepen innovative functions and approaches to the maximum optimisation of the existing mechanisms of the economic development model in the country and forecasting of the economic growth, including expansion of GDP formation sources. Over the last 10-15 years, the economy in Azerbaijan increased almost three times. However, economic contraction is observed due to the negative impact of global problems, especially the covid-19 pandemic, in recent years. Therefore, new and improved mechanisms are required to increase economic growth and GDP intensifying.

There are objective and subjective factors of economic growth. Objective factors are factors that directly and finally affect the rate of economic growth. Subjective factors are indirect factors affecting the scale and pace of economic growth.

The objective factors of economic growth are the following: 1) increase in the volume and quality of fixed capital; 2) changes in production technologies; 3) increase in the volume of economic resources;
- increase in entrepreneurial activity of the population;
- increase in the quantity and quality of labour resources;
- Activation of the population's needs, leading to an increase in production volumes.

Subjective factors of economic growth are the following:
- expansion of the credit system. The activation of this system allows the population to consume as much as possible. This, in turn, stimulates production.
- Reduction of monopoly in the markets for products and services. This, in turn, activates entrepreneurial activity;
- Reducing the cost of production resources. This process increases production and prices. This, in turn, allows for growing demand.
- Tax cuts. Tax cuts lead to an increase in overall economic activity.
- At the present stage of economic development, economic growth affects the following factors:
- natural resources directly affect economic growth. The value of these resources is growing every day since resource resources are limited;
- Population growth, increase in labour resources;
- increase in the capital within the borders of the country. The increase in capital creates opportunities for increasing production and scale, conducting new scientific and technical research and investing in human resources;
- scientific and technological progress, which is the basis of economic growth, as scientific and technological progress, contributes to the transition of the quality of economic development to a new level.

The relationship between economic growth factors within the national economy is becoming more

complicated. In such a situation, the state's primary goal is to effectively use existing economic factors to promote economic growth to benefit the general populace, as said by Zang (1999).

As mentioned above, one of the indicators of a country's economic growth is gross domestic product (GDP), and one of the factors of economic growth is capital. A dynamic model that demonstrates the dependence of GDP on investment in the country's economy is given in the article.

Literature Review. The central hypothesis is optimising the dynamic system of fundamental problems in revealing reserves and turning them into productive sources of GDP growth and the added value to the country's economy. Similar approaches solve the accumulated problems based on optimal and integrated solutions with the development of more effective measures and mechanisms in the economic system. In the works of Barro and Lee (1994), Bryson (1972) and Gurman (1995), attention is paid to the analysis of sources and determinants of growth. Further, the most important aspect is the macroeconomic analysis, which identifies the predominant factors used by the economic - organisational and management mechanisms to ensure GDP growth (Goliuk, 2017).

In their research and approaches, Wang and Li (2021) review several important issues concerning resource potential, the issues of effective use of the human capital and labour force, the use of production forces, and its role in strength improvement of the national economy. In Aslanli (2015) research, the formation of foreign exchange reserves due to the incomes of the oil export and the implementation of more effective mechanisms for insurance of sustainable economic growth are reviewed.

In the work of Hasanov and Huseynov (2013), a special emphasis is placed on the economic and financial aspects of the processes of ensuring the growth of the output in the non-oil sectors in the economy of Azerbaijan, which can help to reduce the dependence of the economy on the oil and gas factor and help to form more productive sources of economic growth. The most critical issues and factors provoking an increase in inflation, which has a negative impact on social and economic, macroeconomic and macro-financial stability, are considered then. The author reviews a number of priorities for the enhancement of the economic activity and improvement of the active economic mechanisms for restraining the inflation rate and insurance the sustainable economic growth in Azerbaijan.

Besides, the works of Ciarreta and Nasirov (2012) consider the most important trends of oil and gas sector development in Azerbaijan, which has a decisive influence on the development of the economy of the country, GDP growth, insurance of competitiveness of Azerbaijan in the international system of differentiation of labour and on the formation of the country as one of the strategic energy partners of the EU.

