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Коинтеграционный анализ торгово-экономического сотрудничества между Россией и Азербайджаном в условиях санкций

Цель исследования. *Цель исследования – анализ динамики развития торгово-экономических отношений между Азербайджанской Республикой и Российской Федерацией в условиях санкций с применением эконометрических методов. Это включает построение эконометрической модели взаимосвязи ключевых макроэкономических показателей, таких как ВВП на душу населения обеих стран, численность экономически активного населения и товарооборот между двумя странами, в рамках эмпирического исследования, охватывающего период с 1992 по 2023 год.*

Материалы и методы. *Для оценки динамики экономических отношений использованы эконометрические методы. В исследовании проведена статистическая обработка исходных данных, построена формальная регрессионная модель, выполнен анализ причинности Грейнджера и применен метод коинтеграции Йохансена-Грейнджера. В результате была реализована модель коррекции ошибок, которая показала статистическую значимость. Все расчёты выполнены в программном обеспечении EViews 12. Для проверки корректности модели и достоверности полученных результатов проведён ряд диагностических тестов.*

Результаты. *Результаты исследования показывают, что товарооборот между Азербайджаном и Россией находится в состоянии долгосрочного равновесия, а между экономическими показателями наблюдаются взаимные влияния. Модель построена с учётом последствий санкций, введённых против России западными странами и США в 2014 году, а также их ужесточения в 2022 году. Влияние различных факторов на товарооборот анализировалось с использованием модифицированной базы гравитационной модели. Была изучена реакция итоговых переменных на изменения причинных факторов, а также получена годовая декомпозиция дисперсии остаточных значений. Проведен анализ статистически значимой коинтеграционной зависимости и определена степень отклонения от равновесной траектории.*

Заключение. *Установлено, что санкции, введённые в 2014 году, не оказали значительного влияния на товарооборот, в то время как санкции 2022 года оказали положительный эффект. Это можно объяснить тем, что Россия разработала новые экономические стратегии и укрепила сотрудничество с партнёрами, такими как Азербайджан. Учитывая неопределённость санкционной политики и международной экономической среды, для поддержания торговых отношений между Азербайджаном и Россией необходимо внедрять новые экономические стратегии. Эти стратегии должны быть направлены на укрепление долгосрочного экономического партнёрства и взаимных инвестиций.*

Ключевые слова: *товарооборот; ВВП; санкции; коинтеграция; тест причинности Грейнджера; модель коррекции ошибок.*

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Cointegration Analysis of Trade and Economic Cooperation Between Russia and Azerbaijan Under Sanction Conditions

Purpose of the study. *The purpose of the study is to analyze the development dynamics of trade and economic relations between the Republic of Azerbaijan and the Russian Federation under sanction conditions using econometric methods. This involves constructing an econometric model of the relationship between key macroeconomic indicators such as the GDP per capita of both countries, the number of economically active populations, and the trade turnover between the two countries - within the framework of an empirical study covering the years 1992 to 2023.*

Materials and methods. *Econometric methods were employed to evaluate the dynamics of economic relations. The study included statistical processing of initial data, the construction of a formal regression model, Granger causality analysis, and the application of Granger-Johansen cointegration analysis. As a result, the Error Correction Model (ECM), which demonstrated statistical significance, was implemented. All calculations were conducted using the EViews 12 software. Several diagnostic tests were performed to verify the model's correctness and the reliability of the results.*

Results. *The results indicate that the trade turnover between Azerbaijan and Russia is in a state of long-term equilibrium, and mutual influences are observed between economic indicators. The model has been constructed considering the effects of sanctions imposed against Russia by Western countries and the United States in 2014, as well as their intensification in 2022. The impact of factors on trade turnover has been analyzed using a newly modified baseline gravity model. The reaction of outcome variables to shocks in causal factors has been examined, and the yearly decomposition of the variance of residuals has been obtained. A statistically significant cointegration relationship has been analyzed, and the extent of deviations from the equilibrium trajectory has been determined.*

Conclusion. *It has been determined that the sanctions imposed in 2014 did not significantly impact trade turnover, whereas the sanctions imposed in 2022 had a positive effect. This can be explained by Russia developing new economic strategies and strengthening its cooperation with partner countries such as Azerbaijan. Considering the uncertainty of sanctions and the international economic environment, new economic strategies should be implemented to sustain trade relations between Azerbaijan and Russia. These strategies should aim to enhance long-term economic partnerships and mutual investments.*

Keywords: *Trade turnover; GDP; sanctions; cointegration; Granger causality test; Error Correction Model (ECM).*

Introduction

Trade relations between the Republic of Azerbaijan and the Russian Federation have been steadily developing over the years and hold strategic importance for both countries. The geographical proximity, historical ties, and mutual interests between the two nations have been key factors in shaping these relations. Russia, as a significant trading partner for Azerbaijan, collaborates in sectors such as energy, agriculture, metallurgy, and other product categories. Azerbaijan, in turn, has been making efforts to diversify its export markets and increase the export of agricultural and non-oil products to Russia. In recent years, geopolitical changes on the international stage, particularly the sanctions imposed on Russia, have had direct and indirect impacts on the trade relations between the two countries. While the economic sanctions imposed by Europe and the United States on Russia have created restrictions in sectors such as banking, energy, technology, and transportation, Azerbaijan has pursued a balanced and pragmatic foreign policy during this period. This approach has allowed Azerbaijan to maintain its trade position while continuing its trade relations with Russia. Due to the sanctions, Russia has been compelled to diversify its trade routes and partners. Within this context, Azerbaijan has emerged as an essential transit country and alternative market for Russia's export and import activities. However, this process has not only created new opportunities but also introduced certain economic and trade risks. Trade restrictions, currency exchange rate fluctuations, and restrictions on banking operations have affected Azerbaijan's trade turnover. The primary purpose of this article is to evaluate the impact of international sanctions imposed on Russia on Azerbaijan-Russia trade relations and to assess the short-term and long-term implications of these effects. This topic is highly relevant in the context of on going geopolitical uncertainties.

