ORIGINAL PAPER

DOI: 10.26794/2587-5671-2026-30-5-1389-03
JEL C1, C12, C51

Model of Correction of Errors of the Current Account of the Balance of Payments of Azerbaijan, Taking Into Account Macroeconomic Indicators and World Oil Prices

N.S. Ayyubova
Baku State University, Baku, Azerbaijan

ABSTRACT

The **purpose** of the study is to determine the impact of GDP, investment, the national currency rate, the state budget deficit, indicators of the foreign trade sector, the level of foreign exchange reserves, and world prices for Brent and West oil on the dynamics of the current account of Azerbaijan's balance of payments. An econometric analysis of the interdependence of the indicators of the current account of the balance of payments with the listed macroeconomic indicators and the residuals of the model was carried out to form an error correction model. The paper applies and summarizes the latest methodological developments in the direction of modern econometrics research. As a result, the degree of dependence of endogenous and exogenous factors was revealed, as well as the short-term and long-term relationship between dependent and independent factors. To check the stability of the AR model, the Roots of Characteristic Polynomial test was applied, and the inverse roots of the characteristic equation of the polynomial from the shift operator were calculated. An error correction model has been created, which makes it possible to conduct an economic and statistical analysis of the dynamics of the current account of the balance of payments and on the basis of which it is possible to give a forecast assessment for the future period.

Keywords: balance of payment; macro indicators; oil prices on world markets; stationarity; an error correction model; responses of impulse functions

For citation: **Ayyubova N.S. Model of correction of errors of the current account of the balance of payments of Azerbaijan, taking into account macroeconomic indicators and world oil prices. *Finance: Theory and Practice*. 2026;30(5). DOI: 10.26794/2587-5671-2026-30-5-1389-03**

ОРИГИНАЛЬНАЯ СТАТЬЯ

Модель коррекции ошибок текущего счета платежного баланса Азербайджана с учетом макроэкономических показателей и мировых цен на нефть

Н.С. Айюбова
Бакинский государственный университет, Баку, Азербайджан

АННОТАЦИЯ

Цель исследования — определить влияние на динамику текущего счета платежного баланса Азербайджана таких факторов, как ВВП, инвестиции, курс национальной валюты, дефицит государственного бюджета, показатели внешнеторгового сектора, уровень валютных резервов и мировых цен на нефть марки Brent и West. Проведен эконометрический анализ взаимозависимости показателей текущего счета платежного баланса с перечисленными макроэкономическими показателями и остатками модели для формирования модели коррекции ошибок. Применяются и обобщаются новейшие методологические разработки в направлении современных исследований эконометрики. В результате выявлена степень зависимости эндогенных и экзогенных факторов, а также краткосрочная и долгосрочная взаимосвязь между зависимыми и независимыми факторами. Для проверки устойчивости *AR* модели применен тест «Корни характеристического полинома», вычислены обратные корни характеристического уравнения многочлена от оператора сдвига. Создана модель коррекции ошибок. Она помогает анализировать изменения текущего счета платежного баланса. На основе этой модели можно делать прогнозы на будущий период.

Ключевые слова: платежный баланс; макропоказатели; цены на нефть на мировых рынках; стационарность; модель коррекции ошибок; реакции импульсных функций

***Для цитирования*: Ayyubova N.S. Model of correction of errors of the current account of the balance of payments of Azerbaijan, taking into account macroeconomic indicators and world oil prices. *Финансы: теория и практика*. 2026;30(5). DOI: 10.26794/2587-5671-2026-30-5-1389-03**

INTRODUCTION

The variety of macroeconomic models that characterize the dynamics of individual items of the balance of payments, international economic relations, and currency movement needs to be better covered by econometric studies. For Azerbaijan and the CIS countries, the balance of payments only in the early 90s took the form in which it functions "today". From this point of view, econometric modeling and forecasting of individual items of the balance of payments can be practically unexplored in our country.

One of Azerbaijan's macroeconomic strategies is ensuring a positive balance in payments. The balance of trade, the leading indicator of imports and exports, mainly forms the results of the balance of gains since the country's participation in world trade relations is the main form of foreign economic relations. Growth or decline in exports of national economic sectors and imports directly affects the strengthening or weakening of the national currency, smoothes the effect of devaluation on the growth and development of the economy as a whole, on the financial and banking system, on state budget revenues, on changes in the country's gold and foreign exchange reserves, etc. d. One of the most acute problems of the state budget of Azerbaijan is the high sensitivity of revenues to changes in the external environment. Oil prices on world markets determine the volume of exports in the country. Also, a change in oil prices significantly affects the volume of production, the value of the national currency, prices, state budget indicators, etc.

Based on this, there is a need to further improve the tools for predictive and analytical assessments of the dynamics of the country's balance of payments, which is the primary indicator of foreign economic relations and currency movement, to develop regulatory monetary policy measures for equilibrium exchange rates that reduce economic instability. To solve the above problems, it is essential to analyze the dynamics of macroeconomic indicators and create financial and mathematical models that account for many macroeconomic aggregates that affect the balance of payments.

LITERATURE REVIEW

The paper [1] examines the causes of the emergence and growth of the balance of payments crisis. Based on data from Eastern Europe, the primary signals of impending crises in Eastern Europe are studied and analyzed using econometric methods. These signals allow you to notice the impending crisis in time and avoid negative consequences in the future. Based on the results obtained in this work, one can observe how the nature of the balance of payments crisis is changing. The purpose of the paper [2] is to study the relationship between the trade balance and the real exchange rate of bilateral merchandise trade between Singapore, Korea, Malaysia, and the US and Japan every quarter. In the course of the study, the partially reduced form model of Rose and Yellen was obtained from the models of imperfect substitutes of the two countries. In the paper [3], the author established the presence of a cyclical factor in the relationship between macroeconomic indicators and the dynamics of certain types of activities. The possibilities of using a special class of time functions for modeling economic dynamics at the level of individual types of activity are also investigated. The formation of the model is studied by taking into account capital flows, interest payments on public debt, terms of trade, and various tests are carried out for the model. The article [4] analyzes Kazakhstan's long-term economic growth exposure to macroeconomic constraints. Balance-of-payments-constrained growth models predict that a country's growth rate can be approximated by the ratio of the export growth rate to the income elasticity of demand for imports. The Johansen cointegration method was used to evaluate trading parameters. A vector error correction model is used to analyze short-term adjustments in income elasticity. The study [5] examines the Thurlwall Act for Pakistan. Various estimates of growth rates using *ARDL* regression analysis also indicate that Pakistan's long-term growth is limited, albeit partly by a balance of payments deficit, stagnation in the primary structure of exports.

ANALYSIS OF THE STATE OF THE CURRENT ACCOUNT OF THE BALANCE OF PAYMENTS AND WORLD OIL PRICES

Let us analyze the dynamics of the balance of payments for the last period. We can see a reasonably significant increase in the surplus in the first quarter of 2022 for 1572.4 million dollars. This indicator increased by 4.8 times compared to the same indicator of the previous year. Such high growth was due to an even more significant increase in the current account surplus, which amounted to $ 4 billion in the first quarter of 2022, which is 6.3 times higher than in 2021. It should be noted that these data characterize the dynamics of only the first quarter of 2022. If oil prices continue to rise, the current account surplus could reach record highs by the end of the year.

