İPƏK YOLU, No.3, 2025, səh.81-100
https://doi.org/10.30546/SI.2025.3.75.317

STATISTICAL ANALYSIS OF THE IMPACT OF PRODUCTION IN OIL AND NON-OIL SECTORS ON ECONOMIC GROWTH IN AZERBAIJAN

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Abstract. The article presents a statistical analysis of the impact of GDP production in the oil and non-oil sectors in the Republic of Azerbaijan on economic growth. The stationarity of time series was determined using first-order differences and cointegration relationships between economic indicators were investigated. One cointegration relationship was found between the variables considered in the study. The constructed VECM explains the restoration and stabilization of the disturbed equilibrium between time series after 1 year and 7 months. The results confirmed the long-term balanced relationships between the variables under consideration.

Keywords: Economic growth rates, GDP production in oil and non-oil sectors, VECM, impulse functions, decomposition method.

AZƏRBAYCANDA NEFT VƏ QEYRİ-NEFT SEKTORLARINDA İSTEHSALIN İQTİSADİ ARTIMA TƏSİRİNİN STATİSTİK TƏHLİLİ

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Xülasə. Məqalədə Azərbaycan Respublikasında neft və qeyri-neft sektorlarında ÜDM istehsalının iqtisadi artıma təsirinin statistik təhlili aparılmışdır. Zaman sıralarının birinci tərtib fərqlərlə stasionarlığı müəyyən edilərək iqtisadi göstəricilər arasında kointeqrasiya münasibətləri araşdırılmışdır. Tədqiqat işində baxılan dəyişənlər arasında 1 kointeqrasiya münasibəti müəyyən olunmuşdur. Qurulmuş VECM 1 il və 7 aydan sonra zaman sıraları arasında pozulmuş tarazlığın bərpasını və sabitləşməsini izah edir. Alınan nəticələr baxılan dəyişənlər arasında uzunmüddətli tarazlı münasibətləri əsaslandırmışdır.
Açar sözlər: İqtisadi artım templəri, neft və qeyri-neft sektorlarında ÜDM istehsalı, VECM, impuls funksiyaları, dekompozisiya metodu.

СТАТИСТИЧЕСКИЙ АНАЛИЗ ВЛИЯНИЯ ПРОИЗВОДСТВА В НЕФТЯНОМ И НЕНЕФТЯНОМ СЕКТОРАХ НА ЭКОНОМИЧЕСКИЙ РОСТ В АЗЕРБАЙДЖАНЕ

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Резюме. В статье проводится статистический анализ влияния производства ВВП в нефтяном и ненефтяном секторах в Азербайджанской Республике на экономический рост. Стационарность временных рядов определялась с помощью разностей первого порядка и исследовались коинтеграционные связи между экономическими показателями. Между переменными, рассмотренными в исследовании, была выявлена одна коинтеграционная связь. Построенная VECM объясняет восстановление и стабилизацию нарушенного равновесия между временными рядами через 1 год и 7 месяцев. Полученные результаты подтвердили долгосрочные сбалансированные связи между рассматриваемыми переменными.
Ключевые слова: Темпы экономического роста, производство ВВП в нефтяном и ненефтяном секторах, VECM, импульсные функции, метод декомпозиции.

1. Introduction

The effectiveness of the implementation of economic policy elements is of great importance in improving the system of state macroeconomic regulation. Identification and study of dependencies between indicators in various sectors of the economy, between endogenous and exogenous indicators, quantitative assessment of these relationships, identification of patterns, development of trends characterizing the dynamics of development of various sectors of the economy and their application in management are of great importance. Econometric models based on mathematical and statistical methods, their verification and application allow us to determine the relationships between quantitative characteristics of economic objects for drawing up forecast conditions, determine the values of all parameters in the model and ensure the adequacy of its correspondence to the real behavior of the parameter under study, obtain effective values of the model and base economic assessment and conclusions on the results of the model on empirical data [7; 10; 14].

Relevance. Ensuring sustainable socio-economic development, especially in the context of the transformation period, is impossible without a systematic and high-quality analysis of the most important trends and interrelations of economic processes. The need for reliable and prompt assessments of the impact of various monetary policy instruments for decision-making in a complex of macroeconomic regulation measures requires continuous development and improvement of the system of indicators and models.

The economic crises experienced in world markets, the intensive fluctuations in oil prices under the influence of various economic and political processes indicate the need to eliminate the current dependence on hydrocarbon resources in Azerbaijan. At present, reducing the republic's dependence on raw materials, achieving rapid development of the non-oil sector, increasing the efficiency of the economy and ensuring competitiveness are considered one of the main tasks of the Azerbaijani economy. The economic reforms carried out in this area in recent years are bearing fruit and quite effective results have been achieved in this direction. The dynamics of the growth rate in the agricultural, tourism, construction, transport, forestry, fisheries, etc. sectors, the added value created, confirm what has been said.

In econometric studies, modeling of economic indicators by studying the reactions of variables to various shocks has become widespread. By applying modern econometric methods, the researcher can not only show the quantitative change of the studied indicator, but also examine what other indicators this change may depend on and how. In the process of developing models for forecasting, statistical analysis of data, analysis of dependencies and relationships between factors are necessary. Autoregressive models, which are widely used in econometric studies due to their wide capabilities, allow for the presentation of vector models in a structural form to correct cointegration relationships and errors, as well as to solve analytical problems that are impossible to solve or that create difficulties in implementing regression modeling [1; 12; 13; 17]. The most important parameters characterizing economic growth include gross domestic product, investment volume, consumption level of the population and state enterprises, export and import of products and services, as well as the volume of production in the oil and non-oil sectors, which are considered the leading sectors of the national economy.

Analysis of the dynamics in the oil and non-oil sectors. One of the most important exogenous factors of the economy of Azerbaijan is the price of oil, which is determined by the structure of the national economy and the export potential of the country. Changes in world oil prices inevitably affect the volume of GDP, capital investments in the country, the real exchange rate, the average income and standard of living of the population, etc. [2; 18]. Despite the steady strengthening of the national currency as a result of regulatory measures at the state level, the rise and fall of world oil prices, which increase the financial flow to the country and are closely dependent on the prices of other energy sources on world markets, have a strong impact on the dynamics of economic processes in countries trading in oil products. This fact turns the strong dependence of the Azerbaijani economy on the export of oil products into a serious problem affecting the macroeconomic stability in the country.

For a visual analysis of the relationship between GDP and oil prices on world markets, a graphical method was used. Figure 1 shows the combined price chart of Azerbaijan Gross Domestic Product [15; 16], Azeri Light [3], Brent [4] and West Texas Intermediate [5] crude oil. For all variables in the chart, the unit of measurement was the US dollar and the period of study with annual indicators was 2000-2024. The similar dynamics of all four parameters in Figure 1 clearly confirms the close and strong influence of oil prices in the world markets on the economic growth of Azerbaijan.

