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Econometric analysis of trade relations between Azerbaijan, Ukraine and Georgia

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Abstract.
In this article, the integration processes between Azerbaijan, Ukraine and Georgia are considered through the indicators of integratedness of Azerbaijan's GDP and the trade turnover of this country with the other two. All considered time series are non-stationary. So, there are problems of correct modeling of the corresponding time series, the components of which lead to a deviation from stationarity. The publication uses an econometric cointegration methodology for modeling the relationship between the non-stationary time series. A dynamic model of the long-term equilibrium is built, allowing to qualitatively forecast the state of foreign trade integration of the three countries under consideration and analyze the openness of the Azerbaijani economy in the regional aspect.

Keywords:
cointegration
error correction mechanism
dispersion decomposition
impulse response function
GDP
econometric analysis
time series

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Introduction and purpose of the research. The article has devoted to topical issues of the study of trade cointegration processes of Azerbaijan's foreign economic activity with Ukraine and Georgia. Here, by the cointegration processes the corresponding realizations of non-stationary time series of integrated indicators of these countries are cointegrated up to a certain order of differences (Verbeek,2012). The integration processes between Azerbaijan, Ukraine and Georgia are considered through the indicators of Azerbaijan's GDP and the trade turnover of this country with two others in this research. These indicators are the most significant variables for analyzing the dynamics of the turnover of mutual trade in the environment of regional cooperation and for assessing the impact of mutual trade on their inclusive growth. As the observation period, nominal data with a unit of measurement thousand US dollars from 1994 to 2018 from (www.stat.gov.az; www.geostat.ge/ka; www.ukrstat.gov.ua) are considered. The study uses an econometric methodology for studying the statistical relationship between multivariate non-stationary time series, including Angle-Granger and Johansen tests for cointegration, Granger causality studies, responses to shocks (Hall,1992) based on the vector error correction model (VECM), performing forecast error variance decomposition, as well as the Excel (Berk&Carey,2009) and Eviews (Johnson,2015) application packages.

Analysis of recent publications. The work (Golovan,2012) analyzes the dynamics of the structure of Ukraine's foreign trade from 2005 to 2011. It establishes the relationship between the geographical structure of foreign trade with both external debt and the unfavorable commodity structure of Ukraine's foreign trade. The article (Chebotareva & Fayzulina, 2016) characterizes the main trends in the development of Ukraine's foreign trade, gives the geographical structure of exports and imports of goods, and conducts a correlation analysis of the impact of exports and imports on the formation of Ukraine's GDP.

The authors of (Moroz et al.,2017) studied the peculiarities of the state and dangerous relations between Ukraine and the Visegrad countries. Econometric models of trade flows between Ukraine and many countries have been built from time to time. The research (Kalyuzhna,2020) carried out a retrospective analysis of Ukraine's foreign trade in goods in the deepening of interstate economic contradictions. An econometric analysis in (Orudzhev&Alizade,2020) of the mutual influence of the GDP of Azerbaijan and the trade turnover of this country with Ukraine was carried out. Estimates of the parameters of the econometric model are found, after which, with the execution of the model, the correction of errors of high quality qualitative indicators. From the calculations for the lag (1-3) of this work, it can be seen that α(-2.147153; -1.755) is a correction vector. At such coordinates, the equilibrium is off the scale. However, in the case of lag (2 2), there are estimates of the cointegrating vector β(1; 13.7559; -0,148975) and cointegrating vector α(-0.017035; -0.146521), where (21.7) (-1.03) (-1.94) (-20.2) t-values are indicated in brackets under the coordinates.

The study (Orudzhev&Alizade,2021) built a mathematically-statistically correct structure of an analog model of trade flows between Ukraine and Azerbaijan depending on the GDP countries, which includes a comprehensive analysis of the impact of state regulation of export and import operations between countries to balance mutual trade Regarding the results of this work, we note that for lag (1 2) the first coordinate 0.035560 of the correction vector α is not significant, the second coordinate 0.129695 is weakly significant, the third coordinate 0.281805 is significant. A positive value of the correction factor means that the endogenous variable has changed by an amount exceeding the equilibrium bar, and not it, but the regressors need to move to eliminate the excess. We focus on the phrase "estimates of lag parameters" in the Conclusions in paragraph 2 of the same work, for lag (2 2), the following estimates take place:

β(1;1.021300;-0.511663; -0.241085), α(-0.790773; -0.081164; -0.030074; 4.510271), and (1.96) (1.28) (7.95) (-3.63) (-1.06) (-0.28) (3.83)

for lag (3 3) such estimates:

β(1; 1.670113; -1.288832; -0.198243), α(-0.673228; -0.013418; -1.79E-0.5; 4.713989)

(3.18) (-3.16) (-0.966) (-3.89) (-0.18) (-0.00017)

(5.19).