It should be noted that such dynamics of the surplus of the current set of the balance of payments are accompanied by a deficit of other components. In the current period, some other balances of payment items show a deficit, even those that showed positive values last year. This applies to the capital account, which had a deficit of $ 0.3 million, to the financial account,

where the deficit was $ 1.2 billion, and to the balancing item, where the deficit exceeded the same indicator by $ 1.18 billion (3.7 times). Moreover, the deficit in the balance of services in the first quarter of 2022 decreased compared to the same period. It amounted to 23.3%, which is considered a positive effect on the balance of payments of Azerbaijan because this is usually the weakest side of the balance of payments in Azerbaijan, etc. So, we conclude that the balance of payments is mainly formed at the expense of the foreign trade balance, a significant part of which is trade in petroleum products. In the first quarter of 2022, the surplus in the oil and gas sector increased 2.9 times or by $ 5.5 billion compared to the same period last year. I consider it necessary to note that although the main component of foreign trade relations is energy trade, the non-oil sector is not left without state policy's attention in growth, development, investment, etc. This issue became more relevant for the country's economy after the devaluation of the national currency of Azerbaijan in 2015, which resulted from a decrease in oil prices in world markets. At the beginning of 2022, the non-oil sector grew by 18.2% over the year, reaching up to $ 1.5 billion. This figure is 22.4% of Azerbaijan's GDP. For the first quarter, Azerbaijan received 3.8 billion dollars for oil exports and 3.5 billion dollars for gas exports [6].

The dynamics of the current account indicators of the balance of payments of Azerbaijan over a longer period are presented in *Fig. 1*. The figure clearly shows the growth of the current account in the periods 2004–2014, 2016–2019, 2020–2022 and from the end of 2022 to the current period. *Figure 2* shows line graphs of world prices of Brent and West crude oil. A comparison of *Fig. 1* and *2* reveals similar dynamics of the current

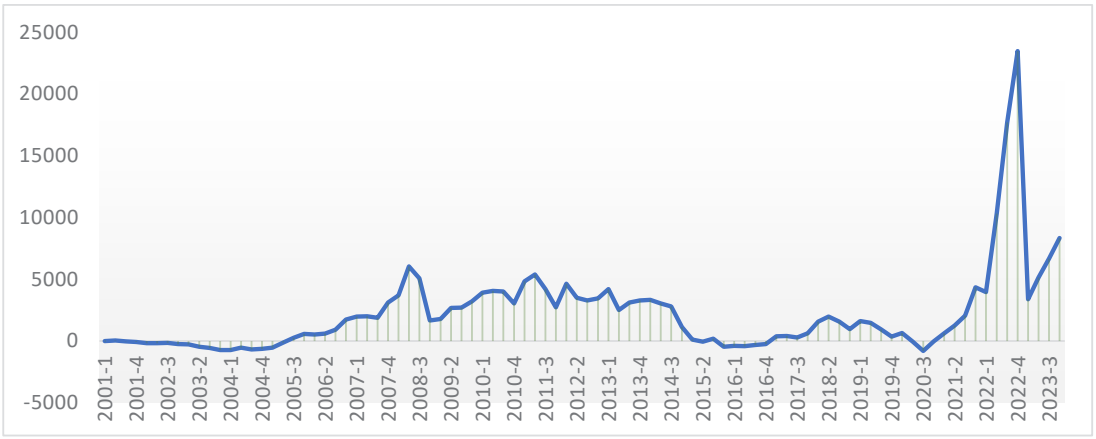

Fig. 1. **Dynamics of the Current Account of the Balance of Payments of Azerbaijan by Quarterly Indicators in the Period From 2001 to 2023 (Million US Dollars)**

Source: Prepared by the author in the Excel program according to data: Macroeconomic statistics. URL: https://www.cbar.az/; Central Bank of Azerbaijan. URL: https://www.cbar.az/page-41/macroeconomic-indicators (accessed on 30.03.2024).

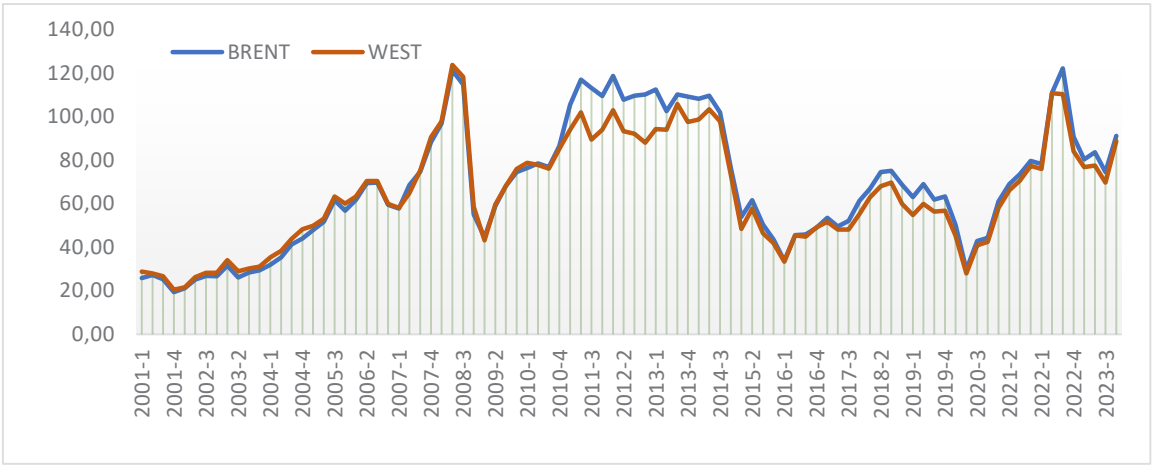

Fig. 2. **Price Dynamics for Brent and West Crude Oil by Quarterly Indicators in the Period from 2001 to 2023 (Million US Dollars)**

Source: Prepared by the author in the Excel program according to data: Fred-Economic data. Economic Research Reseurces. URL: *https://fred.stlouisfed.org/series/DCOILBRENTEU*; https://fred.stlouisfed.org/series/DCOILWTICO#0; Crude Oil Prices – 70 Year Historical Chart. Macrotrends is the premier research platform for long-term investors. URL: https://www.macrotrends.net/1369/crude-oil-price-history-chart; Average annual Brent crude oil price from 1976 to 2024. Empowering people with data (accessed on 30.03.2024).

account of the balance of payments of Azerbaijan and the prices of Brent and West crude oil on world markets in 2001–2023.

DATA AND METHODOLOGY

Relying on a high coefficient of determination, ignoring the preliminary DW test, indicating autocorrelation and the absence of two-way causal relationships for all factors, "may lead to false" regression [7], which reduces the quality of the positive results obtained, implying false relationships between the dependent and independent factors. In this case, either this fact should be eliminated or considered before applying the forecasting model. It was expedient to perform an extended analysis of the model's residuals and, applying the cointegration method, determine the cointegration equation for correcting and eliminating errors [8].