Review of literature

In this aspect, the published scientific articles cover the development of trade-economic relations between Azerbaijan and Russia, the economic effects of sanctions, and analyses conducted using econometric methods. Research indicates that trade turnover between Azerbaijan and Russia is closely related to indicators such as GDP and the economically active population. In study [1], cointegration methods were used to examine the relationship between the trade turnover of Azerbaijan and Ukraine and their GDPs. However, other economic growth factors were not included in this analysis. Similarly, in study [2], the trade relations between Azerbaijan and Turkey were investigated, focusing on the long-term stability of these relations. However, other economic growth factors were also not considered in this study. In study [3], the economic relations between the GDPs of Azerbaijan, Russia, Belarus, and Kazakhstan were explored, and their mutual influences were evaluated. Nevertheless, this study did not conduct an empirical analysis of trade turnover between these countries in connection with their key macroeconomic indicators, nor did it consider the sanctions imposed on Russia.

The impact of sanctions on the Russian economy has been extensively studied in numerous research works. In studies [4] and [5], the long-term changes in AZN/RUB and USD/RUB exchange rates in the context of sanctions against Russia were evaluated, and cointegration relationships among the exchange rates were examined. In study [6], trade relations between Russia and certain Eastern and Southeast countries were predicted using a gravity model constructed considering the sanctions imposed on Russia, along with an analysis of the future development of these relations. However, the statistical validity of the model was not substantiated. Since the mentioned factors are non-stationary, their cointegration dependence should have been analyzed, but this issue was not explored. In study [7], the equilibrium state of long-term co-movement between the GDP growth rates of Azerbaijan and Ukraine was examined using the ARDL model, but other factors were not considered. Study [8] investigated the dependence of Azerbaijan's export volume to Ukraine on Ukraine's economic openness, per capita GDP, and Azerbaijan's economically active population. Study [9] assessed the impact of sanctions on trade turnover between the European Union and Russia during 2015–2019, revealing that Russia loses, on average, 2.5% of its GDP annually as export revenues due to sanctions. The econometric model used in this study considered the nominal GDP values, annual average exchange rate changes of the Russian ruble relative to the currencies of EU countries and the inflation levels in these countries. However, the econometric modeling of the relationship between trade turnover, per capita GDP and economically active population was not addressed. In study [10], an error correction model was developed to evaluate the relationship between the real exchange rate of the Russian ruble and oil prices with time-varying parameters. However, the issues intended to be addressed in our research were not reflected here. Study [11] examined the impact of financial sanctions on the Russian economy, analyzing the challenges created by sanctions on capital flows, financial market stability, and the banking sector's resilience. Study [12] analyzed the effects of 2022 sanctions on the Russian economy and provided recommendations for mitigating the potential negative impacts of these sanctions. Study [13] assessed the overall potential cargo flows of the North-South Transport Corridor, but econometric

analysis between relevant factors was not conducted. Study [14] investigated the development of cross-border economic cooperation between Russia and Kazakhstan and the role of regions in this process. The author emphasized the strategic importance of border regions in trade, transportation, and industrial cooperation. The study analyzed the dynamics of cross-border trade, the intensity of economic relations, and the key factors affecting trade turnover between Russia and Kazakhstan. It also examined the impact of infrastructure projects, customs procedures, and economic policies on cross-border trade. Study [15] explored the key problems and risks posed by sanctions, as well as potential opportunities to mitigate their effects on the economy. The article evaluated the implications of sanctions across various sectors and proposed possible solutions for Russia's long-term economic strategy. We would like to specifically highlight the [16] study, which evaluates the development trends of the Russian economy under the impact of sanctions and conducts a quantitative analysis to ensure global competitiveness.

Purpose and methodology of the study

The purpose of the study is to conduct a cointegration analysis of the determinants of trade relations between the Republic of Azerbaijan and the Russian Federation, including the GDP per capita of both countries (LN_GDP_RUS_PER_CAPITA, LN_GDP_AZE_PER_CAPITA), the economically active population (LN_EC_POP_RUS, LN_EC_POP_AZE), and trade turnover (TRADE_TURNOVER_RUS) under sanction conditions. It is assumed that sanctions imposed against Russia directly influence inflation, interest rates, and exchange rate fluctuations of the Russian ruble relative to major global currencies, thereby indirectly affecting the aforementioned indicators.

To achieve the objective, a cointegration analysis was conducted and an ECM model was constructed using a newly modified version of the gravity model [17], along with multivariate statistical analysis, multivariate regression approaches [18], [19], [20], and appropriate statistical tests applied correctly.