The research (Kovtun&Matviienko,2019) considers current trends in international trade in goods and features of Ukraine's foreign trade. The reorientation in the geographical scope of exports from the CIS countries towards the country application was analyzed, and foreign trade relations of Ukraine with Azerbaijan and Georgia were not considered. The main environmental factors in (Baliuk,2021; Baliuk,2022), that are characteristic for the development of export-import activities of domestic industrial enterprises in modern conditions are summarized, and priority economic strategies for the development of export-import industrial activity in Ukraine are also substantiated. The article (Dyogtev et al.,2016) analyzes the economic connection of Georgia with Russia, Turkey, Iran and Kazakhstan using indicators of the trade turnover of foreign direct investment, cross-border movement of finance, tourism and transport development. The issue of interconnection of Georgia's trade and economic relations with Azerbaijan and Ukraine was not touched upon. The current trends in the world economy, the EU economy, the post-Soviet economy, mainly the economy of Georgia, are considered and the main aspects of the socio-economic development of Georgia are identified in (Silagadze,2020).

We also note that , the regional organization GUAM (Georgia, Ukraine, Azerbaijan and Moldova) is an organization for democracy and economic development, established in 1997, which is still practically inactive in the implementation of a free trade zone between countries, sectoral cooperation, in the fuel and energy sector , in the field of cross-border transportation, logistics and communication, which could give an incentive to free economic and trade interaction between the GUAM member states in the relevant areas.

The main results of the research. In this study, with a more detailed change from (Orudzhev&Alizade,2020; Orudzhev&Alizade,2021), a new specification of models for the relationship between Azerbaijan's GDP and trade turnover with Ukraine, supplemented with Georgia is defined. Forecasting the qualitative indicators of these countries in terms of export-import operations was carried out by the method of logarithmic approximation of actual data with reproduction by extrapolation. This study is an addition to the article (Alizade,2022). Descriptive statistics on the logarithms of given indicators from (www.stat.gov.az; www.geostat.ge/ka; www.ukrstat.gov.ua) are shown in Table 1:

Table 1

Descriptive statistics on logarithms of variables

	LN_ GDP_AZ	LN_GEO_T	LN_ UKR_T	LN_ RESIDS
Mean	16.58730	12.39040	12.50237	-1.905920
Median	16.85922	12.72032	12.71052	-1.671260
Maximum	18.13612	13.45978	14.19880	-0.208230
Minimum	14.30366	10.10928	10.74011	-6.692644
Std. Dev.	1.261864	0.937253	1.057384	1.303291
Skewness	-0.238608	-0.613268	-0.060990	-2.139986
Kurtosis	1.529524	2.337551	1.725032	8.558521
Jarque-Bera	2.489621	2.024198	1.708773	51.26596
Probability	0.287995	0.363455	0.425544	0.000000
Sum	414.6826	309.7601	312.5592	-47.64800
Sum Sq. Dev.	38.21520	21.08266	26.83344	40.76559
Observations	25	25	25	25

Table 1 shows, that the elements of the 2nd, 3rd, and 4th columns have a slight left-sided asymmetry of the empirical curves relative to the theoretical one, and for the element of the 5th column, the vertex is significantly shifted to the left. The excesses for the elements of columns 2, 3, and 4 show that there is a slight peak of the empirical curve, and for the element of the 5th column, this value increases approximately four times, which leads to a significant deviation of the empirical distribution of residuals from the normal one.

Based on a comparative analysis with the results of (Orudzhev&Alizade,2020; Orudzhev&Alizade,2021) and Table 1, it can be assumed that the dependence of the logarithm of Azerbaijan's GDP on the logarithms of Azerbaijan's foreign trade turnover with Ukraine and Georgia is described by a linear regression model

$$lny_t = \alpha_0 + \alpha_1 lnx_{1t} + \alpha_2 lnx_{2t} + ln\varepsilon_t \quad , \quad t = \overline{1,25} \qquad (1)$$

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where y_t,x_{1t}, x_{2t} – the corresponding factors, α_0 , α_1, α_2,– are the unknown parameters of the model; ε –.is a random term, which includes the total effect of all factors not taken into account in the model, measurement errors

The estimated multiple least squares regression model implemented in the special software Eviews 8 is described in Table 2:

Table 2

Estimated multiple regression model with logarithms of variables

Dependent Variable: LN_GDP_AZ				
Method: Least Squares				
Date: 10.04.23Time: 17:17				
Sample:1994 - 2018 Included observations: 25				
Variables	Coefficient	Std. Error	t-Statistic	Prob.
LN_UKR_T	0.239611	0.128864	1.859411	0.0770
LN_GEO_T	1.042763	0.137025	7.610046	0.0000
LN_RESIDS	-0.044078	0.057396	-0.767975	0.4511
C	0.587326	0.909477	0.645784	0.5254
R-squared	0.943674	Mean dependent var		16.58730
Adjusted R-squared	0.935628	S.D. dependent var		1.261864
S.E. of regression	0.320157	Akaike info criterion		0.705633
Sum squared resid	2.152504	Schwartz criterion		0.900653
Log likelihood	-4.820416	Hannan-Quinn criter.		0.759724
F-statistic	117.2768	Durbin-Watson stat		0.752777
Prob(F-statistic)	0.000000			

and has the following formal form:

$$LN\_GDP\_AZ = 0.239611479406*LN\_UKR\_T + 1.04276314802*LN\_GEO\_T- 0.0440784945713*LN\_RESIDS+ 0.587325841035 \quad (2)$$

As can be seen from the results obtained in Table 2, the general formal model is the most accurate, the coefficient of determination has a higher value of 94%.

The coefficient at LN_UKR_T means that each percent of the growth in foreign trade turnover between Azerbaijan and Ukraine is followed by an increase in Azerbaijan's GDP by 0.23% per year, and a 1% increase in Azerbaijan's trade with Georgia leads to an increase in Azerbaijan's GDP by 1.04 % in (2). At the same time, the indicator of foreign trade turnover does not reflect multidirectional shifts in exports and imports. It should be noted that this model does not take into account changes in other important indicators that directly affect the size of Azerbaijan's GDP. Nevertheless, the results achieved during the construction of the model can be correlated, for example, with the GDP forecast according to the IMF (http://www.imf.org/external/Publs/ft/weo/2017/ weodata/weoselagr. aspx).

The stability analysis of the model parameters is explained by the representation of the cumulative sum of squares of the residuals, and the graphical description of the CUSUM test demonstrates that all parameters are dynamically stable, since the curves lie within the critical limits in the 5% region.

Let's pay attention to the correlation coefficients between the factors, presented by the correlation matrix of Table 3:

Table 3

Correlation matrix

	LN_GDP_AZ	LN_UKR _T	LN_GEO _T
LN_GDP_AZ	1.000000	0.887882	0.963465
LN_UKR_T	0.887882	1.000000	0.859080
LN_GEO _T	0.963465	0.859080	1.000000

The correlation coefficients are close to 1, demonstrating an almost complete positive correlation in Table 3. In other words, Azerbaijan's GDP is strongly linked to the growth of trade with regional strategic partners Georgia and Ukraine.

Here, the correlation captures the proximity of short-term relationships between variables and does not take into account the stationarity or non-stationarity of these indicators. Therefore, building a model based on correlation-regression analysis gives biased estimates of the model coefficients.

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Based on this, it is necessary to consider models based on cointegration analysis, which make it possible to analyze series with non-stationary components, both in the short-term and in the long-term periods. The construction scheme will be described below.

To test the significance of the constructed model (2), the observed and critical values of the Fisher criterion were calculated. These values are respectively equal to 117.2768 and 3.44 at a significance level of 5% and degrees of freedom $k_1 = 2$, $k_2 = 22$. Since 117.2768 > 3.44, the model is considered significant. The significance of the regression coefficients is also confirmed using t-statistics.

Autocorrelation had checked using Durbin-Watson d-statistics. According to the table of critical values of d-statistics for the number of observations 25, the number of explanatory variables 2 and the given significance level 0.05, the values $d_{low} = 1.21$ and $d_{up} = 1.55$, which divide the segment [0.4] into five regions, the observed value $d_{obs} = 0.75$. Since $d_{obs} = 0.75 < d_{low}, d_{up}$ then there is an autocorrelation of the residuals.

Now consider the problem of heteroscedasticity. Heteroskedasticity leads to the fact that the estimates of the regression coefficients are not effective, the dispersions of the distributions of the coefficient estimates increase. Here, the heteroscedasticity of the residuals is verified by the White test, $nR^2 = Obs * R - squared$, где $n = 25$, according to which the value , R^2 —where is the coefficient of determination for the auxiliary regression of the squares of the residuals on all regressors, their squares, pairwise products and a constant, is 5.230084, and this value is less than the value $\chi^2_{0,16}(5)$= 5.303272885. The corresponding P-value is greater than 0.05, ithe null hypothesis that the random term is homoscedastic is not rejected.

The results of the extended Dickey-Fuller test showed that the original series and their first differences are not stationary, while the second-order difference operators are stationary. The test results are shown in Table 4:

The results of the above tests show that the estimates of the regression coefficients are poor. The reason for this is the nonstationarity of the studied series. One of the

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approaches to the correct mathematical description of series is the cointegration approach of Engle-Granger and Johansen. This approach can be applied to build an error correction model if the time series are integrable of the same order. In our case, all series are second-order integrable.