Thus, taking into account the results of previous works in the area under consideration [9–13] and in related areas [14–17], increasing the number of observations and explanatory factors, we continue our research in the field of modeling the current account of the balance of payments. The following parameters were included in the study. Dependent variable: CUR — current account of the balance of payments (net export). Explanatory variables: EXP —export; *IMP* — import; GDP; MAN — rate of the national currency (manat); BD — budget deficit (state); *CI* — capital investment; BRENT — price per barrel of Brent brand; WEST — price per barrel of West brand. All statistical data used in the paper were obtained from electronic resources of the Central Bank of Azerbaijan and from sources.[1] The author carried out calculations and preparation of tables and figures using EViews and Excel.

EMPIRICAL RESULTS

As mentioned above, the results of regression analysis can demonstrate false regression. Therefore, the study should begin with checking the stationarity of the time series. If there is non-stationarity according to the initial data, it is necessary to determine the order of integration of these series using the Dickey-Fuller test. Next, we need to investigate the time series cointegration hypothesis.

Figures 3 and *4* show time series graphs of all variables in the model. As can be seen from the presented graphs, we can say that all variables have been changing their trajectory since 2006 and are recovering within two years. For the CUR variable, stationarity is broken starting from 2006, decreases to a minimum in 2007 relative to the considered period, and is restored by 2008. In this period, there is also a decrease, then sharp jumps and a resumption of values for the variables WEST, BRENT, EXP, and relatively minor changes, but similar dynamics can be considered for the variables *CI*, GDP, and *IMP*. These facts can be substantiated by the denomination of the Azerbaijani MAN in 2006 and changes in energy prices on world markets. The dynamics of the MAN variable since 2006 can be said to be stable, with slight deviations from the "straight line", given the devaluation processes in Azerbaijan in 2015, the policy of regulating and maintaining the exchange rate of the MAN of the Central Bank of Azerbaijan. The variable current "smoothly" decreases in 2015 and recovers during the year. These processes can also be explained and justified by the decline in oil prices on world markets and the manat devaluation.

Before starting the analysis of the stationarity of time series, it is important to study the residues according to the AR model. Model specifications: estimation sample 2001q1–2023q4, number of observations 92, lag intervals for endogenous 12. We have included the residuals in the model as the independent variable *MRESID* in order to study their "quality" in detail.

The heteroscedasticity of the residuals violates the conditions of the *LSM*, which leads to a decrease in the model quality and errors in calculating the model characteristics. A *White* test was performed to determine the presence of heteroscedasticity in the residues.

The results of the White test are shown in *Table 1*, where *prob. F(54, 29)* = 1.0000 > 0.05. At $n = 92$ *Obs*R-squared* — the coefficient of determination is 25.11865 and it is less than the value $\chi^2_{0,99}(54) = 29.7$. The corresponding *p*-value is greater than the significance level of 0.05 (0.99 > 0.05), i.e. the null hypothesis that the random term is homoscedastic may not be rejected. Therefore, the *H1* hypothesis is rejected, and according to the *White* test, we conclude that there is no heteroscedasticity in the residuals.

Moreover, in *Fig. 5*, the quantile-quantile plot for the residuals of the estimated model characterizes the distribution of residuals by points [18]. As seen in *Fig. 5*, all points are almost on the same straight line. This indicates the maximum closeness of the distribution of the model's residuals to the ordinary distribution law.

[1] Macroeconomic statistics. URL: https://www.cbar.az/; Central Bank of Azerbaijan. URL: https://www.cbar.az/page-41/macroeconomic-indicators; Fred–Economic data. Economic Research Reseurces. URL: https://fred.stlouisfed.org/series/DCOILBRENTEU; https://fred.stlouisfed.org/series/DCOILWTICO#0; Crude Oil Prices — 70 Year Historical Chart. Macrotrends is the premier research platform for long–term investors. URL: https://www.macrotrends.net/1369/crude-oil-price-history-chart; Average annual Brent crude oil price from 1976 to 2024. Empowering people with data (accessed on 30.03.2024).

At the next stage, the uncorrelatedness of the model's residuals was investigated, and estimates of AC and PAC were found.

Autocorrelation is observed at levels 1 through 5. The absence of autocorrelation at levels 6 through 36 for AC and PAC is confirmed by the ratio of probabilities of the model residuals exceeding the significance level of prob. = 0.05, and the hypothesis of autocorrelation at these levels is refuted. Analyzing the results presented in *Fig. 6*, it can be concluded that, although not complete, stationarity of the residuals of the first-difference model does exist, since stationarity of the model residuals covers more than 90% of the series.

For analysis, first of all, it is necessary to calculate the inverse roots of the polynomial characteristic equation from the shift operator [19], the result of which serves to test the stationarity of the AR model. If the reverse roots lie inside the unit circle, the process under consideration is assumed to be stationary.

To check the stability condition of the AR model, the Roots of Characteristic Polynomial test was applied for CUR and MRESID (see *Table 2* and *Fig. 7*).

As you can see, the values of the roots do not exceed one. Also, in the diagram in *Fig. 7*, no root lies outside the unit circle. So VAR satisfies the condition, i.e., the process is stationary.

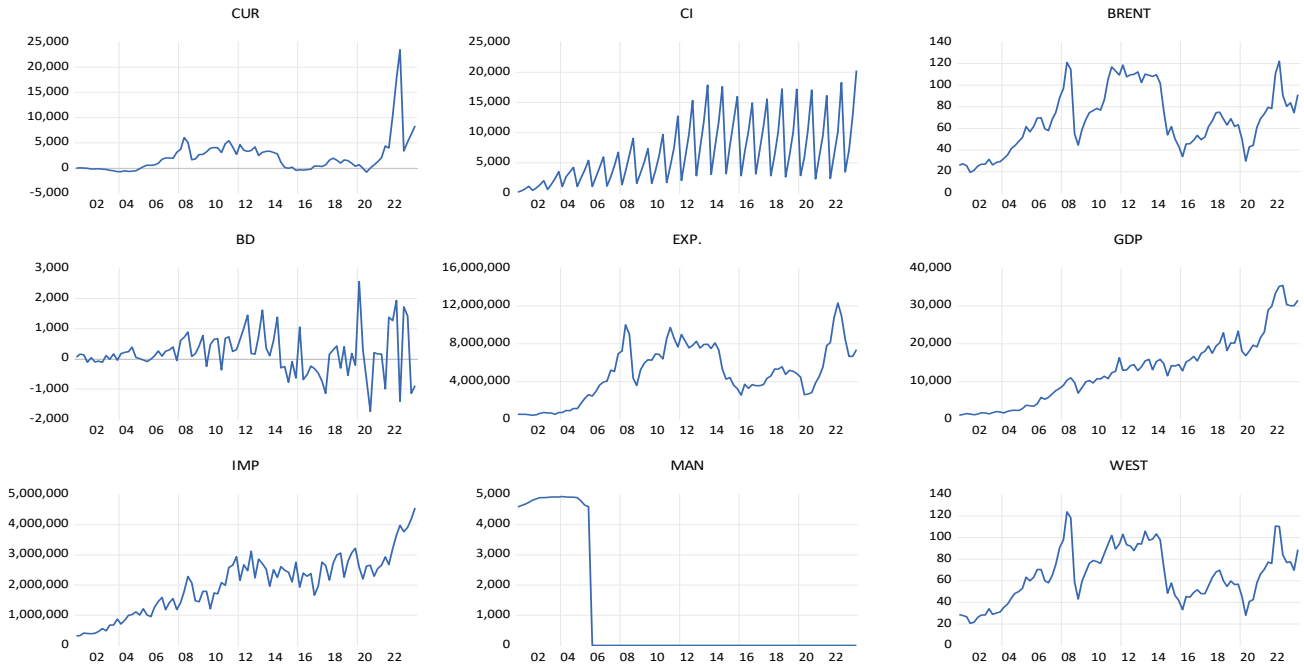

Fig. 3. **Dynamics of Variables Included in the Model**

Source: Prepared by the author in the Eviews.