The scientific work of Sabiroglu and Bashirli (2012) considered the economic policy and sources of economic development in Azerbaijan in the context of oil export and the income of the oil revenues. The main argumentation of the authors lies in the innovatization of the economy in the country and the creation of abundant sources of GDP growth alongside the oil and gas sector (Hassan et al., 2011).

In the approaches of Golichenko (1999), Jurasek and Potocky (2020), and Mikhnevych et al. (2020), bias is made on conditions of imperfect competition. The need to preferentially use a more innovative focus on the development of economic processes and certain sectors of the national economy is justified, thereby accelerating the formation of more reliable sources of economic growth; mainly, the country's GDP is considered. In scientific arguments and assumptions of a group of scientists - Hasanli and Ismayilova (2017), Huseynov (2021), Huseynov et al. (2021) modelling of national economy due to econometric calculations and correlation with identification of interrelation and the primary elements promoting the acceleration of GDP growth is considered. In addition, the emphasis is on innovative development, considering balancing the country's socio-economic development in the context of global shocks and threats. Group of researchers – Hvolkova and Klement (2019), Roubini and Sala-I-Martin

(1992), Levchenko et al. (2018), Zang (1999), and Kasaeva (2019) most all drew attention to the possibilities of expanding the structure of the economy to ensure GDP growth, taking into account the increase in the efficiency of the applied economic mechanisms, natural, financial, labour and, in general, economic resources to increase the growth of the country's economy (Acemoglu et al. 2005).

In the works of a number of Azerbaijani scientists - Ibraghimov (2022), Ibrahimovet al. (2021) focus given to the innovative development of the Azerbaijani economy, increasing the competitiveness of certain sectors of the national economy in the context of sustainable development with the involvement of the required financial and credit resources with the active participation of banking and credit organisations and the use of financial inclusion mechanisms, which could have a positive effect on economic growth.

The main aim of the article is to develop and realise the more effective mechanisms and models considering the active use of innovative approaches and functions for optimisation of the economic calculations and forecasts of the dynamic development of the economy in Azerbaijan, including in particular the sustainable growth of the GDP. It is necessary to form a more optimal and productive environment for the activity and development of the national economy and, thus, ensure the innovativeness of the data in the article of calculations and forecasts on the dynamics of the economy's growth in the country as a whole.

Methodology and research methods. The structure built by the author is taken as methodological approaches and analyses, where the main goal is optimal research and forecasting of GDP in Azerbaijan in the context of global transformation and a period of difficulty in ensuring the dynamic growth of the country's economy. The main factors and problems associated with the slowdown or vice versa, intensification of GDP growth, have been consistently analysed. The main methods and forms of GDP calculation with emphasis on expenses and income, as well as a grouping of objective and subjective factors of economic growth in Azerbaijan, are systematised. Several important approaches are substantiated that could positively affect GDP growth, for example, minimising monopolism in different sectors of the economy and further optimising the stimulating effects of tax mechanisms and instruments. The views and arguments of Zang (1999), who considered the relationship between a number of factors of economic growth in the structure of the country's economy, are used as methodological approaches.

Further, the author considered it advisable to build a model of the optimal trajectory for achieving the desired level of GDP, taking into account the determination of the amount of investment to solve this problem. In this case, the coefficients are determined by authors Shafizade and Hasanova (2018) and Golichenko (1999). Based on analysis and synthesis, as well as carrying out mathematical calculations and solving problems, the effectiveness of factors that allow strategic planning and forecasting of GDP growth is further determined. At the same time, the volume of investments is considered one of the key factors contributing to GDP growth.

The model of the optimal trajectory to achieve the desired level of GDP was developed and estimated. The reliance is placed on attracting the required volume of investment resources and capital to various sectors of the national economy, thereby ensuring the dynamism of GDP growth. Further, the statistical data on the volume of GDP and investments in the industry of Azerbaijan in 2006-2020 and indicators of GDP were used, as well as the results of the calculated model Model Values of GDP in 2006-2020.