Table 4

Results of Dickey-Fuller test

Variables	Statistic Criteria	Critical value 1%	Critical value 5%	Critical value 10%	Prob.
Second difference					
LN_GDP_AZ	-4.615559	-4.440739	-3.632896	-3.254671	0.0070
LN_UKR_T	-8.159048	-4.440739	-3.632896	-3.254671	0.0000
LN_GEO_T	-3.998869	-4.467895	-3.644963	-3.261452	0.0254
LN_RESIDS	-5.029874	-4.532598	-3.673616	-3.277364	0.0039

Verification of causal relationships between factors for lag values m=1,2,3,4 was carried out by the Granger test. The test results are provided in Table 5.1, 5.2.

Table 5.1

Granger causality test

Null Hypothesis:	m=1		m=2		m=3		m=4	
	F-Stat.	Prob.	F-Stat.	Prob.	F-Stat.	Prob.	F-Stat.	Prob.
DLNUKRAINET does not Granger Cause DLNGDPAZ	0.67	0.42	0.20	0.82	0.07	0.97	1.65	0.23
DLNGDPAZ does not Granger Cause DLNUKRAINET	4.12	0.05	1.96	0.17	3.08	0.06	5.54	0.01
DLNGEORGIAT does not Granger Cause DLNGDPAZ	0.01	0.91	0.53	0.59	0.28	0.83	0.27	0.88
DLNGDPAZ does not Granger Cause DLNGEORGIAT	0.41	0.52	1.03	0.37	1.75	0.20	1.65	0.23
DLNGEORGIAT does not Granger Cause DLNUKRAINET	0.44	0.51	0.22	0.79	0.66	0.58	1.27	0.34
DLNUKRAINET does not Granger Cause DLNGEORGIAT	0.93	0.34	1.76	0.20	1.07	0.39	1.19	0.36
DDLNUKRAINET does not Granger Cause DDLNGDPAZ	1.25	0.27	0.88	0.43	0.33	0.80	1.16	0.39
DDLNGDPAZ does not Granger Cause DDLNUKRAINET	1.92	0.18	23.37	3.E-05	7.88	0.004	5.53	0.01
DDLNGEORGIAT does not Granger Cause DDLNGDPAZ	1.05	0.31	0.01	0.98	0.24	0.86	0.55	0.69

Table continuation 5.1

DDLNGDPAZ does not Granger Cause DDLNGEORGIAT	2.48	0.13	1.65	0.22	2.34	0.12	1.10	0.41
DDLNGEORGIAT does not Granger Cause DDLNUKRAINET	2.09	0.16	1.35	0.28	1.35	0.30	0.82	0.54
DDLNUKRAINET does not Granger Cause DDLNGEORGIAT	1.53	0.23	1.004	0.39	1.04	0.41	1.04	0.44

Table 5.2

Results of Granger causality test

m=1	m=2	m=3	m=4
DLNUKRAINET no link DLNGDPAZ	DLNUKRAINET no link DLNGDPAZ	DLNUKRAINET no link DLNGDPAZ	DLNUKRAINET → DLNGDPAZ***
DLNGDPAZ→ DLNUKRAINET*	DLNGDPAZ → DLNUKRAINET***	DLNGDPAZ → DLNUKRAINET**	DLNGDPAZ → DLNUKRAINET*
DLNGEORGIAT no link DLNGDPAZ	DLNGEORGIAT no link DLNGDPAZ	DLNGEORGIAT no link DLNGDPAZ	DLNGEORGIAT no link DLNGDPAZ
DLNGDPAZ no link DLNGEORGIAT	DLNGDPAZ no link DLNGEORGIAT	DLNGDPAZ → DLNGEORGIAT***	DLNGDPAZ → DLNGEORGIAT***
DLNGEORGIAT no link DLNUKRAINET	DLNGEORGIAT no link DLNUKRAINET	DLNGEORGIAT no link DLNUKRAINET	DLNGEORGIAT no link DLNUKRAINET
DLNUKRAINET no link DLNGEORGIAT	DLNUKRAINET→ DLNGEORGIAT***	DLNUKRAINET no link DLNGEORGIAT	DLNUKRAINET no link DLNGEORGIAT
DDLNUKRAINET no link DDLNGDPAZ	DDLNUKRAINET no link DDLNGDPAZ	DDLNUKRAINET no link DDLNGDPAZ	DDLNUKRAINET no link DDLNGDPAZ
DDLNGDPAZ → DDLNUKRAINET***	DDLNGDPAZ → DDLNUKRAINET*	DDLNGDPAZ → DDLNUKRAINET*	DDLNGDPAZ → DDLNUKRAINET*
DDLNGEORGIAT no link DDLNGDPAZ	DDLNGEORGIAT no link DDLNGDPAZ	DDLNGEORGIAT no link DDLNGDPAZ	DDLNGEORGIAT no link DDLNGDPAZ
DDLNGDPAZ → DDLNGEORGIAT**	DDLNGDPAZ → DDLNGEORGIAT***	DDLNGDPAZ → DDLNGEORGIAT**	DDLNGDPAZ no link DDLNGEORGIAT
DDLNGEORGIAT → DLNUKRAINET***	DDLNGEORGIAT no link DDLNUKRAINET	DDLNGEORGIAT no link DDLNUKRAINET	DDLNGEORGIAT no link DDLNUKRAINET
DDLNUKRAINET → DDLNGEORGIAT***	DDLNUKRAINET no link DDLNGEORGIAT	DDLNUKRAINET no link DDLNGEORGIAT	DDLNUKRAINET no link DDLNGEORGIAT