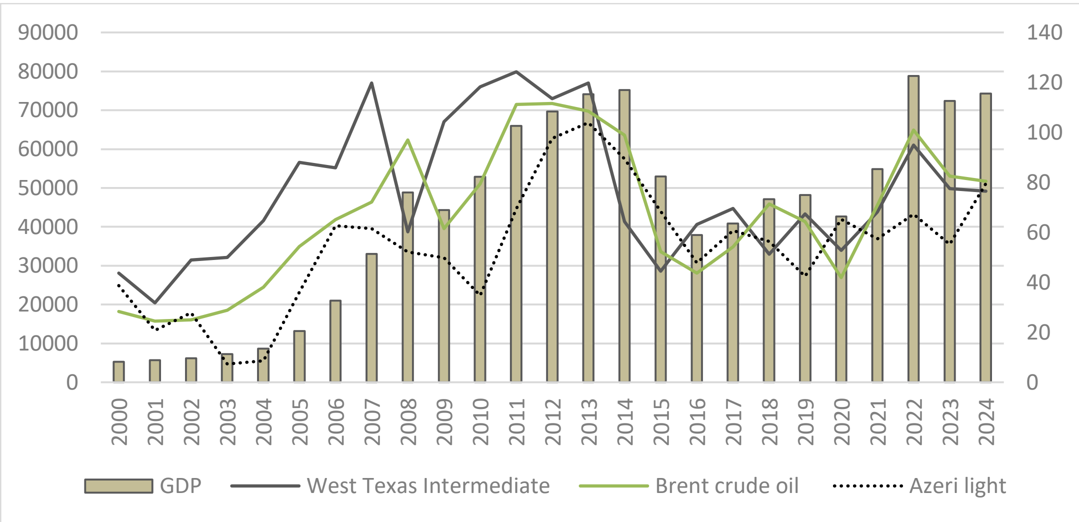

Figure 1. Dynamics of GDP and oil prices on world markets
Source: Implemented by the author in Excel

The ongoing macroeconomic processes in the world against the backdrop of ongoing geopolitical tensions and growing uncertainties and risks in the global economy have had a serious impact on the economy of Azerbaijan. The growth of supply in the world energy markets and the lack of parallelism in the growth of supply and demand mean that the price of oil, which is the main source of income and foreign exchange investments, remains low. Currently, ensuring the development of the non-oil sector in order to improve the efficiency of the economy and increase its competitiveness is one of the main economic priorities of our state. As a result of the successful economic policy pursued in the country, in addition to achieving economic diversification, there has been a significant increase in the share of the non-oil sector in GDP. In 2023, industrial enterprises of Azerbaijan and the private sector operating in this area will produce industrial products worth 66.6 billion manats. Production in the oil and gas sector decreased by 2%, while in the non-oil sector it increased by 8%. In 2023, GDP production in Azerbaijan will reach 123 billion manats, or an increase of 1.1% compared to the previous year. The non-oil sector accounted for 63.2% of GDP. In 2023, GDP in the non-oil sector will increase by 3.7% compared to the previous year and reach $ 77.7 billion. was manat. Of the GDP created in the non-oil sector, 8.8% accounted for agriculture, forestry and fisheries, 8.1% - for the non-oil and gas industry, 9.8% - for construction, 15.9% - for trade and repair of vehicles, 9.8% - for transport and warehousing, 3.5% - for tourist accommodation and catering, 2.8% - for information and communication, 29.4% - for other industries[1]. In the first 9 months of 2024, economic growth and diversification continued in the country's economy. So, 92.8 billion. manats or 4.7% more than in the GDP compared to the same period of the previous year. The non-oil sector accounted for 66.1% of GDP. GDP increased by 7.1% to 61.4 billion manats. In the non-oil sector, 9.7% of GDP came from agriculture, forestry and fisheries, 7.9% from the non-oil and gas industry, 9.5% from construction, 14.5% from trade and repair of vehicles, 10.6% from transport and warehousing, 3.7% from tourist accommodation and catering, 2.7% from information and communication, 29.1% from social and other sectors[2] (Figure 2).

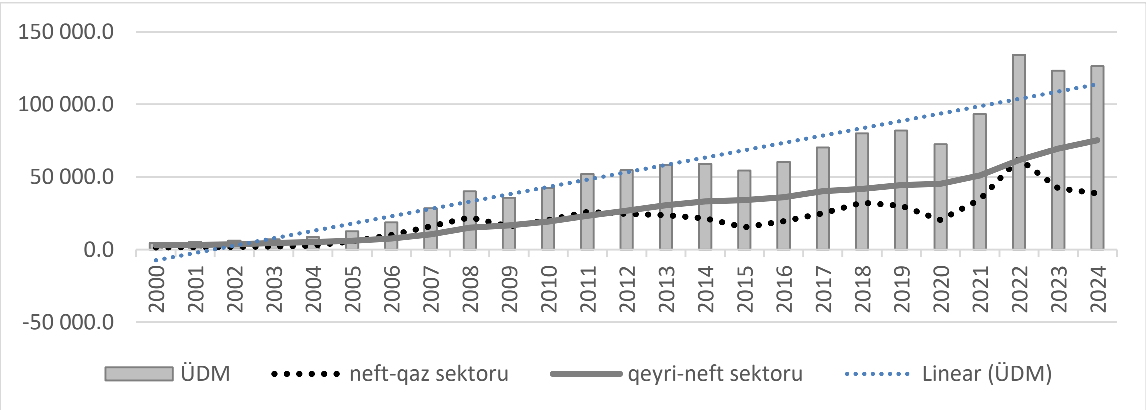

Figure 2. Dynamics of GDP production by the oil and gas and non-oil sectors for 2000-2024
Source: Implemented by the author in Excel

[1]https://economy.gov.az/storage/files/files/6299/yUY5C6dFoLmFDuOYjpbSBHAJmyb9dtNLJUtnNyZE.pdf
[2]https://economy.gov.az/storage/files/files/8453/fVAKFegQS0xKJ4n8l6I7BTq0DnPA8Eo7Mej05A2t.pdf

In general, in recent years, the share of the non-oil sector has dominated the GDP structure. Thus, in 2019, the corresponding indicator was 61.6%, in 2020 - 70.4%, in 2021 - 62%, in 2022 - 52.2%, in 2023 - 63.2%, in 2024 - 66.1% (Figure 3).

