ASSESSMENT OF THE LONG-TERM RELATIONSHIP BETWEEN RA PERSONAL TRANSFERS-ECONOMIC GROWTH USING THE VEC MODEL

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Abstract: The article evaluates the macroeconomic impact of personal transfers from abroad in Armenia. The analysis utilizes quarterly data on macroeconomic indicators spanning the period from 1996 to 2024.The data sources are the databases of the Central Bank of Armenia and the Statistical Committee of Armenia. Hypotheses have been proposed, and to test them, ARDL class and Vector Error Correction (VEC) models were constructed. The Granger causality test indicated unidirectional causality, where personal transfers from abroad drive changes in economic growth, but not vice versa. Meanwhile, the Johansen cointegration test confirmed the existence of a long-term relationship between personal transfers from abroad and economic growth in Armenia. The results of the VEC model indicate that a 1% increase in personal transfers from abroad leads to a 0.42% rise in Armenia's real GDP in the long run, whereas a 1% increase in the export of goods and services results in a 0.35% growth. An increase in the rate of economic growth in Armenia leads to a reduction in personal transfers from abroad. A 1% increase in real GDP leads to a reduction in external personal transfers by 1.08% after 4 quarters, 1.05% after 5 quarters, and 1.22% after 6 quarters. The findings from the regression and VEC models indicate that personal transfers from abroad do not have a significant short-term effect on Armenia's economic growth. The results of the research can be useful in the development of Armenia's macroeconomic policy.

Introduction

Personal transfers from abroad play an important social and economic role in Armenia's economy. For many households, these transfers provide a source of income and create opportunities for building and enhancing physical and human capital. At the national level, they serve as a source of foreign currency, boosting aggregate demand and ultimately contributing to GDP growth. From 2013 to 2019, our country's dependence on foreign remittances decreased: in 2013, the net inflow of transfers to individuals through Armenian banks constituted 13.0% of GDP, while in 2019, it dropped to 3.7%. However, during 2020-2022, this indicator increased from 4.5% to 12.8%, and in 2023, it amounted to 6.9%

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(CB of RA, 2024). Notably, starting from 2016, the amounts transferred from Armenia abroad have been increasing year by year. In 2018-2019, this was mainly due to the large import of vehicles from abroad, while in 2022-2023, it was linked to the Russia-Ukraine conflict. The decrease in the ratio of net transfers/GDP is evidence of the country's reduced economic dependence on foreign monetary transfers.

According to Armenia's Balance of Payments, the inflow of personal remittances from abroad amounted to $18.4 million in 1995. Due to the devaluation of the Russian ruble, the volume of transfers sharply decreased in 1997 from $101.6 million to $84.3 million in 1998. From 2000 to 2008, transfers increased from $104.0 million to $837.3 million, contributing to the growth of both consumption and construction in the country. As a result of the 2008-2009 financial crisis, the flow of remittances decreased, but it began to recover at an average rate of 4%. Between 2017 and 2022, the inflow of external personal transfers increased from $680.5 million to $1,150.6 million, while in 2023, it decreased to $845 million (CB of RA, 2024). In 2023, the top five countries in terms of volume of remittances were Russia, the USA, Germany, the UAE, and France. In the first quarter of 2024, external personal transfers amounted to $170 million, and $149 million in the second quarter.

The primary aim of this study is to evaluate the interaction between economic growth and external personal transfers in Armenia. The proposed hypotheses include:

- **Hypothesis 1:** There is a long-term positive relationship between personal transfers from abroad and economic growth in Armenia.
- **Hypothesis 2:** An increase in Armenia's economic growth rate leads to a reduction in personal transfers from abroad.

Literature review

The economic literature includes numerous empirical studies examining the impact of remittances from abroad on various macroeconomic indicators. Cazachevici et al. (2020, pp. 1–14) highlight the lack of consensus on the impact of remittances on economic growth. Analyzing 538 estimates from 95 studies, they observe that around 40% of the studies report a positive effect, another 40% report no effect, and 20% indicate a negative effect. They conclude that, while the average impact of remittances on growth remains positive, it is economically modest. Ahmed and Uddin (2009, pp. 79–92) demonstrated that in Bangladesh, imports, exports, and remittances influence economic growth in the short term; however, their long-term impact is insignificant. Similarly, Paul et al. (2012, pp. 164–192) investigated the long-term effects of remittances on the living standards of poor rural households in Mexico over the long term and concluded that these remittances could lead to sustained income growth if part of them is invested in productive activities. Abdelhadi and Bashayreh (2017, pp. 98–102) utilized the VEC model to analyze Jordan and found a significant positive relationship between foreign remittances and economic growth in both the short and long term.