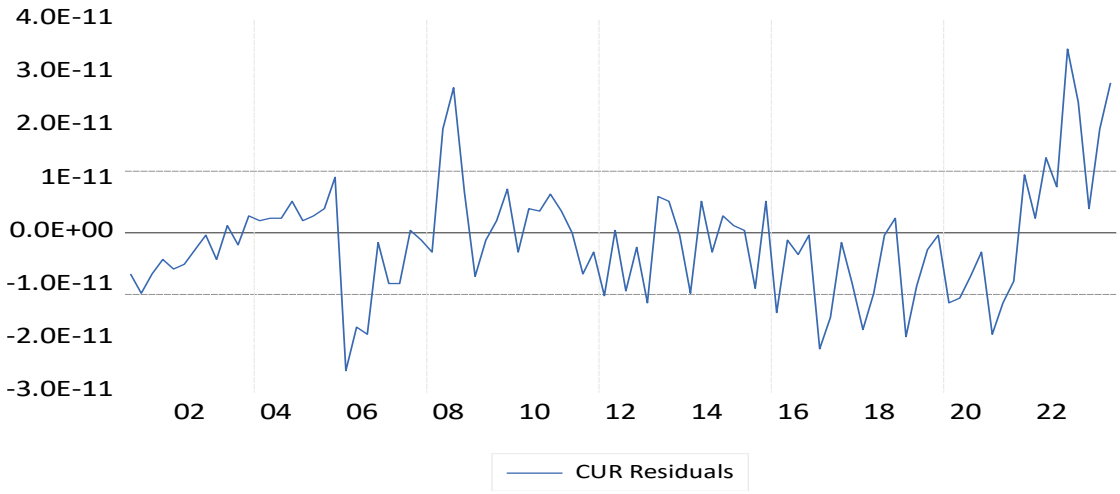

Fig. 4. **Dynamics of the Current Residuals**

Source: Prepared by the author in the Eviews.

Table 1

White's Test Results

F-statistic	0.229099	Probability F(54,29)	1.0000
Obs*R-squared	25.11865	Probability Chi-Square (54)	0.9997

Source: Prepared by the author in the EViews.

Table 2

The Result of the Test for the Roots of the Characteristic Polynomial

CUR		*MRESID*	
Root	**Modulus**	**Root**	**Modulus**
0.875584	0.875584	0.588057	0.588057
0.126241	0.126241	–0.106594	0.106594

Source: Prepared by the author in the EViews.

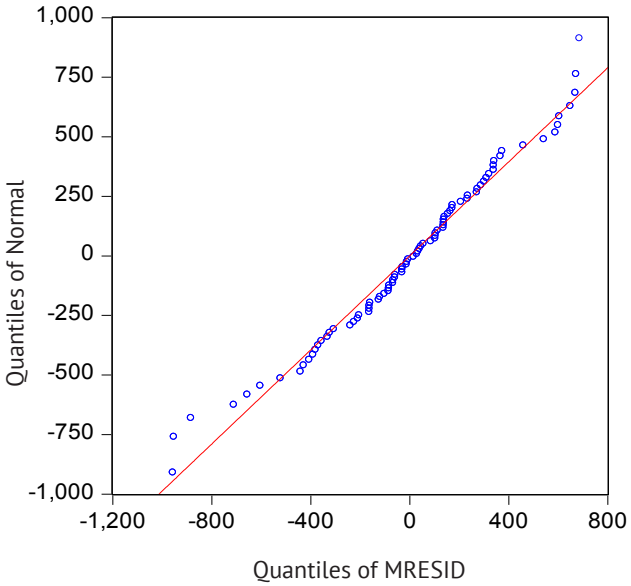

Fig. 5. **Quantile-Quantile Plot of Model Residuals**

Source: Prepared by the author in the Eviews.

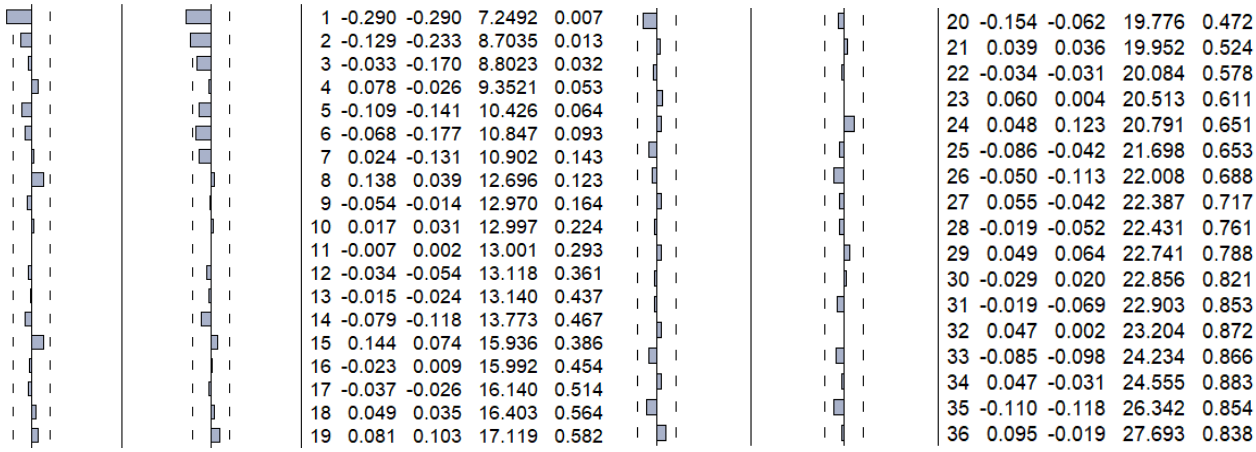

Fig. 6. **Estimates of the Sample Autocorrelation and Partial Autocorrelation Functions of the Model Residuals**

Source: Prepared by the author in the EViews.