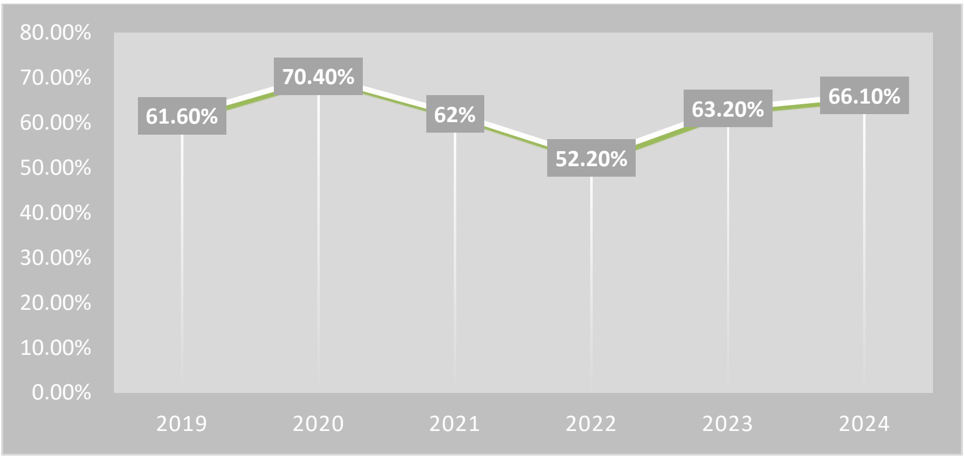

Figure 3. The share of the non-oil sector in the structure of GDP (in %)
Source: Realized by the author in Excel

Empirical research. Vector models have many advantages for error correction, which expands the applicability of the regression model for the studied time series. It should be noted that due to the non-stationarity of time series, interdependence and correlation of variables in the model, a large number of equations and cointegration relationships can be formed, which turn out to be unfounded after testing hypotheses and tests [9; 11]. After checking the degree of exogeneity of the variables, the number of these equations can be reduced to one.

In this article, the dependencies between the factors under consideration are studied based on the logarithmic values of all variables. This will ensure high-quality characteristics of the estimates according to the model. Thus, the regression equation is linear with respect to the logarithms of the initial variables ($t = \overline{1,25}$):

$$\ln y_t = \propto + \beta_1 \ln x_{t1} + \beta_2 \ln x_{t2} + \ln \varepsilon_t \quad (1)$$

A preliminary analysis of the time series parameters was conducted to form a cointegration relationship and cointegration rank characterizing the relationship between economic growth in Azerbaijan and GDP production indicators in the oil and non-oil sectors, as well as to construct a vector error correction model. The statistical data required to conduct econometric tests were taken from the official website of the State Statistical Committee of Azerbaijan [16], the official website of the Central Bank of Azerbaijan [15] and open international Internet resources [3]. The observation period covers 2000-2024 (with annual indicators). For economic growth, GDP was taken as the dependent variable - in million manats and GDP production in the oil sector - in million manats and GDP production in the non-oil sector - in million manats were taken as independent variables. The empirical analysis was carried out using the capabilities of the Excel and Eviews 12 software packages. In the analysis, economic growth is denoted as LN_GROWTH, GDP production in the oil sector as LN_OIL and GDP production in the non-oil sector as LN_NON_NEFT. To improve the quality of the model being formed and to analyze its adequacy, logarithmic residuals were included in the model: LN_RESİD.

Logarithmic time series allow for a more visual representation of the relationship between the factors under consideration. The first differences of logarithms are an approximation of the growth rates of variables. Figure 4 graphically presents the dynamic descriptions of the time series under consideration.

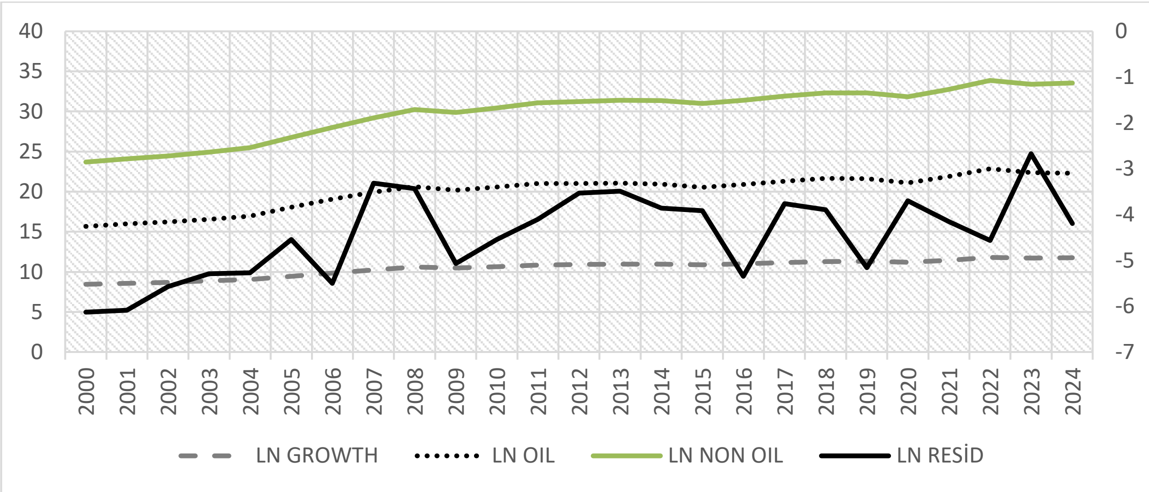

Figure 4. Dynamic description of the data
Source: Realized by the author in Excel

Based on the results of the regression analysis showing a linear relationship between the dependent variable LN_GROWTH and the explanatory variables LN_OIL, LN_NON_OIL and LN_RESID, the formal model is as follows:

LN_GROWTH=0.411923LN_OİL+0.583326LN_NON_OİL+0.013069LN_RESID+0.881384 (2)

The results of the regression analysis based on the initial indicators are as follows: It was determined that R^2 for the model was 99%; F-statistics 16972.65 (probability 0.000000); AIC -4.578269; Schwarz criterion -4.383249; Durbin-Watson statistics 1.05; The t statistics for LN_OIL, LN_NON_OIL and LN_RESID were obtained 31.1 with probability=0.000, 43.7 with probability=0.000 and 1.8 with probability=0.08 respectively. The determination coefficient explains 99% of the choice of explanatory factors for the model, leaving 1% for random components, which is considered satisfactory. The value obtained by the Fisher criterion was also obtained with a high probability. Despite the positive results obtained, the Durbin-Watson statistics is not satisfactory enough. Based on the number of observations k_1=25 and the number of degrees of freedom k_2=3, the lower and upper boundaries of the critical points with a probability of 95% are d_l=1.123 and d_u=1.654, respectively. Since DW=1.05 and is located to the left of these points. This explains the positive autocorrelation in the regression model and the non-stationarity of the model.

To conduct tests that determine cointegration relationships, it is necessary to ensure the stationarity of the studied series.

The Dickey–Fuller, KPSS, Phillips–Perron, Breusch–Godfrey serial correlation, LM test, Ljung–Box and augmented Dickey–Fuller procedures are used in autoregressive modeling to determine the stationarity of time series.

The results of the augmented Dickey-Fuller test show that the null hypothesis is a unit root, while the alternative hypothesis is stationarity [6]. The coefficient λ = 1 indicates the presence of a unit root, which characterizes the non-stationarity of the series. The Dickey-Fuller test can be represented as the following equation:

$$y_t = \lambda y_{t-1} + \delta_t, \tag{3}$$

where y_t is the time series studied at time t; λ is the coefficient determining the unit root; δ_t is white noise. If these levels $y_1, \ldots, y_n$ are independent of each other and the conditions M(y_t)=0, D(y_t)=const are met, then this sequence is a random process, a special case of stationary series. Mathematically, the unit root test consists of the following elements:

$$y_t = d_t + s_t + u_t \tag{4}$$

where d_t is the deterministic component; s_t is the stochastic component; u_t is the steady-state error process. The unit root test determines whether the stochastic component of an equation contains a unit root.