Bucevska (2022, pp. 79–94) employed panel regression with a fixed-effects model to examine the role of remittances as a driver of economic growth in six South-East European (SEE) countries and found that remittances significantly and positively influence economic growth across the SEE region. Kumar et al. (2018, pp. 95–126) examined the impact of remittances on the economies of Kyrgyzstan and North Macedonia, highlighting the role of banks and pension funds. In both countries, remittances are considered a source of income that promotes socio-economic development and contributes to economic growth. Adela and Meyer (2013, pp. 3–19) examined data from 21 developing countries to assess

the influence of remittances on different dimensions of economic development and revealed that significant economic growth was recorded in countries with substantial inflows of remittances compared to others. Olofsdotter and Abdullaev (2011, pp. 16–31) explored the effect of remittances on economic growth in countries across Asia and the former Soviet Union. Using regression analysis, they found that remittances have a positive effect on per capita income growth in the 10 countries studied. Comes et al. (2018, pp. 1–16) analyzed seven Central and Eastern European countries with a GDP per capita of $25,000 and found that foreign direct investments have a greater impact on GDP than remittances.

Data and Methodology
The analysis considers quarterly data on the following variables for the Republic of Armenia (RA) from 1996 to 2024: nominal GDP[1] (GDP), real GDP (GDPR), personal remittances from abroad (TRANS), exports (EX), imports (IM), private consumption expenditures (CC), and gross investments (INV). The data sources are the databases of the Central Bank of Armenia and the Statistical Committee of the RA. The research was conducted using the ARDL class model and Vector error correction models.

In addition to the personal remittances from abroad and real GDP variables, the research also considered the expenditure components of GDP, which affect economic growth and help improve the model as macroeconomic variables. Later, the personal consumption expenditure variable was removed from the models.

Stationary time series were considered in the regression model. To test the stationarity of the series, the Augmented Dickey-Fuller (ADF) unit root test was applied, which estimates the following equation:

$$\Delta X_t = \beta_1 + \gamma X_{t-1} + \beta_2 t + \sum_{i=1}^{k} c_i \Delta X_{t-i} + \varepsilon_t \quad (1)$$

In (1), $\beta_1, \beta_2, \gamma, c_i$ are coefficients, t is the time or trend variable, and ε_t is the random error, which represents a White Noise process. The ADF tests the null hypothesis $\gamma = 0$. If this hypothesis is accepted, the time series has a unit root and is therefore non-stationary. To achieve stationarity, the differencing operator is applied.

If there is no cointegration, the ARDL class model for two explanatory variables is presented by the following formula:

$$\Delta y_t = \alpha_0 + \alpha_1 \Delta Y_{t-1} + \cdots + \alpha_P \Delta Y_{t-P} + \beta_0 \Delta X_{1,t} + \beta_1 \Delta X_{1,t-1} + \cdots + \beta_q \Delta X_{1,t-q} + \gamma_0 \Delta X_{2,t} +$$
$$\gamma_1 \Delta X_{2,t-1} + \cdots + \gamma_k \Delta X_{2,t-k} + \varepsilon_t, \quad (2)$$

where y_t is the dependent variable, X_{jt} is the j-th explanatory variable, β_j is the j-th parameter, and ε_t is the random error.

Using the VEC model, a long-run relationship between Armenia's economic growth and personal remittances from abroad has been identified. For the application of the VEC model, the variables must represent a first-order integration process, I(1). According to Engle and Granger (Engle & Granger, 1987, 251-276), if the linear combination ε_t of the I(1) processes X_t and Y_t is an I(0) process, then the variables X_t and Y_t are cointegrated. This means that there is a long-run interdependence between these variables.

If ε_t is an I(0) process, then the equilibrium error for the previous period is represented by the following formula:

$$\varepsilon_{t-1} = Y_{t-1} - \beta_0 - \beta_1 X_{t-1} = Y_{t-1} - \widehat{Y_{t-1}}, \quad (3)$$

where Y_{t-1} is the actual value of Y_t in the previous period, and $\widehat{Y_{t-1}}$ is the equilibrium

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[1] All indicators are measured in million drams.

value. The change in Y_t over time is represented by the following equation:

$$\Delta Y_t = \alpha_0 + \alpha_1 \Delta X_t + \alpha_2 \varepsilon_{t-1} + u_t, (4)$$

where ε_{t-1} is the error correction component of the model. The logic of error correction is as follows: if $\varepsilon_{t-1} \neq 0$, there is no equilibrium, and ε_{t-1} is used to correct the imbalance. $|\alpha_2|$ represents the speed of equilibrium restoration. If $\alpha_2 < 0$, the imbalance is corrected, indicating cointegration and a long-term interdependence.