The model of the optimal trajectory to achieve the desired level of *GDP.* Consider the following task: how much investment should be allocated in a certain year to achieve the desired level of GDP after a certain time?

To do this, consider the following task:

$$J = \sum_{i=0}^{N}(x_{jel} - x_i)^2 + \sum_{i=0}^{N-1} u_i^2 \rightarrow \tag{1}$$

$$x_{i+1} = Fx_i + Gu_i + v, i = \underline{0, n-1} \tag{2}$$

$$x(0) = x_0 \tag{3}$$

where, u_i is the volume of investment and x_i is the volume of GDP in the i-th year. Since we want to achieve the desired level at the end of the trajectory, we can write (22) as follows:

$$J = (x_{jel} - x_N)^2 + \sum_{i=0}^{N-1}(x_i^2 + u_i^2) \rightarrow \tag{4}$$

or:

$$J = \frac{1}{2}q(x_{jel} - x_N)^2 + \sum_{i=0}^{N-1}(k_1 x_i^2 + k_2 u_i^2) \rightarrow \tag{5}$$

$$x_{i+1} = Fx_i + Gu_i + v, i = \underline{0, n-1} \tag{6}$$

$$x(0) = x_0 \tag{7}$$

where q, k_1, k_2 are coefficients, F, G, v was defined in by the author earlier, x_{jel} is the desired level of GDP, and N is the number of years. For this, we construct an extended criterion of quality $\underline{J}$ by Golichenko (1999). To do this, are added systems of equations with coefficients $\lambda(i)[1, 7]$ to function J:

$$\underline{J} = \frac{1}{2}q(x_{jel} - x_N)^2 + \sum_{i=0}^{N-1}\left[\frac{1}{2}(k_1 x_i^2 + k_2 u_i^2) + \lambda_{i+1}(Fx_i + Gu_i + v - x_{i+1})\right] \tag{8}$$

The following notation:

$$\Phi(x(N)) = \frac{1}{2}q(x_{jel} - x_N)^2$$

$$H^i = \frac{1}{2}(k_1 x_i^2 + k_2 u_i^2) + \lambda_{i+1}(Fx_i + Gu_i + v)$$

The formula (8) can be rewriten:

$$\underline{J} = \frac{1}{2}q(x_{jel} - x_N)^2 - \lambda_N x_N + \sum_{i=1}^{N-1}\left[\frac{1}{2}(k_1 x_i^2 + k_2 u_i^2) + \lambda_{i+1}(Fx_i + Gu_i + v) - \lambda_i x_i\right] + H^0 \tag{9}$$

The following problem:

$$\underline{J} = \frac{1}{2}q(x_{jel} - x_N)^2 - \lambda_N x_N + \sum_{i=1}^{N-1}\left[\frac{1}{2}(k_1 x_i^2 + k_2 u_i^2) + \lambda_{i+1}(Fx_i + Gu_i + v) - \lambda_i x_i\right] + H^0 \tag{10}$$

$$x_{i+1} = Fx_i + Gu_i + v, i = \underline{0, n-1} \tag{11}$$

$$x(0) = x_0 \tag{12}$$

To solve the problems (31)-(33), i.e. to find the values $\lambda_i, (i = \underline{0, n+1})$, $u_i, (i = \underline{0, n-1})$ and $x_i, (i = \underline{0, n})$, the following system of equations need to solved:

$$\frac{\partial H^i}{\partial x_i} = \lambda_i \tag{13}$$

$$\frac{\partial H^i}{\partial u_i} = 0 \tag{14}$$

$$\frac{\partial \Phi}{\partial x_N} = \lambda_N \tag{15}$$

$$\lambda_i = k_1 x_i + \lambda_{i+1} F \tag{16}$$
$$0 = k_2 u_i + \lambda_{i+1} G \tag{17}$$
$$\lambda_N = q(x_N - x_{jel}) \tag{18}$$