The augmented Dickey-Fuller test is an extended form of the Dickey-Fuller test. This test tests for stationarity by removing existing autocorrelation from the time series using the time series difference method for the data. The augmented Dickey-Fuller unit root test computes a t-test criterion with a significance level of p, obtaining critical values for the t-test with probabilities of 1%, 5% and 10%. Based on these results, the time series is determined to be stationary.

Thus, the augmented Dickey-Fuller unit root test was used to determine the first-differenced stationarity for the LN_GROWTH, LN_OIL, LN_NON_OIL and LN_RESİD time series and the following results were obtained. According to the initial data, the test equation was constructed with constant, lag length=0 and maxlaq=5. The equation for first order differences is constructed with trend and intercept, lag length 0; maxlag=2, 5 (Table 1).

Table 1. Results of the extended Dickey-Fuller test

	critical values:1% level	critical values:5% level	critical values:10% level	t-statistic	prob.
Time series with initial indicators					
LN_GROWTH	-3.737853	-2.991878	-2.635542	-2.162537	0.2240
LN_OIL	-3.737853	-2.991878	-2.635542	-2.116860	0.2401
LN_NON_OIL	-3.737853	-2.991878	-2.635542	-2.003246	0.2835
LN_RESİD	-3.737853	-2.991878	-2.635542	-3.648602	0.0122
Time series with first-order differences					
LN_GROWTH	-4.416345	-3.622033	-3.248592	-3.677901	0.0449
LN_OIL	-4.416345	-3.622033	-3.248592	-3.907287	0.0285
LN_NON_OIL	-3.752946	-2.998064	-2.638752	-2.970746	0.0528
LN_RESİD	-4.440739	-3.632896	-3.254671	-6.709180	0.0001

Source: Author's calculations, made in Eviews

As can be seen from the Table, the stationarity of the time series was achieved using first-order differences. Note that for the LN_NON_OIL series, stationarity was obtained with probability =0.0528, i.e. the result was obtained by barely exceeding the 0.05 significance level.

Table 2. Descriptive statistics results

	LN_GROWTH	*LN_OIL_*	*LN_NON_OIL_*	*LN_RESİD*
Mean	10.48956	9.525720	9.844200	-4.443120
Median	10.90300	9.924000	10.19800	-4.196000
Maximum	11.80500	11.04200	11.22900	-2.671000
Minimum	8.459000	7.223000	8.024000	-6.125000
Std. Dev.	1.050502	1.115883	1.025121	0.922796
Skewness	-0.747474	-0.973104	-0.527954	-0.180655
Kurtosis	2.249004	2.613170	1.891798	2.096462
Jarque-Bera	2.915483	4.101417	2.440680	0.986382
Probability	0.232761	0.128644	0.295130	0.610675
Sum	262.2390	238.1430	246.1050	-111.0780
Sum Sq. Dev.	26.48532	29.88468	25.22094	20.43724
Observations	25	25	25	25

Source: Author's calculations, made in Eviews

To analyze the parameters of the model, the results of descriptive statistics presented in Table 2 were used. As can be seen, the Jarque-Bera test indicates a normal distribution of the levels of the time series LN_GROWTH, LN_OIL, LN_NON_OIL and LN_RESID. For all four - time series, the results JB_{LN_GROWTH}=2.915483, prob.=0.232761>0.05, JB_{LN_OIL}=4.101417, prob.=0.128644>0.05, $JB_{LN\_NON\_OIL}$=2.440680, prob.=0.295130, JB_{LN_RESID}=0.986382, prob.=0.610675 confirm that the distribution is normal.

The Jarque-Bera test checks for normality of observation errors by comparing the third- and fourth-order central moments with the central moment of the normal distribution. This test tests the null hypothesis of normal distribution against the alternative hypothesis of non-normal distribution of observation errors. In Figure 5, the histograms of the standard distribution of residuals for the variables LN_GROWTH, LN_OIL, LN_NON_OIL and the random component of the model, skewness, kurtosis and other obtained criteria show the above result for both the model parameters and the residuals, i.e., that the distributions are normal.

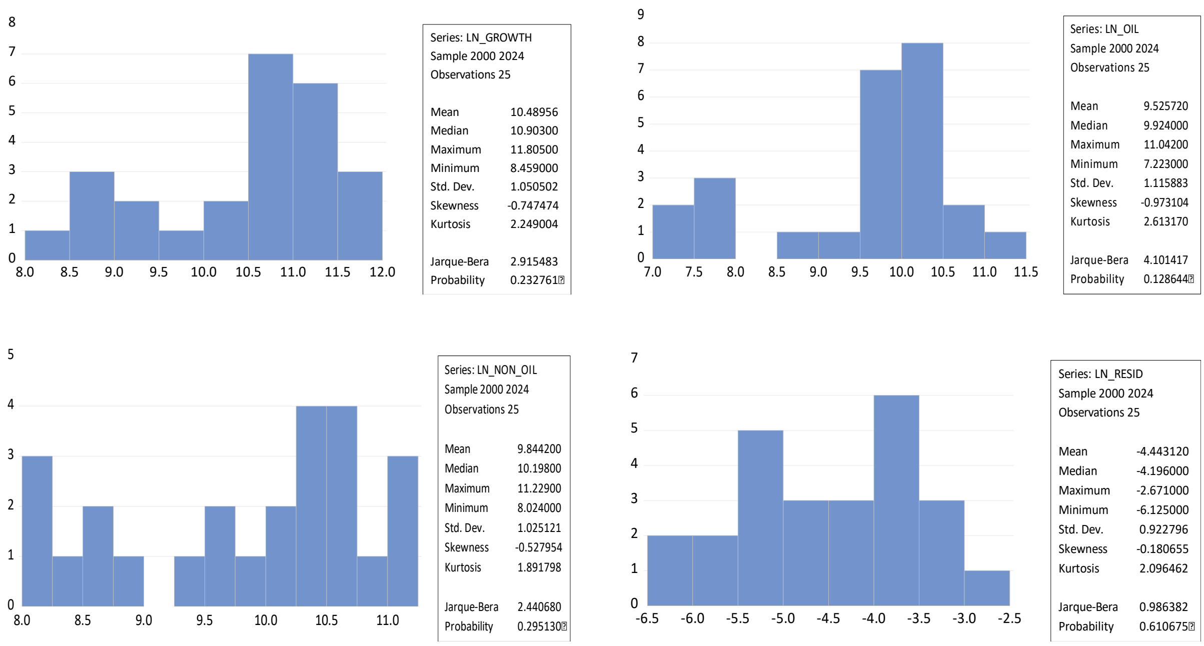

Figure 5. Histogram of the standard distribution of residuals for the variables LN_GROWTH, LN_OIL, LN_NON_OIL and LN_RESID