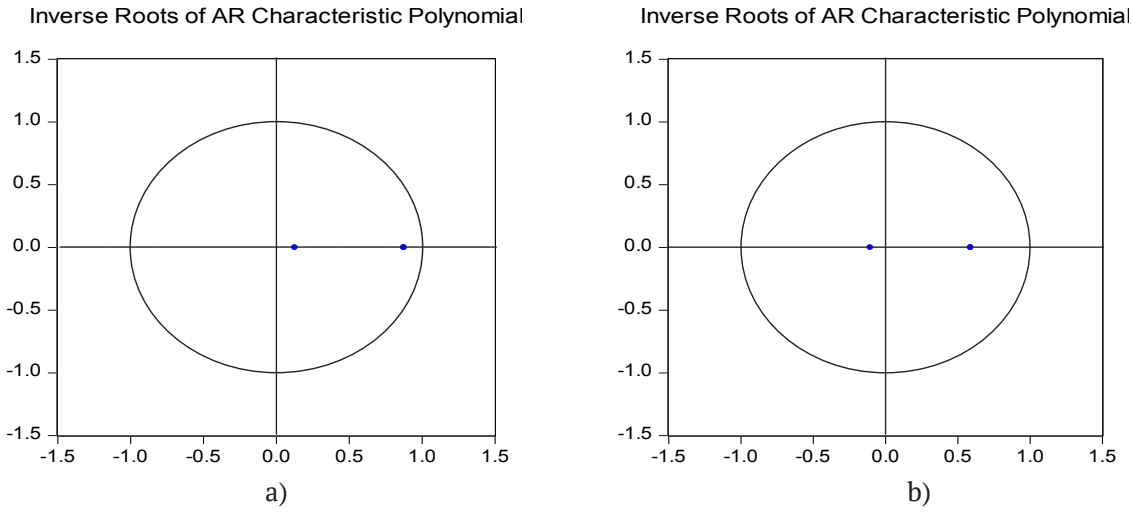

Fig. 7. **Graphic Representation of Unit Roots a)CUR; b)MRESID**

Source: Prepared by the author in the EViews program.

The hypothesis of non-stationary time series was tested using the *ADF*. The null hypothesis determines the presence of a unit root in the time series under study, and the alternative hypothesis accepts the series as stationary [20]. The results show that the result obtained is observed without errors and allows us to reject the H_0 hypothesis, which confirms the single root. *t-statistics* at significance levels of 1%, 5%, and 10% are located to the left of the t-Statistic value. Note that the maximum number of delays in the test was 11, the number of observations was 92, with differences of the first orders (*Table 3*).

The Granger causality test has been implemented to test causality between all variables for lags 1 to 16. When performing the test, if the calculated F-statistic value exceeds the criterion's critical value, the null hypothesis is rejected, i.e., there is causality between the variables [21–23]. This condition must also be met when defining feedback for some variables. The test indicated a one-way relationship with the dependent variable for all variables.

As a result of the *Engle Granger* test and *Johansen* test, it was determined that the variables are cointegrated and that there are 3 cointegrating equations at the level of 0.05. The results of the respective tests are presented in *Table 4* and *5*.

According to the *Akaike* information criterion, the third lag was the best, and according to the *Schwartz* criterion, the first lag. *Trace and Maximum Eigenvalue* tests were carried out, where null and alternative hypotheses were tested. For both tests, when testing hypotheses, in cases where the calculated values of the statistics exceeded the critical values, alternative hypotheses were accepted (see *Table 5*). Three cointegration ratios with 95% probability were obtained. The results obtained indicate a long-term relationship and the validity of the correlation between the variables.

Thus, it is possible to present the relations under study in the form of *ECM* which expresses a long-term equilibrium relationship between variables. The resulting equations make it possible to measure fluctuations, the intensity and speed of their recovery after the appearance of shocks (economic crises) to an initially stable, equilibrium state of the object under study. An error correction equation for the first-order differences for the series of the current account of Azerbaijan's balance of payments has been compiled. After removing some non-essential variables, the following model was obtained. The removed variables showed large standard errors and unsatisfactory statistics.

Thus, an ECM model was constructed with the following characteristics: a linear trend in the data with first-order differences, an intercept and trend in the cointegration equation, no trend in the vector autoregressive model (VAR), and a number of lags from 1 to 2. Of the three cointegration equations, one representing the most significant characteristics was selected. The cointegration relationship (1) and the error correction model (2) for the current account balance are presented below.

Table 3

Results of the Extended ADF Test

Variables	Critic.1%	Critic.5%	Critic.10%	Lag length	t-Statistic	Probability
By rows with first differences						
CUR	–3.51	–2.89	–2.58	4	–8.04	0.0000
EXP	–3.50	–2.89	–2.58	0	–7.32	0.0000
IMP	–3.50	–2.89	–2.58	3	–4.49	0.0004
GDP	–3.50	–2.89	–2.58	5	–4.87	0.0001
MAN	–3.50	–2.89	–2.58	0	–9.35	0.0000
BD	–3.50	–2.89	–2.58	2	–12.86	0.0001
CI	–3.52	–2.89	–2.59	3	–4.31	0.0008
BRENT	–3.50	–2.89	–2.59	1	–7.49	0.0000
WEST	–3.51	–2.89	–2.59	1	–7.64	0.0000
MRESID	–3.51	–2.89	–2.59	2	–9.81	0.0000

Source: Prepared by the author in the Eviews.

Table 4

Results of the Angle-Granger and Johansen Test for Time Series Cointegration

Included observations: 92 Sample (adjusted): 2001–2023 Series: *CUR IMP EXP GDP MAN BD CI BRENT WEST* Lags interval: 1 to 2					
Number of cointegrating ratios at the 0.05 level					
Trend	**There are no deterministic trends in the data**	**There are no deterministic trends in the data**	**Presence of a deterministic linear trend in the data**	**Presence of a deterministic linear trend in the data**	**Presence of a deterministic quadratic trend in the data**
Test	No Intercept No trend	Intercept No trend	Intercept No trend	Intercept Trend	Intercept Trend
Trace	2	3	2	3	3
Max-Eig	2	2	2	3	3

Source: Prepared by the author in the Eviews.

Table 5

Trace and Maximum Eigenvalue test Results for a Linear Deterministic Trend

Hypothesis	**Alternative hypothesis**	**Trace statistic**	**Critical value 5%**	**Probability**
None *	$H_A: r > 0$	421.6335	273.1889	0.0000
At most 1 *	$H_A: r > 1$	276.4794	228.2979	0.0000
At most 2 *	$H_A: r > 2$	201.6225	187.4701	0.0077
At most 3	$H_A: r > 3$	140.9475	150.5585	0.1530
Hypothesis	**Alternative hypothesis**	**Maximum Eigenvalue statistic**	**Critical value 5%**	**Probability**
None *	$H_A: r > 0$	145.1541	68.81206	0.0000
At most 1 *	$H_A: r > 1$	74.85692	62.75215	0.0023
At most 2 *	$H_A: r > 2$	60.67501	56.70519	0.0191
At most 3	$H_A: r > 3$	40.14774	50.59985	0.3918

Source: Prepared by the author in the Eviews.
Note: * Means rejection of the hypothesis at the 0.05 level.