All time series under investigation, except for the TRADE_TURNOVER_RUS variable, will be transformed into logarithms. This transformation allows for a clearer representation of the relationships between the analyzed indicators. The research used statistical data obtained from the official websites of the State Statistical Committee of the Republic of Azerbaijan and the World Bank [21], [22].

The descriptive statistics and dynamic changes of the variables during the years are presented in Figure 1 and Table 1.

In this study, to analyze the dependency of the Russian Federation's trade turnover per capita, the GDP per capita of both the Republic of Azerbaijan

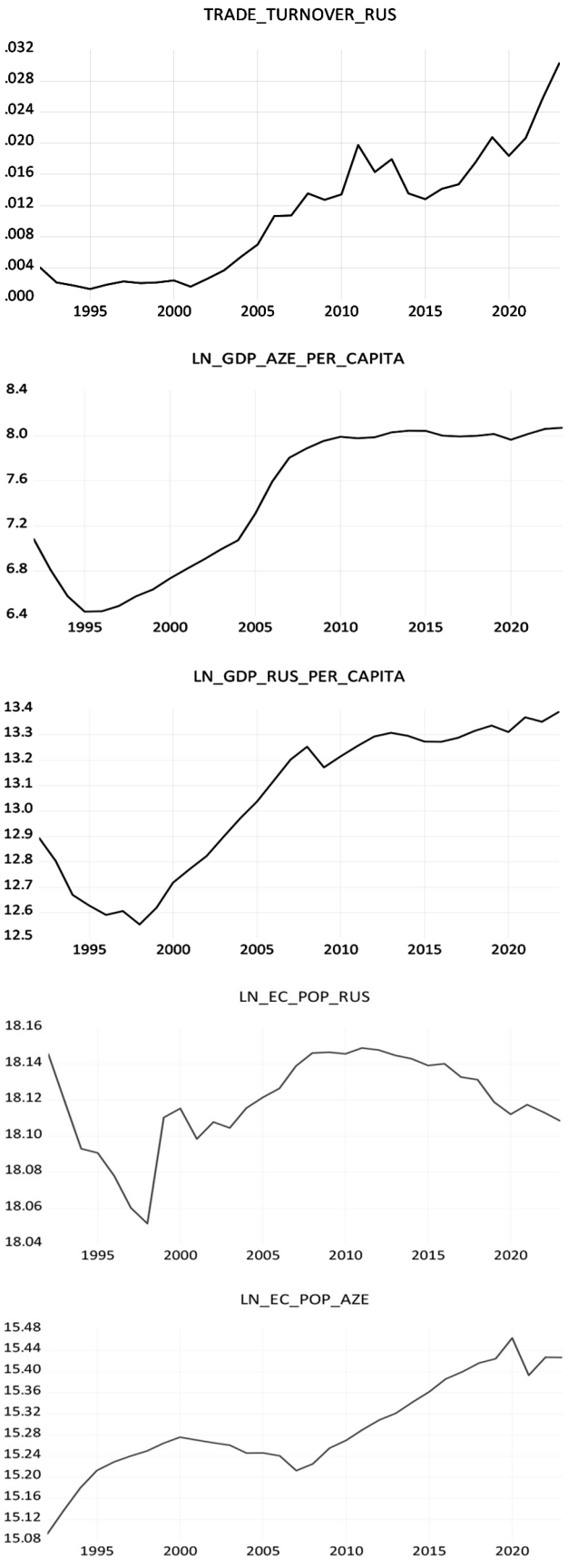

Рисунок 1. Динамическое описание данных
Figure 1. Dynamic description of the data

Источник: График создан автором в программе EViews
Source*:* The graph was created by the author in the EViews software

Таблица 1 / Table 1

Описательная статистика данных

Descriptive statistics of the data

	TRADE_ TURNOVER_RUS	LN_GDP_RUS_ PER_CAPITA	LN_GDP_AZE_ PER_CAPITA	LN_EC_POP_RUS	LN_EC_POP_AZE
Mean	0.010743	13.04994	7.447668	18.11918	15.29160
Median	0.011729	13.18691	7.845828	18.11913	15.26734
Maximum	0.030306	13.38943	8.072227	18.14891	15.46377
Minimum	0.001271	12.55317	6.437912	18.05154	15.09243
Std. Dev.	0.008114	0.286460	0.631853	0.025240	0.090240
Skewness	0.457500	-0.477951	-0.414568	-0.927614	0.125449
Kurtosis	2.291090	1.635053	1.435242	3.458283	2.465929
Jarque-Bera	1.786370	3.702437	4.181245	4.869196	0.464242
Probability	0.409350	0.157046	0.123610	0.087633	0.792850
Sum	0.343791	417.5982	238.3254	579.8138	489.3310
Sum Sq. Dev.	0.002041	2.543848	12.37637	0.019749	0.252439
Observations	32	32	32	32	32

and the Russian Federation, and the economically active population of both countries on the natural logarithms of these variables – and taking into account the natural logarithm of the residuals – we have selected the following multifactor specification for the multivariate regression model:

$$y_t = \alpha_{00} + \alpha_1 lnx_{t1} + \alpha_2 lnx_{t2} + \alpha_3 lnx_{t3} + \alpha_4 lnx_{t4} + ln\varepsilon_t,$$
$$t = \overline{1,25}, \quad (1)$$