Source: Completed by the author in Eviews

Table 3. Correlation matrix

	LN_GROWTH	LN_NON_OIL	LN_OIL	LN_RESID
LN_GROWTH	1	0.9808272677642286	0.988041307903061	0.696165998777457
LN_NON_OIL	0.9808272677642286	1	0.9399873902483774	0.7139475931201198
LN_OIL	0.988041307903061	0.9399873902483774	1	0.6540231261711238
LN_RESID	0.696165998777457	0.7139475931201198	0.6540231261711238	1

Source: Author's calculations, made in Eviews

Estimates of the density and direction of dependencies between parameters are given in Table 3 in the form of a correlation matrix. If the correlation coefficients evaluating the dependency between factors exceed 0.7 and approach unity, the dependency is considered strong and intensive, not random. If the value of the coefficients is less than 0.3, the dependency is interpreted as weak and random. According to the correlation matrix, the correlation between the LN_GROWTH outcome factor and the LN_OIL and LN_NON_OIL independent factors is flat and strong. In general, this situation is good for the model. However, the dependency between the LN_OIL and LN_NON_OIL factors and with the residual component of all factors is also flat and strong. This creates multicollinearity in the model and negatively affects its quality.

The stability of the parameters included in the model is checked based on the CUSUM test, which plots the recursive residuals and the cumulative sums of squares for the variables. If the recursive values of the residuals for the parameters exceed the critical values of the 95% confidence intervals, this indicates the instability of the parameters. If the blue and red lines do not intersect graphically, the hypothesis H_1 about the instability of the model parameters is rejected and the hypothesis H_0 about the stability of the parameters is accepted (Figure 6).

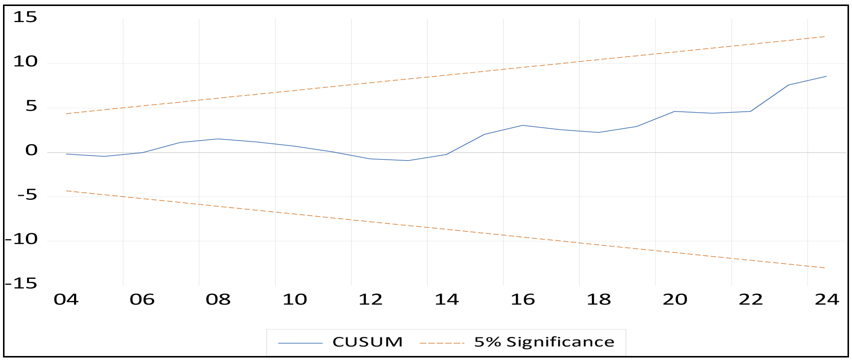

Figure 6. Recursive residuals graph
Source: Implemented by the author in Eviews

According to the results of the Granger causality test for causal relationships between time series variables, GROWTH confirms the one-way causal relationship between the time series LN_OIL, LN_NON_OIL with an interval of 1,2 lags and the number of observations of 23, 24 with a probability of 90% and 95% (Table 4).

The long-term equilibrium relationship of the studied dependencies between the variables can be presented in the form of a vector error correction model - VECM. These equations allow us to measure fluctuations, intensity of changes and speed of recovery of the studied objects aftershocks to their initially stable, equilibrium state (economic crises). The objective of the study is to compile equations for correcting the errors of the first-order difference for the time series LN_GROWTH, LN_OIL, LN_NON_OIL and LN_RESID based on annual statistical data. The results of the Engle-Granger and Johansen tests for cointegration of the time series LN_GROWTH, LN_OIL, LN_NON_OIL, LN_RESID with lag intervals (in first differences) of 2-2 show that the best results according to the Akaike and Schwartz information criteria are -4.800870* and -3.213899* for a linear deterministic trend, constant and with a trend, respectively.

Table 4. Results of the Granger causality test

Null Hypothesis	*Obs.*	*laq*	*F-Statistic*	*Probability*
LN_GROWTH does not Granger Cause LN_NON_OIL	24	1	9.79558	0.0051
LN_GROWTH does not Granger Cause LN_RESID	24	1	10.3003	0.0042
LN_OIL does not Granger Cause LN_NON_OIL	24	1	7.59117	0.0119
LN_OIL does not Granger Cause LN_RESID	24	1	16.1344	0.0006
LN_NON_OIL does not Granger Cause LN_RESID	24	1	6.50011	0.0187
LN_GROWTH does not Granger Cause LN_NON_OIL	23	2	3.38962	0.0563
LN_GROWTH does not Granger Cause LN_RESID	23	2	6.22198	0.0088
LN_OIL does not Granger Cause LN_RESID	23	2	8.03813	0.0032
LN_NON_OIL does not Granger Cause LN_RESID	23	2	9.83400	0.0013

Source: Author's calculations, made in Eviews

Table 5. Trace and Maximum Eigenvalue for linear deterministic trend test results

Hypothesis	*Eigenvalue*	*Trace Statistic*	*Critical Value 5%*	*Probability*
H_0:r=0*; None*	H_A:r>0; 0.843462	86.95528	63.87610	0.0002
H_0:r=1*; At most 1*	H_A:r>1; 0.730734	46.15725	42.91525	0.0229
At most 2	0.462504	17.29202	25.87211	0.3935
At most 3	0.152248	3.633672	12.51798	0.7943

Hypothesis	*Eigenvalue*	*Max-Eigen Statistic*	*Critical Value 5%*	*Probability*
H_0:r=0*; None*	H_A:r>0; 0.843462	40.79803	32.11832	0.0034
H_0:r=1*; At most 1*	H_A:r>1; 0.730734	28.86523	25.82321	0.0193
At most 2	0.462504	13.65834	19.38704	0.2779
At most 3	0.152248	3.633672	12.51798	0.7943

Source: Author's calculations, performed in Eviews
*Indicates rejection of the hypothesis at a significance level of 0.05

To test the null and alternative hypotheses for the time series variables, first-order differences and 2-2 lag intervals were used to test the Trace and Maximum eigenvalue tests. In cases where the calculated statistical values for both tests exceeded the critical values during the hypothesis testing, the alternative hypotheses of the existence of the cointegration equation were accepted at the 0.05 significance level (Table 5). Thus, the existence of 2 cointegration equations was confirmed with a probability of 95% for both tests. One equation was selected based on the quality criteria. The results obtained indicate a long-term relationship between the time series and a close correlation between the time series variables.

The results of the Granger causality test showed that there are one-way causal relationships between the variables. This allows us to construct a vector model to correct errors for both the dependent variable and the other variables [8].

Thus, based on the results of the Engle-Granger, Johansen, trace and maximum eigenvalue tests, the cointegration Equation 5 with intercept and trend was constructed. The VEC model (6)-(9) with a linear deterministic trend in the data and a lag of 2-2 (no trend in VAR) was also formed.