-significance level 5%, **-significance level 15%, *-significance level 25%*

For complete information content of the research, in addition to the Granger causality test, it is necessary to analyze the response 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. Confidence intervals were obtained by bootstrapping with 100 replications, as described in (Hall,1992). unit of its standard deviation for the entire period. The responses of variables to these shocks in the periods t=1,2,…,10 are estimated. The values of the variables in these time periods represent the corresponding impulse response functions.

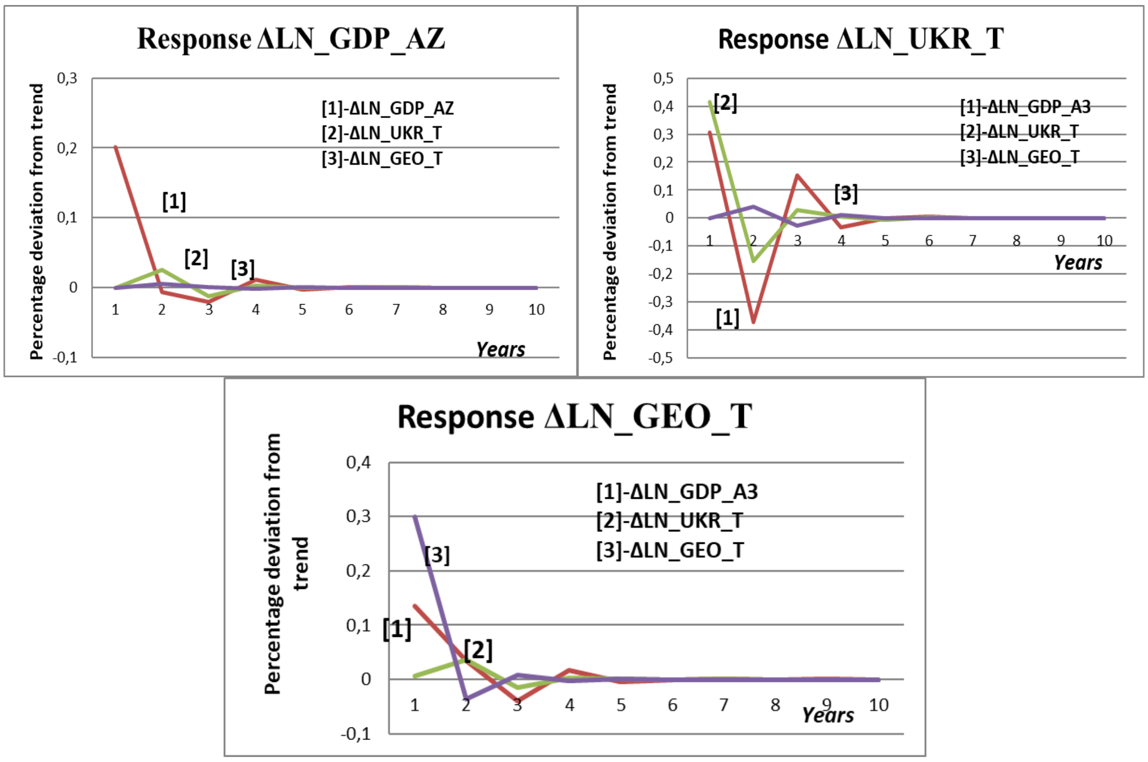

Figure 1
Reactions of impulse response functions

It is clear from Figure 1 that the response of the variables to the deviation from the general stochastic trend is not the same. In the case of response to shocks, the endogenous variable goes its part of the way to equilibrium.