$$\begin{aligned}CUR(-1) = {} & 0.000792EXP(-1) - 0.001925IMP(-1) - 0.280605GDP(-1) + 0.455768MAN(-1) - \\ & - 1.596516BD(-1) + 1.895699CI(-1) - 83.08972BRENT(-1) - 37.31870WEST(-1) - \\ & - 80.92448@TREND(01Q1) + 887.1635 \end{aligned} \quad (1)$$

$$\begin{aligned}\Delta(CUR) = {} & -0.241318(CUR(-1) + 0.000792EXP(-1) - 0.001925IMP(-1) - 0.280605GDP(-1) + \\ & + 0.455768MAN(-1) - 1.596516BD(-1) + 1.895699CI(-1) - 83.08972BRENT(-1) - 37.31870WEST(-1) - \\ & - 80.92448@TREND(01Q1) + 887.1635) - 0.085612\Delta(CUR(-1)) - 0.058603\Delta(CUR(-2)) - \\ & - 0.000326\Delta(EXP\_(-1)) - 0.000855\Delta(EXP\_(-2)) - 0.000374\Delta(IMP(-1)) - 0.001767\Delta(IMP(-2)) + \\ & + 0.728847\Delta(GDP(-1)) + 0.449139\Delta(GDP(-2)) + 0.295375\Delta(MAN(-1)) + 0.224135\Delta(MAN(-2)) + \\ & + 0.180332\Delta(BD(-1)) + 0.021786\Delta(BD(-2)) + 0.140237\Delta(CI(-1)) + 0.143826\Delta(CI(-2)) + \\ & + 174.2806\Delta(BRENT(-1)) - 82.93158\Delta(BRENT(-2)) - 140.3271\Delta(WEST(-1)) + \\ & + 109.3641\Delta(WEST(-2)) - 143.3516. \end{aligned} \quad (2)$$

Table 6

Standard Errors and *T* Statistics of Coefficient Estimates Models

Variables	Standard errors	t statistics	Variables	Standard errors	T Statistics
CUR	0.07432	–3.24707	*BD*	0.01325	9.06130
EXP	7.7E-06	–133.474	*CI*	0.00315	–6.81588
IMP	2.3E-05	45.6416	BRENT	1.03489	11.6504
GDP	0.00197	–4.83268	WEST	0.98047	5.62858
MAN	0.00487	–21.9588	MRESID	0.01305	–84.8790

Source: Prepared by the author in the Eviews.

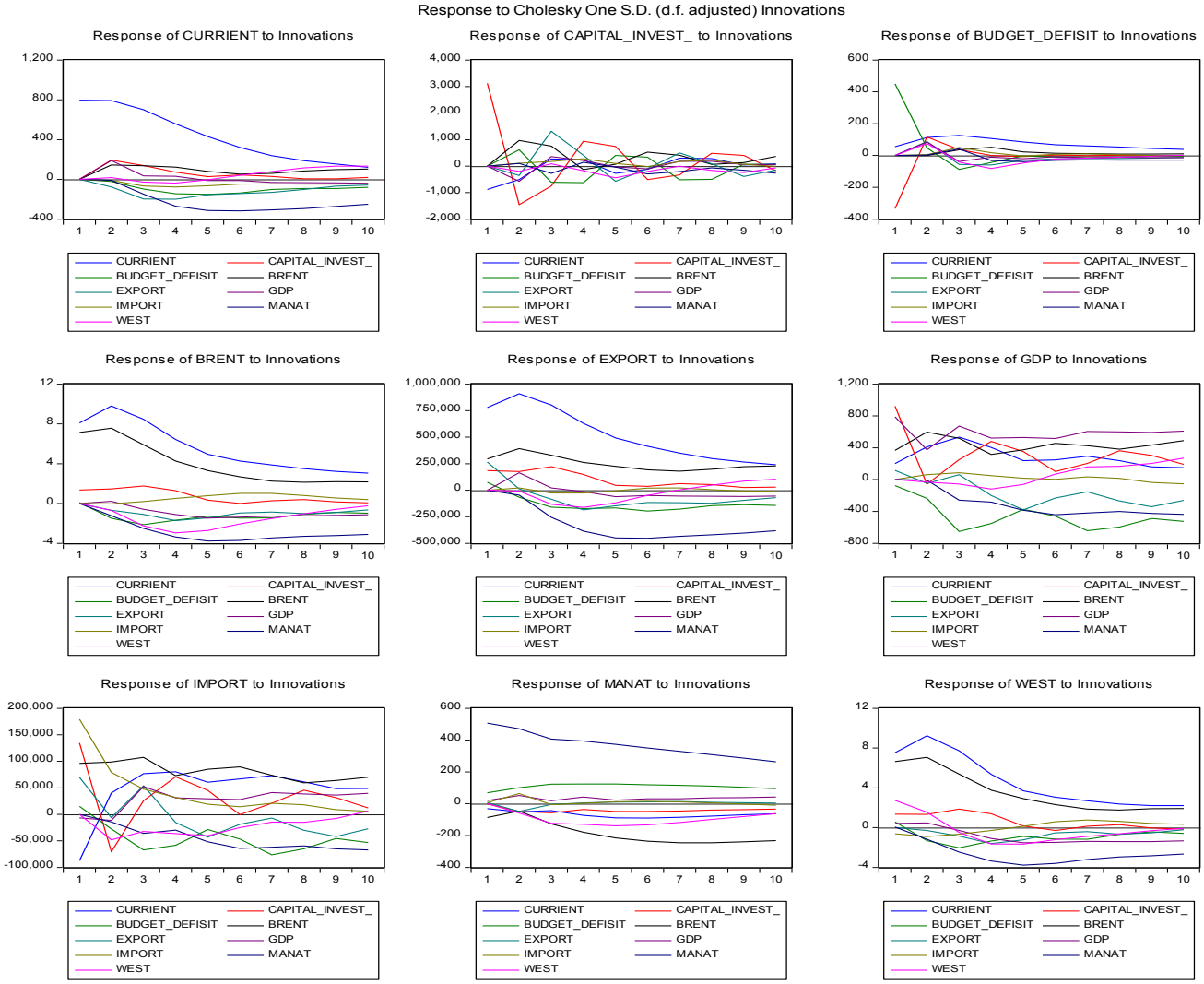

Fig. 8. **Responses of Impulse Function Responses to Model Variables**

Source: Prepared by the author in the EViews program.

The presented error correction model confirms the long-term cointegration relationship between macroeconomic indicators, global Brent and West crude oil prices, and the current account balance in Azerbaijan, allowing for the analysis and forecasting of the mechanisms and dynamics of these economic indicators' influence. The coefficient in the model, equal to –0.24, explains the restoration and stabilization of

the disturbed equilibrium between the time series over 4,16 periods. Restoring balance takes approximately 12.5 months or 1 year.

Table 6 shows the standard errors in the estimation of coefficients based on the results of the model. The coefficient of determination according to the model is 53%. These results can be considered satisfactory.

For a comprehensive study, it is necessary to analyze the reactions of impulse functions. These functions represent the median estimate with a 90% confidence interval of the endogenous variable for a positive shock of one standard deviation of the exogenous variable and indicate the time to return to the equilibrium trajectory. An analysis of *Fig. 8* shows the time-period responses from the manifested shock. It allows conclusions to be drawn regarding the responses of the residuals of the model to the shock of exogenous variables over ten years. Confidence intervals were obtained by bootstrapping with 100 replications. Here, in the period $t = 0$, all variables are equal to 0, after which, in turn, the variables increase by one unit of their standard deviation for the entire period. The reactions of variables to these shocks in the periods $t = 1, 2,\ldots, 10$ are estimated. The values of the variables in these periods represent the corresponding impulse response functions. The graphs in *Fig. 8* characterize the responses of the impulse functions for all variables of the model. It is noticeable that the response of the variables to the deviation from the general stochastic trend is different. When responding to shocks, the endogenous variable moves toward equilibrium.