let y_t, x_{t1}, x_{t2}, x_{t3}, and x_{t4} – denote the respective variables. The specification includes a parameter defined as $\alpha_{00} = \ln\alpha_0 + \alpha_4 \ln d$, where α_1, α_2, α_3 – are the unknown parameters of the model; ε_t – is the residual term, which captures the aggregate impact of all factors omitted from the model as well as measurement errors. The logarithm of ε_t is assumed to be normally distributed with zero mean and constant variance. Specifically, it is assumed that, $V_t = \ln \varepsilon_t \sim N(0, \sigma^2)$. ε_t – is normally distributed with: $M(\varepsilon_t) = e^{\frac{\sigma^2}{2}}$, $D(\varepsilon_t) = e^{\sigma^2}\left(e^{\sigma^2} - 1\right)$. Using the Ordinary Least Squares (OLS) method, the multivariate regression model was implemented in the EViews 12 software package. The resulting estimates and diagnostic measures are presented in Table 2. Table 2. Multivariate Regression Model

The Semi-logarithmic model based on Table 2 is as Follows:

Таблица 2 / Table 2

Многомерная регрессионная модель

Multivariate Regression Model

Dependent Variable: TRADE_TURNOVER_RUS				
Method: Least Squares				
Sample: 1992 2023				
Included observations: 32				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
LN_GDP_RUS_PER_CAPITA	0.017725	0.011156	1.588739	0.1252
LN_GDP_AZE_PER_CAPITA	0.006521	0.004375	1.490756	0.1491
LN_EC_POP_RUS	-0.069605	0.037911	-1.836026	0.0788
LN_EC_POP_AZE	0.027659	0.028123	0.983495	0.3352
DUMMY_V_1	-0.002254	0.001652	-1.364181	0.1852
DUMMY_V_2	0.009137	0.002002	4.563056	0.0001
@TREND	-0.000253	0.000502	-0.503792	0.6190
C	0.573162	0.698317	0.820776	0.4199
R-squared	0.949178	Mean dependent var		0.010743
Adjusted R-squared	0.934355	S.D. dependent var		0.008114
S.E. of regression	0.002079	Akaike info criterion		-9.301604
Sum squared resid	0.000104	Schwarz criterion		-8.935170
Log likelihood	156.8257	Hannan-Quinn criter.		-9.180141
F-statistic	64.03369	Durbin-Watson stat		1.562212
Prob(F-statistic)	0.000000			

$$TRADE\_TURNOVER\_RUS = 0.0177246305 * LN\_GDP\_RUS\_PER\_CAPITA + 0.00652147226 * LN\_GDP\_AZE\_PER\_CAPITA - 0.0696050597 * LN\_EC\_POP\_RUS + + 0.0276588014 * LN\_EC\_POP\_AZE + 0.00913724982 * DUMMY\_V\_2 - 0.0022536207 * DUMMY\_V\_1 - - 0.000252947624 * @TREND + 0.57316160. \quad (2)$$

This model characterizes how the relative change in independent factors influences the absolute change in the dependent variable's value. 1% increase in the independent variables x_{t1}, x_{t2}, and x_{t4} results in an increase in the average value of the dependent variable, in its respective unit of measurement, by approximately 0,01 * α_1, 0,01 * α_2, and 0,01 * α_4 assuming positive coefficients for these factors. In contrast, the effect of the factor, x_{t3} leads to a decrease in the value of the dependent variable by approximately 0,01 * α_3. As observed from the results obtained in Table 2, the overall formal model demonstrates high accuracy, with a coefficient of determination (R-squared) of 94%. The F-statistic (64.03369) and P.(F-statistic) = 0.000000 indicate that the model is statistically significant overall. The 2022 sanctions (DUMMY_V_2) had a positive impact on trade turnover. This is associated with the discovery of new trade routes and the implementation of alternative economic strategies to circumvent these sanctions. On the other hand, the slight negative effect of the 2014 sanctions (DUMMY_V_1) is not statistically significant, which suggests that no substantial changes in trade turnover occurred during that period. The reduction in Russia's economically active population negatively affects trade turnover, likely due to a decline in the labor market and consumption potential. The long-term trend is not statistically significant. It should be noted that when aligning the DUMMY_V_1 variable for 2014 with LN_GDP_RUS_PER_CAPITA, the estimate was -0.00016, with a probability (P.) of 0.1901. Therefore, preference was given to Model (2).

A correlation matrix was constructed using the EViews 12 software package, and the dependencies among factors were identified in Table 3. The intensity of the relationships between factors was qualitatively interpreted using the Cheddock scale.

A strong positive correlation (0.908605) is observed between TRADE_TURNOVER_RUS and LN_GDP_RUS_PER_CAPITA, indicating that as Russia's GDP per capita increases, trade turnover also rises. This result is expected, as economic growth generally boosts trade volume.

A similarly strong positive correlation (0.8956) is observed between TRADE_TURNOVER_RUS and LN_GDP_AZE_PER_CAPITA, suggesting a very strong relationship between Azerbaijan's GDP per capita and trade turnover. This shows that Azerbaijan's economic growth significantly impacts its trade volume with Russia.