To study the influence of exogenous variables on an endogenous variable over the next 10 years, an econometric method of decomposition of forecast error variances was used, which determines the contribution of a change in this variable to its own variance of forecast errors and the variance of other variables. The results of checking the relevant tests are shown in tables 6.1,6.2,6.3:

Table 6.1

Decomposition of the variance of forecast errors ΔLN_GDP_AZ by shocks

Years	St.errors	ΔLN_GDP_AZ	ΔLN_UKR_T	ΔLN_GEO_T	ΔLN_RESIDS
1	0.200260	100.0000	0.000000	0.000000	0.000000
2	0.213077	88.45029	0.166831	0.003996	11.37888
3	0.239997	80.24208	0.705063	4.609816	14.44304
4	0.248661	75.90669	0.677819	4.493289	18.92220
5	0.263947	68.34416	0.615722	8.116687	22.92343
6	0.272195	68.75173	0.820821	7.816624	22.61083
7	0.278522	66.09845	0.824276	9.208542	23.86873
8	0.284818	67.22421	0.894139	8.808053	23.07360
9	0.287045	66.55887	0.894754	9.462333	23.08404
10	0.290047	66.96898	0.909030	9.302865	22.81912

Table 6.2

Decomposition of the variance of forecast errors ΔLN_UKR_T by shocks

Years	St.errors	ΔLN_GDP_AZ	ΔLN_UKR_T	ΔLN_GEO_T	ΔLN_RESIDS
1	0.200260	100.0000	0.000000	0.000000	0.000000
1	0.532177	24.28358	75.71642	0.000000	0.000000
2	0.710557	38.87114	58.94872	1.281564	0.898579
3	0.757328	34.43082	54.93659	4.583763	6.048831
4	0.790819	32.99794	51.22253	10.11301	5.666519
5	0.804677	31.87905	49.64426	9.773106	8.703584
6	0.815695	31.91798	48.37920	10.56300	9.139818
7	0.825332	32.74148	47.43059	10.34645	9.481484
8	0.828112	32.85057	47.11306	10.46540	9.570969
9	0.834326	33.63939	46.43873	10.41893	9.502948
10	0.834689	33.64313	46.39841	10.46152	9.496935

Table 6.3

Decomposition of the variance of forecast errors ΔLN_GEO_T by shocks

Years	St.errors	ΔLN_GDP_AZ	ΔLN_UKR_T	ΔLN_GEO_T	ΔLN_RESIDS
1	0.332262	9.378901	0.160207	90.46089	0.000000
2	0.341082	11.75263	0.338170	86.99917	0.910035
3	0.403760	28.21602	5.275526	62.74573	3.762725

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Table continuation 6.3

4	0.408579	27.55542	6.311652	61.28454	4.848390
5	0.441666	30.37871	5.439327	54.62306	9.558909
6	0.445252	30.21529	5.368019	54.73200	9.684693
7	0.461752	30.12403	5.048652	52.28962	12.53770
8	0.466696	31.03315	5.011967	51.65704	12.29785
9	0.474653	31.32897	4.903178	50.69298	13.07486
10	0.478022	32.14874	4.863859	50.06666	12.92074

Table 6.1 shows that in the annual forecast ΔLN_GDP_AZ, the largest errors fall on the shocks ΔLN_GDP_AZ, ΔLN_UKR_T and ΔLN_GEO_T, respectively, in the amounts of 88.4% on a two-year horizon, 90% on a ten-year horizon, and 9.3% on a ten-year horizon; for ΔLN_UKR_T these values will be 38.87% on the horizon of two years, 75.7% on the horizon of one year, 10.56% on the horizon of six years, and for ΔLN_GEO_T 32.14% on the horizon of ten years, 6.31% on the horizon four years, 90.46% over the horizon of one year. These figures indicate that the greatest uncertainty in the forecast for ΔLN_GDP_AZ, ΔLN_UKR_T and ΔLN_GEO_T during the first five years is given by their own changes.

Based on the Angle-Granger and Johansen test, to obtain the specification of the Vector Error Correction Model (VECM) at a significance level of 1%, all 5 options were analyzed: no free member; the data does not have a deterministic trend, the cointegration relation contains an intercept and does not contain a trend; the data contains a deterministic trend, the cointegration equation contains an intercept and does not contain a trend; the data has a deterministic linear trend, the cointegration relation has both a trend and an intercept; the data contains a deterministic quadratic trend, the cointegration equation contains a trend and an intercept. In the case of the information criteria, Akaike and Schwartz, respectively, had low values of 1.899115 and 3.297802. All variables are cointegrated, which certifies their long-term relationship and the authenticity of the correlation. Taking into account the information criteria of Akaike and Schwartz, the lag equal to 2 turned out to be the best. One cointegration relation with the degree of integration 2 and the cointegration rank equal to 1 was obtained.