And from (17):
$$u_i = -\lambda_{i+1} G k_2^{-1} \tag{19}$$

Using (19) in (11) x_{i+1} was defined us:

$$x_{i+1} = F x_i - G^2 k_2^{-1} \lambda_{i+1} + v, i = \underline{0, n-1}$$

In (16), the following conversion was done:

$$F \lambda_{i+1} = -k_1 x_i + \lambda_i$$

Based on these transformations, the following system of equations were obtained:

$$\{ x_{i+1} = F x_i - G^2 k_2^{-1} \lambda_{i+1} + v, i = \underline{0, n-1} \tag{20}$$

$$F \lambda_{i+1} = -k_1 x_i + \lambda_i \tag{21}$$

$$\{ x_{i+1} + G^2 k_2^{-1} \lambda_{i+1} = F x_i + v, i = \underline{0, n-1} \ F \lambda_{i+1} = -k_1 x_i + \lambda_i$$

The final system in form of matrices was rewriten:
$$[E \ G^2 k_2^{-1} \ 0 \ F \ ][x_{i+1} \ \lambda_{i+1} \ ] = [F \ 0 \ -k_1 \ E \ ][x_i \ \lambda_i \ ] + [v \ 0 \ ].$$
From this: x_{i+1} and λ_{i+1}:

$$[x_{i+1} \ \lambda_{i+1} \ ] = [E \ G^2 k_2^{-1} \ 0 \ F \ ]^{-1}[F \ 0 \ -k_1 \ E \ ][x_i \ \lambda_i \ ] + [E \ G^2 k_2^{-1} \ 0 \ F \ ]^{-1}[v \ 0 \ ] \tag{22}$$

From (22):
$$[x_{i+1} \ \lambda_{i+1} \ ] = [F + G^2 k_1 k_2^{-1} F^{-1} \ -G^2 k_2^{-1} F^{-1} \ -k_1 F^{-1} \ F^{-1} \ ][x_i \ \lambda_i \ ] + [v \ 0 \ ] \tag{23}$$

The following notation:
$$A = [F + G^2 k_1 k_2^{-1} F^{-1} \ -G^2 k_2^{-1} F^{-1} \ -k_1 F^{-1} \ F^{-1} \ ]$$
Then, (23) can be written as such:

$$[x_{i+1} \ \lambda_{i+1} \ ] = A[x_i \ \lambda_i \ ] + [v \ 0 \ ] \tag{24}$$

$$[x_{i+2} \ \lambda_{i+2} \ ] = A[x_{i+1} \ \lambda_{i+1} \ ] + [v \ 0 \ ] = A^2[x_i \ \lambda_i \ ] + A[v \ 0 \ ] + [v \ 0 \ ]$$
$$[x_{i+3} \ \lambda_{i+3} \ ] = A[x_{i+2} \ \lambda_{i+2} \ ] + [v \ 0 \ ] = A^3[x_i \ \lambda_i \ ] + (A^2 + A + A^0)[v \ 0 \ ]$$
$$[x_{i+k} \ \lambda_{i+k} \ ] = A^k[x_i \ \lambda_i \ ] + (A^{k-1} + A^{k-2} + \cdots + A + A^0)[v \ 0 \ ] \tag{25}$$

And so, (25) can be written in the following form:

$$[x_N \; \lambda_N \,] = A^N [x_0 \; \lambda_0 \,] + (A^{N-1} + A^{N-2} + \cdots + A + A^0)[v \; 0 \,] \tag{26}$$

The next notation:
$$A^N = [a_{11} \; a_{12} \; a_{21} \; a_{22} \,],$$

$$[f_1 \; f_2 \,] = (A^{N-1} + A^{N-2} + \cdots + A + A^0)[v \; 0 \,] \tag{27}$$

So, (26) can be written as:

$$[x_N \; \lambda_N \,] = [a_{11} \; a_{12} \; a_{21} \; a_{22} \,][x_0 \; \lambda_0 \,] + [f_1 \; f_2 \,] \tag{28}$$