An average level correlation (0.4801) exists between TRADE_TURNOVER_RUS and LN_EC_POP_RUS. While trade turnover moderately

Таблица 3 / Table 3

Корреляционная матрица в соответствии с моделью множественной регрессии

Correlation matrix according to the multiple regression model

	TRADE_TURNOVER_RUS	LN_GDP_RUS_PER_CAPITA	LN_GDP_AZE_PER_CAPITA	LN_EC_POP_RUS	LN_EC_POP_AZE
TRADE_TURNOVER_RUS	1.000000				
LN_GDP_RUS_PER_CAPITA	0.908605	1.000000			
LN_GDP_AZE_PER_CAPITA	0.895570	0.987332	1.000000		
LN_EC_POP_RUS	0.480114	0.724650	0.743038	1.000000	
LN_EC_POP_AZE	0.768049	0.674834	0.662891	0.137865	1.000000

Таблица 4 / Table 4

Тест Дикки-Фуллера

Dickey-Fuller test

Variable	T-statistic	Critical values: 1%	Critical values: 5%	Critical values: 10%	Prob
First difference, intercept					
TRADE_TURNOVER_RUS	-5.428892	-3.670170	-2.963972	-2.621007	0.0001
LN_GDP_RUS_PER_CAPITA	-3.460385	-3.670170	-2.963972	-2.621007	0.0165
LN_GDP_AZE_PER_CAPITA	-3.155901	-3.670170	-2.963972	-2.621007	0.0330
LN_EC_POP_RUS	-2.996182	-3.711457	-2.981038	-2.629906	0.0485
LN_EC_POP_AZE	-5.577819	-3.670170	-2.963972	-2.621007	0.0001
First difference, trend and constant					
TRADE_TURNOVER_RUS	-5.800865	-4.296729	-3.568379	-3.218382	0.0003
LN_GDP_RUS_PER_CAPITA	-3.350385	-4.296729	-3.568379	-3.218382	0.0776
LN_GDP_AZE_PER_CAPITA	-2.953105	-4.296729	-3.568379	-3.218382	0.1613
LN_EC_POP_RUS	-4.682629	-4.309824	-3.574244	-3.221728	0.0042
LN_EC_POP_AZE	-5.513282	-4.296729	-3.568379	-3.218382	0.0005

increases with the growth of Russia's economically active population, the relationship is not very strong. This may indicate that the growth of Russia's population does not directly impact trade.

A moderate correlation (0.7680) is also found between TRADE_TURNOVER_RUS and LN_EC_POP_AZE, demonstrating a positive but not very strong relationship between Azerbaijan's economically active population and trade turnover. This indicates that the growth of Azerbaijan's economically active population has a certain impact on trade.

A strong positive correlation (0.9873) is found between LN_GDP_RUS_PER_CAPITA and LN_GDP_AZE_PER_CAPITA, showing that Russia and Azerbaijan's GDP per capita are highly synchronized, reflecting the strong economic interdependence between the two countries.

Lastly, a weak correlation (0.1378) is observed between LN_EC_POP_RUS and LN_EC_POP_AZE, indicating almost no connection between the economically active populations of the two countries. This may suggest that the growth rates of the populations and labor markets are shaped by different factors.

The stationarity of time series was tested using the Augmented Dickey-Fuller test in the EViews 12 software package, and the corresponding results are presented in Table 4.

The results indicate that the first-order differences of the time series are stationary under constant, trend, and constant with trend conditions.

The Granger Causality test has revealed the presence of one-way and two-way relationships at 5% and 10% significance levels for lags $m = 1, 2, 3, 4$. A one-way relationship exists between the

Таблица 5 / Table 5

Результаты коинтеграционного теста Йохансена

The results of the Johansen cointegration test

Sample: 1992 2023					
Included observations: 30					
Series:TRADE_TURNOVER_RUS LN_GDP_RUS_PER_CAPITA LN_GDP_AZE_PER_CAPITA LN_EC_POP_RUS LN_EC_POP_AZE					
Lags interval: 1 to 1					
Selected (0.1 level*) Number of Cointegrating Relations by Model					
Data Trend:	None	None	Linear	Linear	Quadratic
Test Type	No Intercept	Intercept	Intercept	Intercept	Intercept
	No Trend	No Trend	No Trend	Trend	Trend
Trace	1	3	1	1	1
Max-Eig	1	3	1	1	1
Information Criteria by Rank and Model					
Data Trend:	None	None	Linear	Linear	Quadratic
Rank or	No Intercept	Intercept	Intercept	Intercept	Intercept
No. of CEs	No Trend	No Trend	No Trend	Trend	Trend
Log Likelihood by Rank (rows) and Model (columns)					
0	415.1732	415.1732	430.5196	430.5196	434.6519
1	432.8561	436.1451	449.3381	451.6121	455.3866
2	443.5124	451.6188	460.8652	463.1407	466.6883
3	447.9062	462.1481	465.0783	471.6062	474.7333
4	450.5264	466.3536	468.6186	475.8029	478.9291
5	450.5320	468.8940	468.8940	478.9903	478.9903
Akaike Information Criteria by Rank (rows) and Model (columns)					
0	-26.01155	-26.01155	-26.70131	-26.70131	-26.64346
1	-26.52374	-26.67634	-27.28921	-27.37414	-27.35911
2	-26.56749	-26.97459	-27.39101	-27.40938	-27.44588*
3	-26.19375	-26.94321	-27.00522	-27.24041	-27.31556
4	-25.70176	-26.49024	-26.57457	-26.78686	-26.92861
5	-25.03547	-25.92626	-25.92626	-26.26602	-26.26602
Schwarz Criteria by Rank (rows) and Model (columns)					
0	-24.84388	-24.84388	-25.30011	-25.30011	-25.00873
1	-24.88901	-24.99491	-25.42094	-25.45917*	-25.25731
2	-24.46570	-24.77938	-25.05569	-24.98063	-24.87702
3	-23.62488	-24.23423	-24.20282	-24.29790	-24.27963
4	-22.66584	-23.26749	-23.30511	-23.33057	-23.42561
5	-21.53247	-22.18974	-22.18974	-22.29596	-22.29596