In tables 7.1 and 7.2, to determine the number of cointegration vectors in the time series, we first tested the null hypothesis that there are no cointegration vectors, against the alternative hypothesis that there is one such vector. We rejected the null hypothesis, since the calculated values were greater than the critical values, from which we concluded that there is one cointegration vector. We then tested the hypothesis that there is one vector against the alternative hypothesis that there are two vectors of cointegration. Here, the calculated criteria are less than the critical values, and we accept the null hypothesis. Thus, we concluded that there is one vector of cointegration.

Table 7.1

Max-Eigenvalue test results

Hypothesis	Alternative hypothesis	Max-Eigenvalue statistics	Critical value 1 %	Prob.
H_0:r=0*	H_A:r >0	37.98374	30.83396	0.0008
H_0:r=1	H_A:r >1	14.09323	23.97534	0.2480
H_0:r=2	H_A:r >2	7.086650	16.55386	0.3356

Table 7.2

Trace Test results

Hypothesis	Alternative hypothesis	Trace statistics	Critical value 1 %	Prob.
H_0:r=0*	H_A:r >0	59.16362	49.36275	0.0006
H_0:r=1	H_A:r >1	21.17988	31.15385	0.1720
H_0:r=2	H_A:r >2	7.086650	16.55386	0.3356

According to (Verbeek,2012), the system of integrated order 2 and cointegrated series can be represented in the form of a vector error correction model (VECM) with a lag equal to 2 and rank 1, which expresses a long-term equilibrium relationship of variables and authenticity their correlations. Performing the procedures of the Eviews 8 program, the following error correction equation was found for the second-order differences of the logarithmic values of Azerbaijan's GDP:

Δ (Δ LN_GDP_AZ) = - 0.0904087547356*(Δ LN_GDP_AZ
(1)+0.0506256133227*(0.34)
Δ LN_UKR_T(-1) - 3.39328543712* Δ LN_GEO_T(-1) –

0.265412275366* Δ (0.39) (0.09)
LN_RESIDUALS(-1) -0.0156540712535) - 0.270128380903* Δ
(Δ LN_GDP_AZ(-1)) - 0.739200447724* Δ(ΔLN_GDP_AZ(-2)) +
0.020367403405* Δ (Δ LN_UKR_T(-1)) - 0.0423208958268* Δ
(Δ LN_UKR_T(-2)) - 0.161521723161* Δ (Δ LN_GEO_T(-1)) -
0.0714700218773* Δ (ΔLN_GEO_T(-2)) + 0.0194415568114* Δ (Δ
LN_RESIDUALS(-1)) - 0.0174702303393* Δ (Δ LN_RESIDUALS(-2))
+ 0.0170954314078 , (3)

where in parentheses under the coefficients are the standard errors of the estimate, $\Delta(\cdot) = \Delta_t(\cdot)$; $\Delta(-i) = \Delta_{t-i}(\cdot)$, $t = \underline{1,3}$, "$\cdot$"– *corresponding variable is marked.*

Above, when implementing the Granger causality test, we showed that there are feedbacks between variables. In the Eviews 8 program procedures, following similar procedures, it is easy to obtain error correction models for the remaining variables:

Δ (Δ LN_UKR_T) = - 0.233217756667*(Δ LN_GDP_AZ(-1) +
0.0506256133227* Δ LN_UKR_T(-1) - 3.39328543712* Δ
LN_UKR_T(-1) - 0.265412275366* Δ LN_RESIDUALS(-1) -
0.0156540712535) - 0.961626950221* Δ (Δ LN_GDP_AZ(-1)) -
2.55753023597* Δ (Δ LN_GDP_AZ(-2)) - 1.06641823054* Δ (Δ
LN_UKR_T(-1)) - 0.286017986354* Δ (Δ LN_UKR_T(-2)) -
0.403195340504* Δ (Δ LN_GEO_T(-1)) - 0.050620592405* Δ (Δ
LN_GEO_T(-2)) - 0.0114979495096* Δ (Δ LN_RESIDUALS(-1)) -
0.0240790766911* Δ (Δ LN_RESIDUALS(-2)) +
+ 0.0729281144544 (4)

Δ (Δ LN_GEO_T) = 0.541606064226*(Δ LN_GDP_AZ(-1) +
0.0506256133227* Δ LN_UKR_T(-1) - 3.39328543712* Δ
LN_GEO_T(-1) - 0.265412275366* Δ LN_RESIDUALS(-1) -
0.0156540712535) - 0.107411240036* Δ (Δ LN_GDP_AZ(-1)) -
0.331538791635* Δ (Δ LN_GDP_AZ(-2)) + 0.0274493350108* Δ (Δ
LN_UKR_T(-1)) + 0.110173484951* Δ (Δ LN_UKR_T(-2)) +
0.444064330926* Δ (Δ LN_GEO_T(-1)) + 0.237738121847* Δ (Δ
LN_GEO_T(-2)) + 0.105953442539* Δ (Δ LN_RESIDUALS(-1)) +
0.0597363921104* Δ (Δ LN_RESIDUALS(-2)) +
+ 0.0177343610901 (5)

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the result of cointegration relation

$coint_t \equiv \Delta\ LN\_GDP\_AZ_t + 0.0506256133227 * \Delta\ LN\_UKR\_T_t - 3.39328543712 * \Delta\ LN\_GEO\_T_t - 0.265412275366 * \Delta\ LN\_RESIDUALS_t$

normality of the cointegrating vector $\beta(1; 0.0506256133227; -3.39328543712; -0.265412275366)$.