From this:
$$\{x_N = a_{11}x_0 + a_{12}\lambda_0 + f_1 \quad \lambda_N = a_{21}x_0 + a_{22}\lambda_0 + f_2$$

If add condition (18) here, the following system of equations were obtained:

$$\{x_N = a_{11}x_0 + a_{12}\lambda_0 + f_1 \tag{29}$$
$$\lambda_N = a_{21}x_0 + a_{22}\lambda_0 + f_2 \tag{30}$$
$$\lambda_N = q(x_N - x_{jel}) \tag{31}$$

The values of f_1 and f_2 are obtained from (27). Considering (29) and (30) in (31):

$$\lambda_0 = (qa_{12} - a_{22})^{-1} \left(x_{jel}q - (qa_{11} - a_{21})x_0 - (qf_1 - f_2) \right) \tag{32}$$

From this x_0 is given to us as an initial condition, and λ_0 can be calculated from (53). Using this: $\lambda_i, (\, i = \underline{0, n+1}\,)$, $u_i, (\, i = \underline{0, n-1}\,)$ and $x_i, (\, i = \underline{0, n}\,)$. Values of $\lambda_i, (\, i = \underline{0, n+1}\,)$ and $x_i, (\, i = \underline{0, n}\,)$ can be calculated from expression (23), and $u_i, (\, i = \underline{0, n-1}\,)$ from expression (19).

Results. The Model Of The Optimal Trajectory To Achieve The Desired Level Of GDP was applied to Azerbaijan based on statistical data (Table 1).

Table 1. The volume of GDP and investments in the industry of Azerbaijan in 2006-2020

Year	GDP (in million manats)	Industry Investment (in million manats)
2006	18746.2	4297.0
2007	28360.5	4591.0
2008	40137.2	4249.0
2009	35601.5	3225.0
2010	42465.0	4 276
2011	52082.0	5370.0
2012	54743.7	6040.0
2013	58182.0	7499.6
2014	59014.1	7639.5
2015	54380.0	8499.9

Continued Table1

Year	GDP (in million manats)	Industry Investment (in million manats)
2016	60425.2	9949.8
2017	70337.8	10610.1
2018	80092.0	8497.2
2019	81896.2	9258.0
2020	72432.2	9065.3

Sources: developed by the authors based on (The State Statistical Committee of the Republic of Azerbaijan).

From 2006-2020 the GDP in Azerbaijan had dynamic growth. However, unstable growth has been observed over the past seven years: for example, in 2015, the GDP growth in Azerbaijan decreased by % 8,46 in comparison with 2014. In 2019 the economic development slowed down, and in 2020 the national economy decreased its development rates by %13.12 because of covid-19. From this data, x_0 was found to be 18746.2. Problems (26)-(28) were reworked in MATLAB with coefficients k1=-5, k2=0.6, q=100000. The following results were found (Table 2):

Table 2. Indicators of GDP and Model Values of GDP in 2006-2020

Year	GDP, statistic values (in million manats)	Model Values of GDP (in million manats)	λ_i
2006	18746.2	18746.2	-2046851
2007	28360.5	38722.71	-2427964
2008	40137.2	58196.69	-2777568
2009	35601.5	76915.41	-3091125
2010	42465.0	94635.93	-3364566
2011	52082.0	111128.3	-3594342
2012	54743.7	126178.5	-3777473
2013	58182.0	139591.1	-3911580
2014	59014.1	151192.2	-3994923
2015	54380.0	160831.1	-4026421
2016	60425.2	168382.8	-4005666
2017	70337.8	173749.3	-3932926
2018	80092.0	176860.9	-3809145
2019	81896.2	177677.3	-3635930
2020	72432.2	176187.8	-3415529

Sources: developed by the authors based on (The State Statistical Committee of the Republic of Azerbaijan).