variables TRADE_TURNOVER_RUS and LN_EC_POP_AZE at lag $m = 1$ (p. = 0.0506), $m = 3$ (p. = 0.0672), and $m = 4$ (p. = 0.0602) at the 10% significance level. A two-way relationship is identified between LN_GDP_AZE_PER_CAPITA and LN_GDP_RUS_PER_CAPITA at lag $m = 2$ (p. = 0.0138) at the 5% significance level, and at lag $m = 2$ (p. = 0.0766) at the 10% significance level. A one-way relationship is observed between LN_EC_POP_RUS and LN_GDP_RUS_PER_CAPITA at lag $m = 2$ (p. = 0.0901) at the 10% significance level. These findings underline the interactive dynamics between the economic indicators of Azerbaijan and Russia, with varying degrees of influence reflected across different variables and time lags. A two-way relationship has been identified between LN_EC_POP_AZE and LN_GDP_RUS_PER_CAPITA at lag $m = 1$ (p. = 0.0414) and $m = 2$ (p. = 0.0422) at the 5% significance level. A one-way relationship is present between LN_GDP_AZE_PER_CAPITA and LN_EC_POP_RUS at lag $m = 1$ (p. = 0.0461), $m = 2$ (p. = 0.0214), $m = 3$ (p. = 0.0195), and $m = 4$ (p. = 0.0207) at the 5% significance level. Additionally, a one-way relationship is observed between LN_GDP_AZE_PER_CAPITA and LN_EC_POP_AZE at lag $m = 2$ (p. = 0.0026) and $m = 3$ (p. = 0.0400) at the 5% significance level, as well as at lag $m = 4$ (p. = 0.0842) at the 10% significance level.

The results of the Granger Causality test indicate that economic indicators between Azerbaijan and Russia are mutually influential, linked to various fundamental factors. Specifically, the relationships among trade turnover, economically active population, and GDP significantly affect the economic development and labor markets of both countries. The presence of two-way relationships underscores economic integration and interdependence.

The observed connection between the GDP indicators of Azerbaijan and Russia demonstrates that the macroeconomic conditions of these countries influence each other. Simultaneously, the existing relationships between employment levels and economic growth confirm that domestic labor markets and income levels move in synchronization with overall economic development.The results of the Johansen cointegration test are presented in Table 5.

Based on the results of the Johansen cointegration test, the trade turnover between Azerbaijan and Russia is in a long-term equilibrium. That is, although short-term fluctuations are observed, trade turnover remains stable in the long term and is restored under the influence of economic indicators. The equations of the VECM (Vector Error Correction Model) are expressed as follows:

$$D(TRADE\_TURNOVER\_RUS) = -0.328227654 * (TRADE\_TURNOVER\_RUS(-1) - 0.0341215073 * LN\_GDP\_RUS\_PER\_CAPITA(-1) - 0.0268817609 * LN\_GDP\_AZE\_PER\_CAPITA(-1) + 0.364368879 * LN\_EC\_POP\_RUS(-1) - 0.0559787631 * LN\_EC\_POP\_AZE(-1) + 0.00186915815 * @TREND(92) - 5.14186076) - 0.255427278 * D(TRADE\_TURNOVER\_RUS(-1)) + 0.0207044592 * D(LN\_GDP\_RUS\_PER\_CAPITA(-1)) - 0.00398607882 * D(LN\_GDP\_AZE\_PER\_CAPITA(-1)) + 0.0425252169 * D(LN\_EC\_POP\_RUS(-1)) + 0.024897510 * D(LN\_EC\_POP\_AZE(-1)) + 0.00051307307 - 0.00099416405 * DUMMY\_V\_1 + 0.00787045454 * DUMMY\_V\_2, \quad (3)$$

$$D(LN\_GDP\_RUS\_PER\_CAPITA) = 4.17604912 * (TRADE\_TURNOVER\_RUS(-1) - 0.0341215073 * LN\_GDP\_RUS\_PER\_CAPITA(-1) - 0.0268817609 * LN\_GDP\_AZE\_PER\_CAPITA(-1) + 0.364368879 * LN\_EC\_POP\_RUS(-1) - 0.0559787631 * LN\_EC\_POP\_AZE(-1) + 0.00186915815 * @TREND(92) - 5.14186076) - 1.76902533 * D(TRADE\_TURNOVER\_RUS(-1)) - 0.20551685 * D(LN\_GDP\_RUS\_PER\_CAPITA(-1)) + 0.39934752 * D(LN\_GDP\_AZE\_PER\_CAPITA(-1)) + 0.482382721 * D(LN\_EC\_POP\_RUS(-1)) + 0.121314898 * D(LN\_EC\_POP\_AZE(-1)) + 0.0101212310 + 0.0061725610 * DUMMY\_V\_1 - 0.0309078124 * DUMMY\_V\_2 , \quad (4)$$