The *Breusch-Godfrey* serial correlation *LM*-test is used in econometric studies to test serial correlation in random model errors. This test requires many observations, in other words, the procedure is asymptotic, which is consistent with our study. The verification is carried out using *LM* statistics equal to nR^2. The test statistic has an asymptotic *Chi-Square* distribution. If the value of the statistic exceeds the critical value, then the autocorrelation is considered significant. Otherwise, it is insignificant.

At $n = 84$ nR^2 — coefficient of determination is equal to 0.177156 and it is less than the critical value $\chi^2_{0.91}(2) = 0.211$. *p*-value exceeds the significance level of 0.05 (0.9152 > 0.05), i.e. the hypothesis of the significance of autocorrelation can be rejected. Serial correlation for residuals is not significant (*Table 7*).

Table 7

Results of the Breusch–Godfrey LM test

F-statistic	0.076085	Prob. F (2, 72)	0.9268
Obs*R-squared	0.177156	Prob. Chi-Square (2)	0.9152

Source: Prepared by the author in the EViews program.

VAR Residual Normality Tests (test about the normal distribution of residuals) checks whether the distribution is normal. The null hypothesis for the test indicates a normal distribution of the residuals. The test results are presented in *Table 8*.

Table 8

Results of the Test About the Normal Distribution of Residuals

Component	Skewness	Chi-square	Degree of freedom	Probability
1	–0.561471	4.308411	1	0.0379
Joint		4.308411	1	0.0379
Component	Kurtosis	Chi-square	Degree of freedom	Probability
1	3.636040	1.382203	1	0.2397
Joint		1.382203	1	0.2397
Component	Jarque-Bera		Degree of freedom	Probability
1	5.690614		2	0.0581
Joint	5.690614		2	0.0581

Source: Prepared by the author in the Eviews.

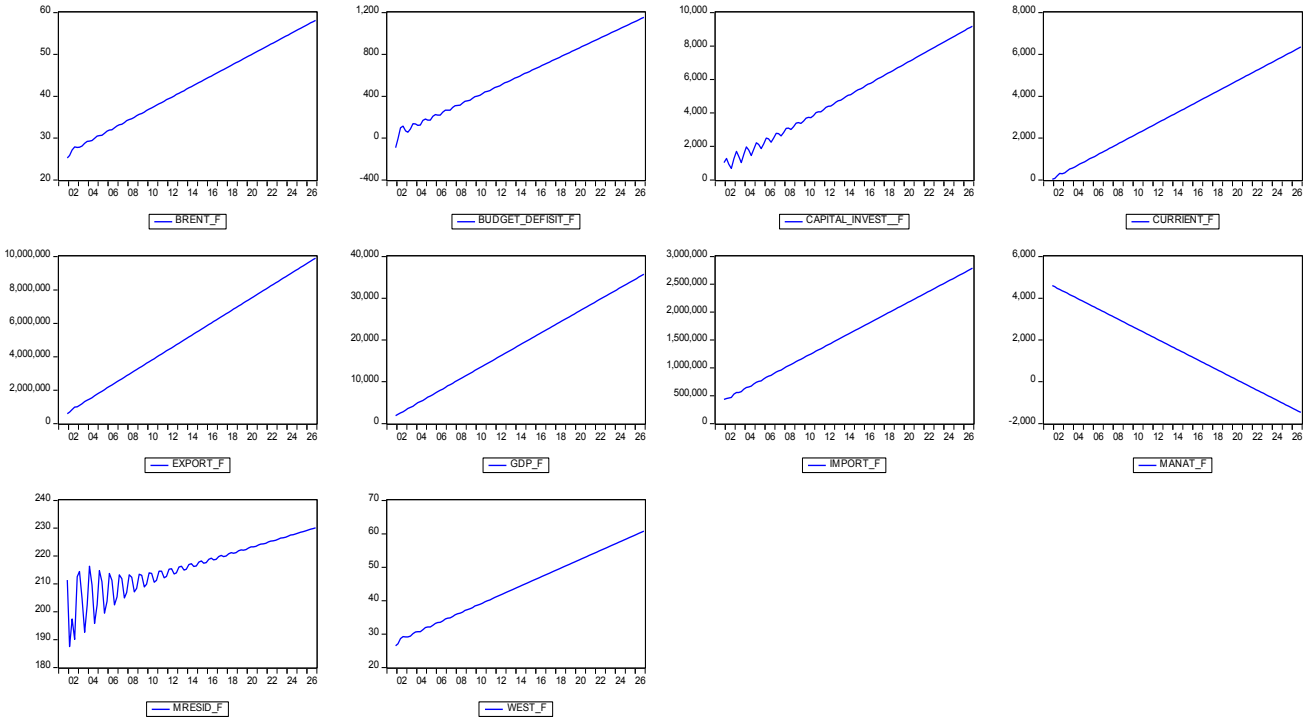

Fig. 9. **Predicted Values of the Studied Variables According to the Error Correction Model**
Source: Prepared by the author in the EViews program.

As seen from the results in *Table 8*, in the distribution of residuals, the skewness is close to zero and negative, which means that the observed asymmetry of the residuals is insignificant, minimal, and left-sided. The kurtosis slightly exceeds the value of 3; the peaked distribution is also insignificant. For both characteristics, the distribution can be considered normal. According to the *Jarque-Bera* test, the distribution is also standard. *JB* = 5.69061, with *prob.* = = 0.0581 > 0.05, indicates the normal distribution of the residuals. The hypothesis of a normal distribution of model residuals was accepted.

Thus, the quality of the presented error correction model (2) is justified by the test results and makes it possible to analyze and predict the dynamics (see *Fig. 9*) of foreign economic activity of the Azerbaijani economy within the framework of the current account of the balance of payments.

CONCLUSIONS AND RECOMMENDATION

The results of the study allow:

- to determine the reasons for the deterioration of the balance of payments, the development and evaluation of measures to regulate it; study of the links between foreign trade and investment; analyze the problems of exchange rates and foreign trade operations, which are reflected in the current account of the balance of payments;
- quantitatively assessed the parameters of stable relationships between the leading indicators of the balance of payments with the most important macroeconomic indicators of the national economy, with indicators of foreign trade relations, with world indicators for the oil, and with other indicators that can be used to assess the impact of foreign economic activity on the development of the national economy within the current account of the balance of payments;
- as a result of the procedures, the short-term and long-term equilibrium relationship between the variables can be considered stable. This is justified by recoverable stability after short-term disturbances from shock reactions;
- the constructed model of error correction (2) makes it possible to quantify the characteristics of the studied indicators and the links between them in the short and long term, to evaluate the prospective dynamics of the indicators, to measure both deviations from the equilibrium state and the rate of equilibrium recovery, to describe and predict the payment indicators with a sufficiently high accuracy balance in the short and long term;
- the results of the study can be used in the analysis of the dynamics, development and assessment of the future period of the balance of payments in Azerbaijan and in econometric studies of the balance of payments in post-Soviet countries.