LN_GROWTH(-1)=-0.436924LN_OIL(-1)-0.568395LN_NON_OIL(-1)+0.042547LN_RESID(-1)
(0,01521) (0,03265) (0.00614)
[-28,7228] [-17,4071] [6.92783]
-0.002540@TREND(00)-0.51281 (5)

For the cointegration relationship (5) the standard errors of the model parameters are presented in brackets and the t-statistic values are presented in square brackets. As can be seen, the results for both criteria are satisfactory.

Δ(LN_GROWTH)=-0.642185(LN_GROWTH(-1)-0.436924LN_OIL(-1)-
-0.568395LN_NON_OIL(-1)+0.042547LN_RESID(-1)-0.002540@TREND(00)-0.51281)+
+2.422721Δ(LN_GROWN(-2))-1.025111Δ(LN_OIL(-2))-1.218674Δ(LN_NON_OIL(-2))-
-0.053701Δ(LN_RESID(-2))+0.117630 (6)

Δ(LN_OIL)=-0.849181(LN_GROWTH(-1)-0.436924LN_OIL(-1)-0.568395LN_NON_OIL(-1)+
+0.042547LN_RESID(-1)-0.002540@TREND(00)-0.51281)-5.019402Δ(LN_ GROWN(-2))-
-2.32388Δ(LN_OIL(-2))-2.476184Δ(LN_NON_OIL(-2))-0.111057Δ(LN_RESID(-2))+0.123094 (7)

Δ(LN_NON_OIL)=0.187093(LN_GROWTH(-1)-0.436924LN_OIL(-1)-
-0.568395LN_NON_OIL(-1)+0.042547LN_RESID(-1)-0.002540@TREND(00)-0.51281)+
+1.364392Δ(LN_ GROWN(-2))-0.488052Δ(LN_OIL(-2))-0.693410Δ(LN_NON_OIL(-2))-
-0.018297Δ(LN_RESID(-2))+0.110174 (8)

Δ(LN_RESID)=-24.78330(LN_GROWTH(-1)-0.436924LN_OIL(-1)-
-0.568395LN_NON_OIL(-1)+0.042547LN_RESID(-1)-0.002540@TREND(00)-0.51281)+
+18.78583Δ(LN_ GROWN(-2))-6.164381Δ(LN_OIL(-2))-10.60910Δ(LN_NON_OIL(-2))-
-0.512331Δ(LN_RESID(-2))-0.240560 (9)

The presented vector error correction model confirms the long-term cointegration relationship between GDP production in the oil and non-oil sectors and economic growth in Azerbaijan and allows us to analyze and forecast the mechanisms and dynamics of the influence of these economic indicators. The fact that the coefficient in the model is -0.64 explains the restoration and stabilization of the disturbed equilibrium between time series after 1 year and 7 months.

In the VAR model, checking the normality of the distribution of residuals and heteroskedasticity in the residuals is a necessary procedure to confirm the quality of the model. With the help of the VEC residual normality test, a certain conclusion can be drawn after checking the null hypothesis that the distribution of the model residuals is normal. Test results are presented in Table 6.

Table 6. Results of the VEC Residual Normality test for normal distribution of residuals

Component	*Skewness*	*Chi-sq*	*degree of freedom*	*Probability**
1	0.262290	0.252252	1	0.6155
2	0.136134	0.067952	1	0.7943
3	-0.235870	0.203994	1	0.6515
4	-0.177264	0.115216	1	0.7343
Joint		0.639413	4	0.9586
Component	*Kurtosis*	*Chi-sq*	*degree of freedom*	*Probability*
1	2.413425	0.315398	1	0.5744
2	2.787912	0.041233	1	0.8391
3	2.580417	0.161379	1	0.6879
4	2.991484	6.65E-05	1	0.9935
Joint		0.518076	4	0.9717
Component	*Jarque-Bera*		*degree of freedom*	*Probability*
1	0.567650		2	0.7529
2	0.109185		2	0.9469
3	0.365373		2	0.8330
4	0.115282		2	0.9440
Joint	1.157490		8	0.9970

Source: Author's calculations, performed in Eviews

*Calculated p-values do not take into account the coefficient

The results presented in Table 6 show that the skewness of the residual distribution is less than 3 for all components and even close to zero. This means that the observed skewness of the residuals is minimal and insignificant. The kurtosis also does not exceed 3, which allows us to consider the kurtosis of the distribution insignificant. For both forms, the distribution can be considered normal. According to the Jarque-Bera test, the normality of the residual distribution is fulfilled for all components. Thus, the results JB_1=0.567650 (probability=0.7529>0.05), JB_2=0.109185 (probability=0.9469>0.05), JB_3=0.365373 (probability=0.8330>0.05), JB_4=0.115282 (probability=0.9440>0.05), with 2 degrees of freedom and JB=1.157490 (probability=0.9970>0.05) with 8 degrees of freedom indicate that the residuals are normally distributed and the hypothesis H_0 about the normal distribution of the model residuals is accepted.

The results of the VEC residual heteroscedasticity test to check the heteroscedasticity of the residuals of the VAR model also confirm the homoscedasticity of the residuals. Thus, with the probability prob.=0.5497>0.05 and with 60 degrees of freedom, the following value of the chi-square distribution is obtained: χ^2 =97.58647 and this result is true in all cases among the residuals for the variables.

It is appropriate to test VEC Residual Serial Correlation LM Tests - for mutual independence of residuals. The number of included observations is 22. Lags of 1, 2 are used. Table 7 shows the results of the LM test of residual serial correlation of VAR. The null hypothesis is: there is no serial correlation with the lag. When testing in all cases, the p-value is more significant than 5%. Therefore, the H_0 hypothesis is accepted and there is no serial correlation with a delay of lags 1, 2.

Table 7. VEC Residual Serial Correlation LM Tests

Laqs	LRE* stat	df	Prob.	Rao F-stat	df	Probability
1	22.44943	16	0.1293	1.572907	(16, 28.1)	0.1426
2	4.318854	16	0.9982	0.229994	(16, 28.1)	0.9983

Source: Prepared by the author in the EViews program

One of the basic concepts of cointegration analysis is equilibrium. Equilibrium is characterized by a state of equilibrium and stability in an economic system, in the absence of external and internal incentives for change. In the cointegration of time series, long-term joint equilibrium movement is achieved when two or more time series with a common stochastic trend are in long-term relationships and the deviation from these relationships is stationary with a finite variance and the series themselves are non-stationary. In the case of non-cointegration of time series, the concept of long-term equilibrium loses its practical meaning. The impulse response functions characterize the time required for the endogenous variable to return to its equilibrium trajectory after a shock to the exogenous variable, explaining the median estimate of the endogenous variable with a 95% confidence interval to the standard deviation of the exogenous variable. The graphs and table of values of the impulse response functions for structural impacts obtained as a result of estimating the VECM model are presented below.