$$D(LN\_GDP\_AZE\_PER\_CAPITA) = 3.56749893 * (TRADE\_TURNOVER\_RUS(-1) - 0.0341215073 * LN\_GDP\_RUS\_PER\_CAPITA(-1) -.0.0268817609 * LN\_GDP\_AZE\_PER\_CAPITA(-1) + 0.364368879 * LN\_EC\_POP\_RUS(-1) - 0.0559787631 * LN\_EC\_POP\_AZE(-1) + 0.00186915815 * @TREND(92) - 5.14186076) - 2.26095921 * D(TRADE\_TURNOVER\_RUS(-1)) + 0.00835271524 * D(LN\_GDP\_RUS\_PER\_CAPITA(-1)) + 0.701033087 * D(LN\_GDP\_AZE\_PER\_CAPITA(-1)) + 0.103077939 * D(LN\_EC\_POP\_RUS(-1)) - 0.204817742 * D(LN\_EC\_POP\_AZE(-1)) + 0.0322046699 - 0.0213107989 * DUMMY\_V\_1 - 0.0280638689 * \quad (5)$$

$$D(LN\_EC\_POP\_RUS) = -2.51975716 * (TRADE\_TURNOVER\_RUS(-1) - 0.0341215073 * LN\_GDP\_RUS\_PER\_CAPITA(-1) - 0.0268817609 * LN\_GDP\_AZE\_PER\_CAPITA(-1) + 0.364368879 * LN\_EC\_POP\_RUS(-1) - 0.0559787631 * LN\_EC\_POP\_AZE(-1) + 0.00186915815 * @TREND(92) - 5.14186076) + 0.801369895 * D(TRADE\_TURNOVER\_RUS(-1)) - 0.0758837629 * D(LN\_GDP\_RUS\_PER\_CAPITA(-1)) + 0.0362725123 * D(LN\_GDP\_AZE\_PER\_CAPITA(-1)) + 0.482195516 * D(LN\_EC\_POP\_RUS(-1)) - 0.017351066 * D(LN\_EC\_POP\_AZE(-1)) + 0.00133852345 - 0.00634530258 * DUMMY\_V\_1 + 0.0078839695 * DUMMY\_V\_2, \quad (6)$$

$$D(LN\_EC\_POP\_AZE) = 0.367623263 * (TRADE\_TURNOVER\_RUS(-1) - 0.0341215073 * LN\_GDP\_RUS\_PER\_CAPITA(-1) - 0.0268817609 * LN\_GDP\_AZE\_PER\_CAPITA(-1) + 0.364368879 * LN\_EC\_POP\_RUS(-1) - 0.0559787631 * LN\_EC\_POP\_AZE(-1) + 0.00186915815 * @TREND(92) - 5.14186076) + 2.46846588 * D(TRADE\_TURNOVER\_RUS(-1)) - 0.181658487 * D(LN\_GDP\_RUS\_PER\_CAPITA(-1)) -$$

$$0.0992721401 * D(LN\_GDP\_AZE\_PER\_CAPITA(-1)) + 0.161639478 * D(LN\_EC\_POP\_RUS(-1)) - 0.591094572 * D(LN\_EC\_POP\_AZE(-1)) + 0.0221081082 - 0.000842202657 * DUMMY\_V\_1 - 0.0174388162 * DUMMY\_V\_2 . \quad (7)$$

In this case, the statistically significant long-term cointegration dependency is as follows:

$$TRADE\_TURNOVER\_RUS(-1)_t = 0.0341215073245 * LN\_GDP\_RUS\_PER\_CAPITA(-1)_t + 0.0268817609649 * LN\_GDP\_AZE\_PER\_CAPITA(-1)_t - 0.364368879822 * LN\_EC\_POP\_RUS(-1)_t + 0.0559787631383 * LN\_EC\_POP\_AZE(-1)_t - 00186915815561 * TREND(92) + 5.14186076913. \quad (8)$$

This reflects the long-term cointegration relationship between the examined economic indicators of the two countries and ensures the tracking of their long-term mutual effects, considering the impact of sanctions.

From the established models (3)-(7), the following specific results are derived:

1. The variable TRADE_TURNOVER_RUS returns to equilibrium approximately within 3 years under the influence of shocks.

2. The correction coefficients for the variable LN_EC_POP_AZE, with respect to the factors LN_GDP_RUS_PER_CAPITA and LN_GDP_AZE_PER_CAPITA, deviate from the range [-1,0], and thus, a return to equilibrium is not ensured. In the VECM model, the return of these variables to equilibrium is not observed.

3. The variable LN_EC_POP_RUS shows unstable results. However, these findings indicate that, despite short-term fluctuations, trade turnover and economically active populations return to long-term equilibrium.

To verify the reliability and accuracy of the VECM model, several tests were conducted: The Residual Serial Correlation LM Test checks for autocorrelation in the model residuals. No issues were detected, as the p-value (0.6376) is greater than 0.05. The Residual Heteroskedasticity Test examined problems related to unequal variance, and none were identified (p-value = 0.7729 > 0.05), confirming that the residuals have constant variance. The Residual Normality Test assessed the normal distribution of residuals. The Jarque-Bera criterion yielded a value of 10.78623, with a probability of 0.3744, confirming that the residuals follow a normal distribution.