REFERENCES

1. Chernyak O., Khomiak V., Chernyak Y. The main triggers of the balance of payment crisis in the Eastern Europe. *Procedia Technology*. 2013;8:47–50. DOI: 10.1016/j.protcy.2013.11.008
2. Wilson P. Exchange rates and the trade balance for dynamic Asian economies — does the J-curve exist for Singapore, Malaysia, and Korea? *Open Economies Review*. 2011;12(4):389–413. DOI: 10.1023/A:1017982901034
3. Suvorov N.V., Treshchina S.V. and Beletsky Yu.V. A study of the connection between intertemporal changes in consolidated macroeconomic indicators and the performance of individual industries in Russia's economy. *Studies on Russian Economic Development.* 2021;32(6):31–42. DOI: 10.1134/S 1075700721060150 (In Russ.: *Problemy prognozirovaniya.* 2021;(6):31–42. DOI: 10.47711/0868-6351-189-31-42).
4. Ybrayev Z. Balance-of-payments-constrained growth model: An application to the Kazakhstan's economy. *Eurasian Economic Review*. 2022;12(4):745–767. DOI: 10.1007/s40822-022-00217-5
5. Bilal Raza. Balance of payments constrained growth in Pakistan — implications for development policy. SBP Working Paper Series. 2021;(107).
6. Efendiyev M. Revenues from oil and gas exports in Azerbaijan equalized. Haqqin.az News Agency. URL: https://haqqin.az/news/249808 (accessed on 14.06.2023). (In Russ.).
7. Kantorovich G.G. Time series analysis. *Ekonomicheskii zhurnal Vysshei shkoly ekonomiki = HSE Economic Journal.* 2002;6(2):251–273. URL: https://cyberleninka.ru/article/n/lektsii-analiz-vremennyh-ryadov (In Russ.).
8. Johansen S. Statistical analysis of cointegration vectors. *Journal of Economic Dynamics and Control*. 1988;12(2–3):231–254. DOI: 10.1016/0165–1889(88)90041–3
9. Orudzhev E.G., Ayyubova N.S. Empirical analysis of the factors affecting the balance of payments in Azerbaijan. Actual Problems of Economics. 2016;(7):400–410. URL: https://www.researchgate.net/publication/345308676_EMPIRICESKIJ_ANALIZ_FAKTOROV_VLIANIA_NA_PLATEZNYJ_BALANS_V_AZERBAJDZANE (In Russ.).
10. Ayyubova N.S. On the measurement of cointegration relations between the indicators of the time series of the current account of the balance of payments and GDP (on the example of the Republic of Azerbaijan). Voprosy statistiki. 2022;29(5):35–45. (In Russ.). DOI: 10.34023/2313-6383-2022-29-5-35-45
11. Ayyubova N.S. Econometric analysis and modeling of the dynamics of the balance of payments' development in Azerbaijan. *Statistika i Ekonomika = Statistics and Economics*. 2022;19(2):14–22. DOI: 10.21686/2500–3925–2022–2–14–22
12. Ayyubova N.S. Analysis of the impact of global oil prices on GDP (on the example of the Azerbaijan Republic). *Statistika i Ekonomika = Statistics and Economics*. 2023;20(2):22–41. DOI: 10.21686/2500-3925-2023-2-21-40
13. Ayyubova N.S. Analysis of cointegration relationships between Azerbaijan's balance of payments and world oil prices. *Finance: Theory and Practice*. 2025;29(1):68–79. DOI: 10.26794/2587–5671–2025–29–1–68–79
14. Orudzhev E., Mammadova L. Prediction of EUR/AZN exchange rate dynamics on the basis of spectral characteristics. *Journal of International Studies.* 2020;13(2);242–258. DOI: 10.14254/2071–8330.2020/13–2/17
15. Patel R., Mohapatra D.R., Yadav S.K. Analysis of FDI determinants using autoregressive distributive lag model: Evidence from India. *Finance: Theory and Practice*. 2024;28(3):144–156. DOI: 10.26794/2587–5671–2024–28–3–144–156
16. An J., Mikhaylov A. Yu., Yousif N.B. Financial and investment model for social security and sustainable economic growth. *Finance: Theory and Practice*. 2024;28(5):133–145. DOI: 10.26794/2587-5671-2024-28-5-133-145
17. Babeshko L.O., Byvshev V.A. Analysis of the stability of the model for forecasting mutual volumes Russia's trade with BRICS partners. *Finance: Theory and Practice.* 2025;29(4):129–145. DOI: 10.26794/2587-5671-2025-29-4-1902-01
18. Mackinnon J.G. Approximate asymptotic distribution functions for unit-root and cointegration tests. *Journal of Business & Economic Statistics*. 1994;12(2):167–176. DOI: 10.2307/1391481
19. Perron P. Further evidence on breaking trend functions in macroeconomic variables. *Journal of Econometrics*. 1997;80(2):355–385. DOI: 10.1016/S 0304-4076(97)00049-3
20. Dickey D.A., Fuller W.A. Distribution of estimators for autoregressive time series with a unit root. *Journal of the American Statistical Association*. 1979;74(366a):427–431. DOI: 10.1080/01621459.1979.10482531
21. Johansen S., Juselius K. Maximum likelihood estimation and inference on cointegration — with applications to the demand for money. *Oxford Bulletin of Economics and Statistics*.1990;52(2):169–210. DOI: 10.1111/j.1468–0084.1990.mp52002003.x

22. Engle R.F., Yoo B.S. Cointegrated economic time series: An overview with new results. In: Engle R.F., Granger C.W.J., eds. Long-run economic relationships: Readings in cointegration. Oxford: Oxford University Press; 1991:237–266. DOI: 10.1093/oso/9780198283393.003.0012
23. Granger C.W.J. Investigating causal relations by econometric models and cross-spectral methods. *Econometrica*. 1969;37(3):424–438. DOI: 10.2307/1912791

ABOUT THE AUTHOR / ИНФОРМАЦИЯ ОБ АВТОРЕ

Natavan S. Ayyubova — Cand. Sci. (Econ.), Assoc. Prof., Department of Mathematical Economics, Baku State University, Baku, Azerbaijan
Натаван Солтан кызы Айюбова — кандидат экономических наук, доцент кафедры математической экономики, Бакинский государственный университет, Баку, Азербайджан
https://orcid.org/0000-0003-3225-389X
nayyubova50@gmail.com

Conflicts of interest statement: the author has no conflicts of interest to declare.
Конфликт интересов: автор заявляет об отсутствии конфликта интересов.

The article was submitted on 20.09.2023; revised on 20.10.2023 and accepted for publication on 27.10.2025.
The author read and approved the final version of the manuscript.
Статья поступила в редакцию 20.09.2023; после рецензирования 20.10.2023; принята к публикации 27.10.2023.
Автор прочитала и одобрила окончательный вариант рукописи.

Переводчик В.И. Тимонина