Table 2 shows the dynamics of GDP, considering the expected effect from the invested investment resources according to the Model Values of GDP. A visual comparison of the statistic GDP values and GDP values to achieve the desired level is given in Figure 1, from which we can see that the actual results are not adequate to the calculations obtained due to the development and calculation of models. Therefore, maximum optimisation and deepening of the innovativeness of the existing mechanisms for forecasting and organising the activities of various sectors of the national economy are required following new challenges and requirements.
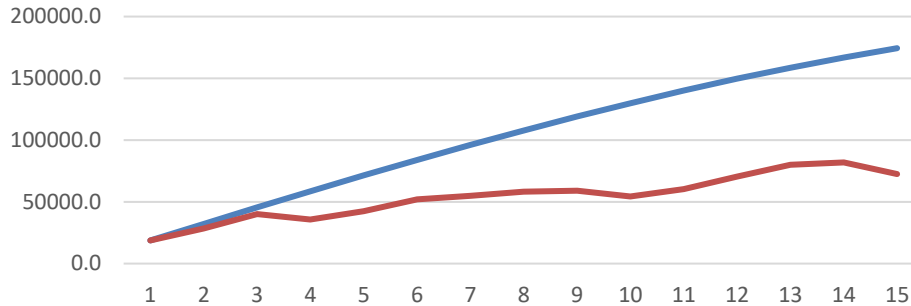
Figure 1. Comparison of statistical GDP values (red line) and GDP values to achieve the desired level (blue line)

Sources: developed by the authors based on (The State Statistical Committee of the Republic of Azerbaijan).

So, suppose we summarise the research materials on the most critical factors of the modelling process in the context of forecasting GDP in Azerbaijan. In that case, they can be grouped in the following blocks (Table 3).

Table 3. Rational scheme of GDP forecasting in Azerbaijan

Components of GDP forecasting model construction	Questions to be answered
Theoretical approaches	It is necessary to analyse theoretical approaches and foundations, problems of ensuring GDP growth, and it is necessary to answer the question: how do we more effectively build a model for predicting GDP in Azerbaijan?
Methodological features	The methods and approaches of various authors and scientists are used, who studied the essence of the problem of ensuring economic growth and the development of methods of accelerating GDP growth with the solution of the problem: how better use objective and subjective factors for economic growth in the context of global transformations?
Formation of the prediction model	Based on the task and perspectives of the development of the country's economy, determining the sources of economic growth required answering the following questions: how to construct an optimal model for ensuring the projected level of the country's GDP?
Objectives and conclusions	Research, analysis, synthesis and generalisation are needed to answer the following questions: what factor most affects the country's adequate GDP growth in the current global transformations?

Sources: developed by the authors.

As a result of research, based on calculations and estimates, it is concluded that among the factors affecting GDP growth and the success of the country's GDP forecasting model, the key factors are adequate definitions of the volume of investments and the effective use of available resources in the processes of forming the main sources of growth of the country's economy in current conditions.

Conclusions. This approach provides an opportunity for strategic planning of GDP for the country. In this work, to achieve the desired level of GDP, the volume of investment is used as the independent variable in the dynamic model. Nevertheless, as indicated above, many other factors affect GDP,

including investment. However, even so, the dynamic model of the optimal GDP trajectory yielded promising results (see Table 2 and Figure 1).

Further research will take into account the other most influential factors on GDP. In this case, a dynamic model of the optimal trajectory of GDP will give even more adequate results. Many parameters of the incoming model are approximate. Therefore, future work can be developed with fluctuations in parameters - in other words, the study of stability concerning the change in error. Another research direction is applying pattern recognition methods with predetermined threshold numbers. In this case, the classification problem is obtained.

The article researches the more optimal mechanisms and effective model constructions of the innovation of economy in connection with the forecasting of the economic growth, taking into account the negative impact of the global transformations and covid-19, unstable price environment in the global energy market, as well as the weakness of innovation infrastructure in Azerbaijan, technological equipment, finding a technological and innovative market at an early stage and new realities in the region, in general, in the world, which requires huge investment resources and capital investments to restore the liberated lands.