From Table 8, Figures 7 and 8 it is evident that the response of LN_GROWTH to the pulse of the LN_ GROWTH variable in the previous period in the amount of one standard error first increases slightly up to the third period, then decreases in the fourth and quickly rises up to the 6th period, after which a decline is observed up to the 8th period and a gradual increase up to the 10th period. The response of LN_GROWTH to the pulse of the LN_OIL variable in the previous period is increasing up to the 2nd period, with a sharp decline up to the 4th period, after which the response slowly increases up to the 6th period, decreases up to the 9th period and stabilizes after it. The influence of the LN_NON_OIL pulse on LN_GROWTH is quite unstable. It is described by an alternating decrease and increase up to the 8th period and only after the 8th period can the stability of the reaction be seen. The response of LN_GROWTH to the pulse of the LN_RESID variable after instability for 8 periods is restored in the 9th period.

Table 8. Estimation of impulse response functions for time series LN_GROWTH

Period	*LN_GROWTH*	*LN_OIL*	*LN_NON_OIL*	*LN_RESID*
Response of LN_GROWTH				
1	0.159128	0.000000	0.000000	0.000000
2	0.162187	0.013149	0.006551	-0.011334
3	0.167531	-0.009124	-0.029743	-0.028715
4	0.147731	-0.022850	-0.028948	-0.019045
5	0.152980	0.000605	-0.001300	-0.011651
6	0.169035	0.005585	-0.003566	-0.011770
7	0.157289	-0.011173	-0.020926	-0.019879
8	0.154421	-0.013599	-0.024075	-0.022150
9	0.159862	-0.003156	-0.009384	-0.012808
10	0.160321	0.000995	-0.004857	-0.012716

Source: Author's calculations, made in Eviews

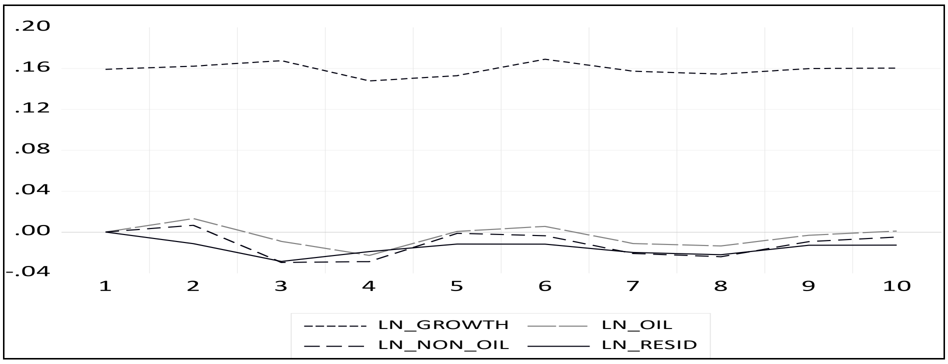

Figure 7. Combined graph for respons of LN_GROWTH to innovations

Source: Completed by the author in Eviews

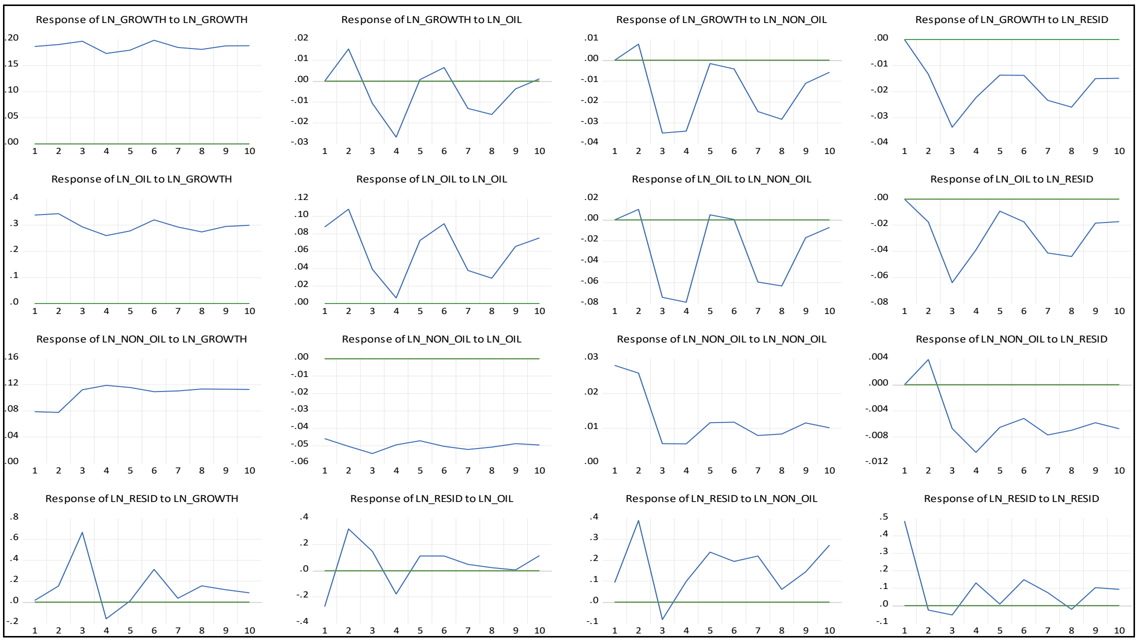

Figure 8. Multiple graphs of impulse response to Cholesky one s.d. innovations for time series LN_GROWTH, LN_OIL, LN_NON_OIL, LN_RESID

Source: Completed by the author in Eviews

The results in Table 9 show that in the annual forecast of LN_GROWTH, the largest errors are attributed to the shocks LN_GROWTH, LN_OIL, LN_NON_OIL and LN_RESID, respectively, of 99.3% in the second year, 0.74% in the fourth year, 1.68% in the fourth year and 1.25% in the fourth year; for LN_OIL, these values are, in respectively order, 93.7% in the first year, 7.7% in the second year, 2.77% in the fourth year, 1.4% in the fourth year; for LN_NON_OIL, respectively, 80.7% in the tenth year, 25.3% in the second year, 8.6% in the first year and 0.32% in the fourth year; for LN_RESID, respectively, 43.5% for the third year, 29.6% for the second year, 26.8% for the second year and 39.5% for the second year. The results of the analysis show that the greatest forecast uncertainty for LN_GROWTH, LN_OIL, LN_NON_OIL and LN_RESID is observed in the first half of the 10-year period.