The coefficient at Δ LN_GDP_AZt is equal to one, which shows that its influence on the equilibrium is large, the trade turnover with Georgia also has a significant impact on the GDP growth rate of Azerbaijan, and the trade turnover with Ukraine plays a smaller role.

In the error correction vector α(-0.090409; -0.233218; 0.541606;), the first component expresses a significant slow movement towards equilibrium, the second - a slow movement towards equilibrium, and for the first, the period of complete elimination of the deviation is 1:0.09=11.11 years, and for the second component, this period will be 1:0.23=4.33 years; the third and fourth components mean that the corrective system noticeably deviates from the equilibrium trajectory, in these cases the endogenous variable will change by a value exceeding the equilibrium bar, and the regressors need to move forward so that the excess of the endogenous factor disappears.

All coefficients in the parameter matrix with the vector of second differences of the lag values of the endogenous variable $\Delta(\Delta LN_{RESIDUAL_t})$, except for $\Delta(\Delta LN_{RESIDUAL_{t-1}})$, and $\Delta(\Delta LN_{RESIDUAL_{t-2}})$, whose values are small, are statistically insignificant and the equation for $\Delta(\Delta LN_{RESIDUAL_t})$, can be omitted for practical use.

Model (4), (5), (6) is statistically correct, since the previous stages of its construction ensure the stationarity of its variables.

The adequacy of the constructed error model (3), (4), (5) is estimated based on the results of a joint analysis of the residuals (errors) of three regression equations. The following hypotheses were tested: on the mutual independence of the residuals using the Lagrange multiplier test (VAR Residual Serial Corellation LM Tests); on the joint normal distribution of random errors using the Jarque-Bera test; on the constancy of residual variance using White's

Heteroscedasticity Tests: No Gross Terms). To make a decision, equivalent forms of criteria were used, which are a comparison of the conditions of significance and P-value.

LM correlation tests showed value of the (P=0.8713 was above 0.05) is correct, White's autoregressive heteroscedasticity test showed no heterogeneous problem (P=0.4110, which was above 0.05). The Jacques-Berre test showed that the residuals are multivariately normal (P=0.8003 was above 0.05) and the asymmetry components are respectively equal to -0.833171; -0.335252; -0.764138 with corresponding probabilities 0.1191; 0.5305; 0.1528, and kurtosis components 3.991224; 3.244348; 3.799928 with probabilities 0.3538; 0.8192; 0.4543 means a comparative improvement with the corresponding values from Table 1.

Based on these estimates, we can conclude that the vector model of error correction (3), (4), (5) is adequate.

Conclusions. The conducted cointegration analysis of the mutual influence of Azerbaijan's GDP and the foreign trade turnover of this country with Ukraine and Georgia allows us to formulate a number of conclusions:

1. Combining the statistical long-term and dynamic short-term relationships between variables in one line, relations (3) and (4) allow measuring deviations from equilibrium in the event of shocks and the rate of its recovery, as well as the convergence of the corrective system from the equilibrium trajectory.
2. The contributions to the variance of forecast errors for shocks of changes in the own variance of the resulting factor and the variance of other variables had determined.
3. In general, it can be stated that the model is properly defined and the results can be used to develop specific measures when conducting a dynamic analysis of the effective state regulation of export-import operations between the three countries and balancing mutual trade Azerbaijan with Ukraine and Georgia.
4. Georgia should intensify its foreign trade policy aimed at changing the structure in favor of net exports of foreign trade turnover with Ukraine and Azerbaijan.
5. To improve the integration trade relations between the three countries, it is necessary to increase the indicator of

the importance of mutual trade in goods.

6. The proposed assessments can be used to determine the significant factors of interaction in the dynamics of trilateral trade relations and to assess the growth trend in the openness of the economies of these countries in the regional context. The analysis performed allows us to identify a number of stable and unstable features that indicate the possibility of modeling reasonable predictive scenarios for further mutually beneficial trade and economic ties in the membership of the GUAM project in the conditions of the Ukrainian-Russian and Georgian-Russian military-political and economic crisis.

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