In the nearest future, it is necessary to ensure the intensification of innovation processes development in Azerbaijan and to accelerate the formation of the innovative national system, to create more favourable conditions and innovative infrastructure for activation of the transfer of advanced technologies from abroad in order to master the essential elements of 4.0. the industrial revolution, to accelerate the modernisation of the non-oil sectors of the economy in the country, which will be able to form more productive sources of GDP growth and economy of the country as a whole.

References

Acemoglu, D., Johnson, S., & Robinson, J. A. (2005). Institutions as a fundamental cause of long-run growth. *Handbook of economic growth*, *1*, 385-472. [Google Scholar] [CrossRef]

Aslanli, K. (2015). Fiscal sustainability and the state oil fund in Azerbaijan. *Journal of Eurasian Studies*, *6*(2), 114-121. [Google Scholar] [CrossRef]

Barro, R. J., & Lee, J. W. (1994). Sources of economic growth. In *Carnegie-Rochester Conference Series on Public Policy* (Vol. 40, No. 1, pp. 1-46). Elsevier. [Google Scholar] [CrossRef]

Bryson, A.. (1872). Applied Optimal Control, Moscow.

Ciarreta, A., & Nasirov, S. (2012). Development trends in the Azerbaijan oil and gas sector: Achievements and challenges. *Energy Policy*, *40*, 282-292. [Google Scholar] [CrossRef]

Golichenko, O. G. (1999). Economic development under imperfect competition. Approximation to multilevel modeling, M:Nauka. [Google Scholar]

Goliuk, V. (2017). Impact Of Innovations On GDP Dynamics. Marketing and Management of Innovations, 2, 151 – 159. [Google Scholar] [CrossRef]

Gurman, V. I. (1995). Basics of macroeconomic analyse, Tver, 1995. [Google Scholar]

Hasanli, Y., & Ismayilova, S. (2017). Econometric model of dependence between the oil prices, and the global external debt level and oil production. *Economic annals-XXI*, (166), 11-16. [Google Scholar]

Hasanov, F., & Huseynov, F. (2013). Bank credits and non-oil economic growth: Evidence from Azerbaijan. *International Review of Economics & Finance*, *27*, 597-610. [Google Scholar] [CrossRef]

Hassan, M. K., Sanchez, B., Yu, J. S. (2011). Financial development and economic growth: New evidence from panel data. *The Quarterly Review of economics and finance*, *51*(1), 88-104. [Google Scholar] [CrossRef]

Huseynov, A. G. (2021). Impact of Environmental Innovation on Country Socio-Economic Development. *Marketing and*

Management of Innovations, 2, 293-302. [Google Scholar] [CrossRef]

Huseynov, A., Huseynov, E., & Samusevych, Y. V. (2021). Innovative Development of Oil & Gas Industry: Role of Environmental Taxation. *Marketing and Management of Innovations*, 4, 79-91. [Google Scholar] [CrossRef]

Hvolkova, L., & Klement, L. (2019). Management of Innovation Development in the Slovak Republic: Critical Evaluation of the Investment Aid System. *Marketing and Management of Innovations*, 1, 26-39. [Google Scholar] [CrossRef]

Ibraghimov, E. A. (2022). Management of Innovation in Azerbaijan: Relationships with Competitiveness and Sustainable Development. *Marketing and Management of Innovations*, 1, 247-256. [Google Scholar] [CrossRef]

Ibrahimov, Z., Hajiyeva, S., Nazarov, V., Qasimova, L., & Ahadov, V. (2021). Bank Efficiency Analysis of Financial Innovations: DEA Model Application for the Institutional Concept. *Marketing and Management of Innovations*, 1, 290-303. [Google Scholar] [CrossRef]