Таблица 6 / Table 6

Рассчитанные импульсные характеристики

The calculated impulse responses

Period	TRADE_ TURNOVER_RUS	LN_GDP_RUS_ PER_CAPITA	LN_GDP_AZE_ PER_CAPITA	LN_EC_POP_RUS	LN_EC_POP_AZE
1	0.002102	0.000000	0.000000	0.000000	0.000000
2	0.001527	-5.13E-06	-0.000126	-0.000310	0.000483
3	0.001878	1.54E-05	0.000599	-0.000314	-5.75E-05
4	0.001702	0.000109	0.000284	-0.000259	0.000372
5	0.001893	0.000250	0.000680	-0.000127	-8.97E-06
6	0.001713	0.000184	0.000468	-0.000174	0.000332
7	0.001868	0.000229	0.000781	-0.000173	3.44E-05
8	0.001752	0.000202	0.000598	-0.000193	0.000282
9	0.001867	0.000265	0.000801	-0.000149	6.19E-05
10	0.001769	0.000237	0.000653	-0.000163	0.000254

Таблица 7 / Table 7

Декомпозиция отклонений ошибки прогноза

Decomposition of forecast error variances

Period	S.E.	TRADE_ TURNOVER_RUS	LN_GDP_RUS_ PER_CAPITA	LN_GDP_AZE_ PER_CAPITA	LN_EC_POP_ RUS	LN_EC_POP_AZE
1	0.002102	100.0000	0.000000	0.000000	0.000000	0.000000
2	0.002664	95.13775	0.000372	0.225030	1.352698	3.284152
3	0.003329	92.72463	0.002366	3.382594	1.757831	2.132581
4	0.003779	92.26151	0.085268	3.191445	1.835150	2.626631
5	0.004290	91.05463	0.405825	4.989952	1.511191	2.038398
6	0.004662	90.61373	0.499990	5.232644	1.419485	2.234149
7	0.005091	89.45171	0.620865	6.743561	1.305871	1.877997
8	0.005431	88.98480	0.684055	7.137209	1.273629	1.920308
9	0.005807	88.17675	0.807234	8.144813	1.180055	1.691150
10	0.006118	87.81310	0.876896	8.479957	1.133983	1.696065

These results validate that the model is statistically reliable and robust.

Impulse response analysis is used to evaluate the impact of external shocks on the investigated economic variables and how this effect evolves over time. This method is employed to study the strength of the influence between variables such as trade turnover (TRADE_TURNOVER_RUS), GDP (LN_GDP_RUS_PER_CAPITA, LN_GDP_AZE_PER_CAPITA) and the economically active population (LN_EC_POP_RUS, LN_EC_POP_AZE), as well as how this influence evolves over time.

According to the results of the test: The impulse response of TRADE_TURNOVER_RUS to external economic shocks is positive in the early years (1st-3rd years), but this effect diminishes rapidly. The response reaches its lowest level in the 2nd year, partially stabilizing from the 3rd year onward. In the medium term (4th-7th years), trade turnover gradually returns to its previous equilibrium. The calculated values are shown in Table 6.

Variance Decomposition is used to determine which portion of the total variability of the analyzed economic indicators can be explained by other variables. This method is employed to study the strength of the influence between variables such as trade turnover (TRADE_TURNOVER_RUS), GDP (LN_GDP_RUS_PER_CAPITA, LN_GDP_AZE_PER_CAPITA), and the economically active population (LN_EC_POP_RUS, LN_EC_POP_AZE), as well as how this influence evolves over time. The results are presented in Table 7.

According to the results, the variance decomposition of the variable TRADE_TURNOVER_RUS indicates that in the early years (1st-3rd years), 100% of the variability in trade turnover is explained by its internal factors. The impact of other variables is minimal during this period, as trade turnover primarily stems from its own dynamics. In the medium term (4th-7th years), starting from the 4th year, Russia's and Azerbaijan's GDP indicators begin to influence trade turnover. From the 5th year onward, Azerbaijan's GDP (LN_GDP_AZE_PER_CAPITA) accounts for more than 5% of trade turnover's variability. From the 7th year, the influence of the economically active population increases, explaining more than 3% of the variability in trade turnover (LN_EC_POP_AZE and LN_EC_POP_RUS).

Conclusion

The trade turnover between Azerbaijan and Russia has shown a consistent growth trend over many years. The econometric analyses conducted in the study reveal that this growth is primarily linked to the development of the GDP levels and economically active populations of both countries.

It was determined that the sanctions imposed in 2014 did not have a significant impact on trade turnover, whereas the sanctions of 2022 had a positive effect. This can be attributed to Russia's development of new economic strategies and its strengthened cooperation with partner countries like Azerbaijan. The use of alternative trade routes and economic diversification measures has contributed to maintaining trade turnover.

The research indicates that the economically active populations of Russia and Azerbaijan have different effects on trade turnover. Specifically, an increase in Russia's economically active population negatively affects trade turnover, while Azerbaijan's economically active population has a moderately positive impact. Considering the uncertainties of sanctions and the international economic environment, new economic strategies must be implemented to sustain trade relations between Azerbaijan and Russia. These strategies should aim to enhance long-term economic partnerships and mutual investments.

The results of the study highlight that the trade-economic relations between Russia and Azerbaijan are robust and enduring. Despite the influence of sanctions and other external factors, both countries employ various strategies to maintain their trade cooperation. In the future, ensuring the stability of trade turnover will require the adoption of new economic models, diversification measures, and enhanced technological collaboration, which will play a more crucial role.

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