Table 9. Variance Decomposition of LN_GROWTH, LN_OIL, LN_NON_OIL, LN_RESID

Variance Decomposition of LN_GROWTH					
Period	S.E.	LN_GROWTH	LN_OIL	LN_NON_OIL	LN_RESID
1	0.186594	100.0000	0.000000	0.000000	0.000000
2	0.267319	99.33753	0.332699	0.082583	0.247186
3	0.335434	97.38879	0.313038	1.133540	1.164630
4	0.380648	96.33739	0.738576	1.675448	1.248587
5	0.421024	96.89930	0.603993	1.370817	1.125889
6	0.465618	97.34908	0.513622	1.128884	1.008415
7	0.502130	97.19821	0.509716	1.209476	1.082598
8	0.535396	96.93349	0.537049	1.341868	1.187589
9	0.567581	97.15956	0.482119	1.231588	1.126736
10	0.598118	97.37060	0.434526	1.118107	1.076770
Variance Decomposition of LN_OIL					
1	0.350152	93.69333	6.306672	0.000000	0.000000
2	0.502855	92.13873	7.698319	0.040808	0.122145
3	0.591905	91.14649	5.997542	1.598538	1.257427
4	0.652633	90.89670	4.942779	2.770358	1.390166
5	0.713006	91.31632	5.176209	2.325876	1.181594
6	0.787051	91.46755	5.605142	1.908847	1.018463
7	0.843593	91.63198	5.080570	2.160322	1.127131
8	0.890946	91.64340	4.660763	2.440675	1.255164
9	0.941072	91.95162	4.664309	2.220538	1.163528
10	0.990585	92.12008	4.789708	2.009485	1.080727
Variance Decomposition of LN_NON_OIL					
1	0.095369	68.17115	23.16795	8.660897	0.000000
2	0.135477	66.67326	25.31850	7.926554	0.081686
3	0.184509	73.07689	22.38104	4.366161	0.175915
4	0.225510	76.90028	19.78838	2.983221	0.328116
5	0.258203	78.78784	18.42136	2.476920	0.313875
6	0.285240	79.29411	18.21534	2.200597	0.289951
7	0.310516	79.58409	18.18814	1.922010	0.305759
8	0.334696	80.01367	17.96257	1.717234	0.306529
9	0.356889	80.42243	17.66609	1.615334	0.296143
10	0.377786	80.70208	17.48807	1.513825	0.296030
Variance Decomposition of LN_RESID					
1	0.566580	0.077402	23.47551	2.740434	73.70665
2	0.774937	3.999436	29.65760	26.82616	39.51681
3	1.038032	43.51213	18.59211	15.59976	22.29600

4	1.077915	42.57653	19.98001	15.30524	22.13822
5	1.109804	40.17253	19.87334	19.06365	20.89048
6	1.184282	42.26774	18.36537	19.44542	19.92147
7	1.208449	40.68506	17.80556	21.99481	19.51457
8	1.220368	41.51608	17.49859	21.81996	19.16537
9	1.238882	41.18940	16.98130	22.53626	19.29304
10	1.280164	39.04570	16.72567	25.63391	18.59472

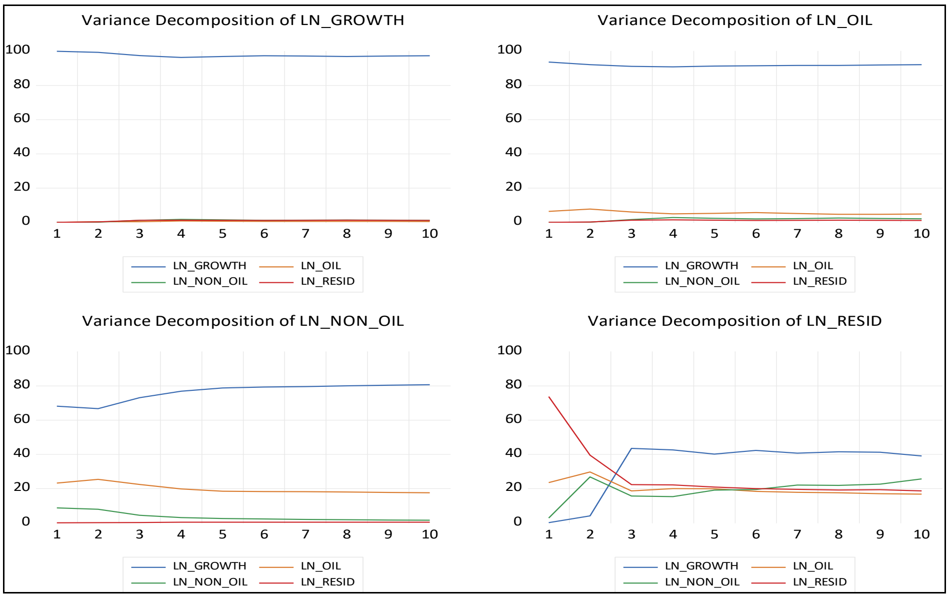

Figure 9. Variance Decomposition using Cholesky (d.f. adjusted) Factors LN_GROWTH, LN_OIL, LN_NON_OIL, LN_RESID

Source: Completed by the author in Eviews

Results. The following results were obtained during the research work dedicated to the construction of a vector error correction model for the quantitative assessment of the impact of GDP production in the oil and non-oil sectors on economic growth in Azerbaijan in the short and long term:

Based on the analysis of primary statistical data, non-stationarity of the LN_GROWTH, LN_OIL, LN_NON_OIL, LN_RESID time series was revealed and the stationarity of the time series was obtained using the integral and extended Dickey-Fuller test of time series with first-order differences. Although the constructed linear multivariate regression model demonstrates sufficient adequacy, it does not fully satisfy the adequacy conditions, the presence of multicollinearity between independent variables creates autocorrelation at the levels of the time series in the model. This situation justified the need to construct a vector model to correct errors between the economic factors under consideration;

The cointegration Equation 5 and the vector error correction model (6)-(9) established during the study can be considered statistically significant. This conclusion is justified by the values of standard errors and t-statistics obtained from the model results, by checking the relevant hypotheses and tests, by the results of tests on the normal distribution of residuals and heteroskedasticity in the VAR model, as well as by the graphical analysis performed;

VECM allowed for a quantitative assessment of the characteristics of the studied time series, the relationships between them in the short and long term and the analysis of the long-term dynamics of the indicators. The long-run equilibrium relationship between variables can be considered stable because after shocks, stability is restored after the equilibrium is disturbed in the short term. The established models allow us to measure both deviations from the equilibrium state and the speed of restoration of equilibrium. The model explains the restoration of the disturbed equilibrium between the time series after 1 year and 7 months and the transition to a stable period.

Analysis of the graphs and tabular values of the impulse response function showed that the responses of the impulse functions of the variables to structural shocks cover the first half of the 10-year period, after which a gradual transition to a stable period occurs;

The decomposition method was used for the variances of forecast errors and the analysis was considered. It was determined that the impact of changes in variables on the variance of forecast errors covers 5 years of the 10-year time period;

The results obtained may be useful in determining the real trends of GDP production in the oil and non-oil sectors of economic growth in Azerbaijan, in assessing prospects and developing future development strategies, in determining the interdependence between other macroeconomic indicators and economic growth, in studying the dynamics of economic growth based on the analysis of its dynamics, in considering their values with their interdependence and in developing recommendations for the prospective development of economic growth. It has been concluded that when studying the characteristics and development dynamics of economic growth in Azerbaijan, exogenous factors such as oil prices, which reflect the impact on GDP, along with production, imports, exports, capital investment, employment levels, population incomes, oil product production and other macro indicators, must also be taken into account;

Based on an empirically constructed econometric model, the dependence of economic growth on fluctuations in oil prices, the level of development of the non-oil sector and state policy in this area is confirmed. The established VECM can be useful as one of the methods for studying and forecasting the development dynamics of economic growth in the Republic of Azerbaijan.

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