Jurasek, M., & Potocky, T. (2020). Management of innovations in cross-cultural communication within an organisation. *Marketing and Management of Innovations*, 2, 108-121. [Google Scholar] [CrossRef]

Kasaeva, J. (2019). Developing the methodology of assessing the potential of countries to attract foreign direct investment. *Marketing and Management of Innovations*, 4, 292-307. [Google Scholar] [CrossRef]

Levchenko, V., Kobzieva, T., Boiko, A., & Shlapko, T. (2018). Innovations in Assessing the Efficiency of the Instruments for the National Economy De-Shadowing: the State Management Aspect. *Marketing and Management of Innovations*, 4, 361-371. [Google Scholar] [CrossRef]

Mikhnevych, L., Marchenko, V., Hristov, P., & Kuzior, A. (2020). Conceptual relationships between country image and economic security. *Marketing and Management of Innovations*, 1, 285-293. [Google Scholar] [CrossRef]

Roubini, N., & Sala-i-Martin, X. (1992). Financial repression and economic growth. *Journal of development economics*, *39*(1), 5-30. [Google Scholar] [CrossRef]

Sabiroglu, I. M., & Bashirli, S. (2012). Input–output analysis in an oil-rich economy: The case of Azerbaijan. *Resources Policy*, *37*(1), 73-80. [Google Scholar] [CrossRef]

Shafizade, E.R., Hasanova, G. (2018). Dynamic model for Gross Domestic Product in Azerbaijan. In *6th International Conference on Control and Optimisation with Industrial Applications, COIA-2018* (pp. 11-13). [Google Scholar]

The State Statistical Committee of the Republic of Azerbaijan. [Link]

Wang, Q., & Li, L. (2021). The effects of population aging, life expectancy, unemployment rate, population density, per capita GDP, urbanisation on per capita carbon emissions. *Sustainable Production and Consumption*, *28*, 760-774. [Google Scholar] [CrossRef]

Zang, V. B. (1999). Synergetic economics. Time and changes in nonlinear economical theory. [CrossRef]

Ельнуре Шафізада, Ph.D., Азербайджанський державний економічний університет, Азербайджан
Нігяр Асланова, Азербайджанський державний економічний університет, Азербайджан

Інноваційні підходи до моделювання та прогнозування економічного розвитку Азербайджану

Одним із показників економічного зростання країни є валовий внутрішній продукт, а одним із факторів економічного зростання – капітал. Основним критерієм економічного розвитку є економічне зростання. Економічне зростання є стійкою тенденцією зростання основних показників національного виробництва. Необхідною умовою забезпечення динамічного розвитку національної економіки з урахуванням глобальних змін є побудова його форсайт сценаріїв. Подібні підходи створюють можливості для формування політики забезпечення стійкого економічного зростання національної економіки та протидії глобальним шокам і ризикам. Ця стаття узагальнює аргументи та контраргументи в межах наукової дискусії з питання моделювання та прогнозування економічного розвитку національної економіки. Основною метою проведеного дослідження є моделювання та прогнозування економічного розвитку Азербайджану. Систематизація літературних джерел та підходів до розв'язання проблеми прогнозування економічного розвитку засвідчила, що форсайт прогнозу економічного зростання повинен враховувати диверсифікацію джерел його зростання та мультиплікаційний вплив взаємопов'язаних галузей економіки країни. У роботі створена динамічна модель, яка дозволяє оптимально планувати та прогнозувати джерела та стратегічні напрями розвитку національної економіки та забезпечення її інтенсивного зростання. Для досягнення оптимального рівня валового внутрішнього продукту обсяг інвестицій використовується як незалежна змінна в динамічній моделі. Визначено, що на розмір інвестицій впливає багато інших факторі, однак, динамічна модель оптимального обсягу економічного зростання національної економіки має статистично значущі результати. Окреслено подальші напрями удосконалення моделі прогнозування економічного зростання національної економіки.

Ключові слова: Азербайджан, інновації, валовий внутрішній продукт, інвестиції, макроекономіка, прогноз.