To identify cointegration among the variables under study, several Vector Autoregression (VAR) models satisfying the stability condition were constructed. The best model was chosen based on the minimum value of the Akaike Information Criterion (AIC). For the selected VAR model, the Johansen cointegration test (Johansen, 1988, pp. 231–254) was applied to examine long-term stable relationships between the variables. For cointegration analysis, the Trace and Maximum Eigenvalue tests were used.

The homoscedasticity, non-autocorrelation, and normal distribution of the residuals of the models were tested using the Breusch-Pagan-Godfrey, Breusch-Godfrey LM, and Jarque-Bera tests, respectively. In the ARDL class model the accuracy of the model specification was confirmed by Ramsey's test.

To assess the quality of the models, the adjusted coefficient of determination ($Adj. R_{sq}$) was used, while the statistical significance of the estimated parameters and hypothesis testing were evaluated using the $t, F, and Chi\_sq$ statistics.

Research Results

All variables included in the analysis exhibit seasonality (Figure 1); therefore, smoothing was performed using the Moving Average method.

Figure 1

Dynamics of variables in 1996-2024.
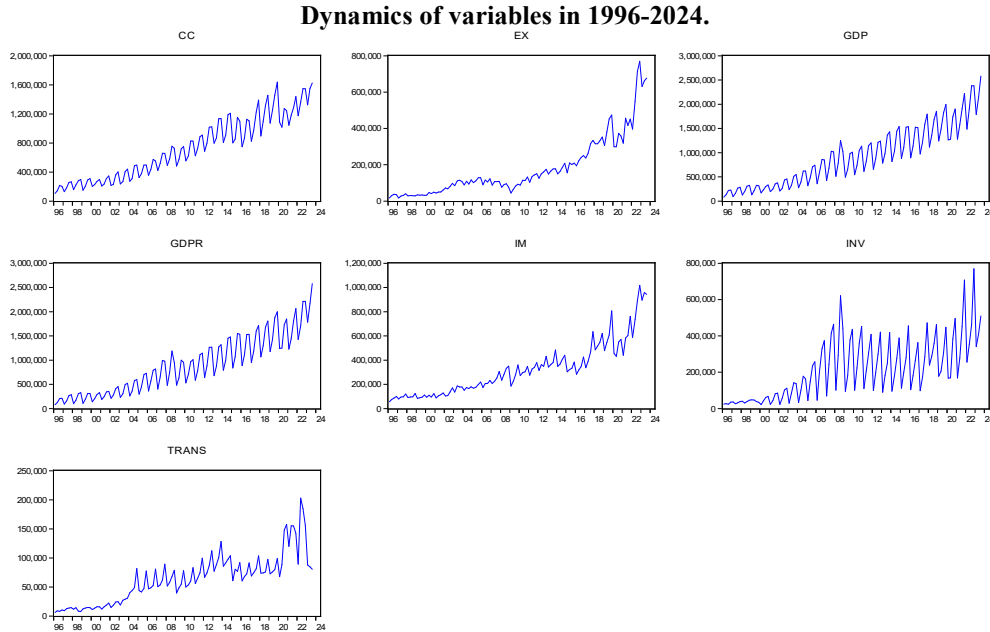
The variables in the model have been used in logarithmic values and made stationary (Figure 2). The stationarity of the variables was tested with the Dickey-Fuller unit root test, which indicated that all variables are I(1) processes (Table 1).

Table 1

Results of the Dickey-Fuller Unit Root Test

| Variables	Test Equation	ADF test stat	5% level	I(d)
d(lcc)	Trend and intercept	-5.6617	-3.4528	I(1)
d(lex)	Trend and intercept	-12.1867	-3.4516	I(1)
d(lgdp)	Trend and intercept	-5.4102	-3,4528	I(1)
d(lgdpr)	Trend and intercept	-5,7192	-3.4528	I(1)
d(linv)	Trend and intercept	-5,9591	-3,4528	I(1)
d(lim)	Intercept	-9,782	-2,8884	I(1)
d(ltrans)	Trend and intercept	-11,5928	-3,451959	I(1)

d indicates first-order differences and l is the natural logarithm

An ARDL (3,2,1,4) model has been constructed to assess the impact of personal remittances from abroad, exports of goods and services, and gross investments on economic growth. The estimated ARDL (3,2,1,4) model is represented by the following equation:

$$d(\text{lgdpr})_t = 0.062 - 0.617 * d(\text{lgdpr})_{t-1} - 0.705 * d(\text{lgdpr})_{t-2} - 0.625 * d(\text{lgdpr})_{t-3} + 0.084 * d(\text{ltrans})_{t-2} + 0.051 * d(\text{linv})_{t-1} + 0.145 * d(\text{lex})_{t-4} + e_t \quad (5)$$

Figure 2

Smoothed and Logged Series of Variables.
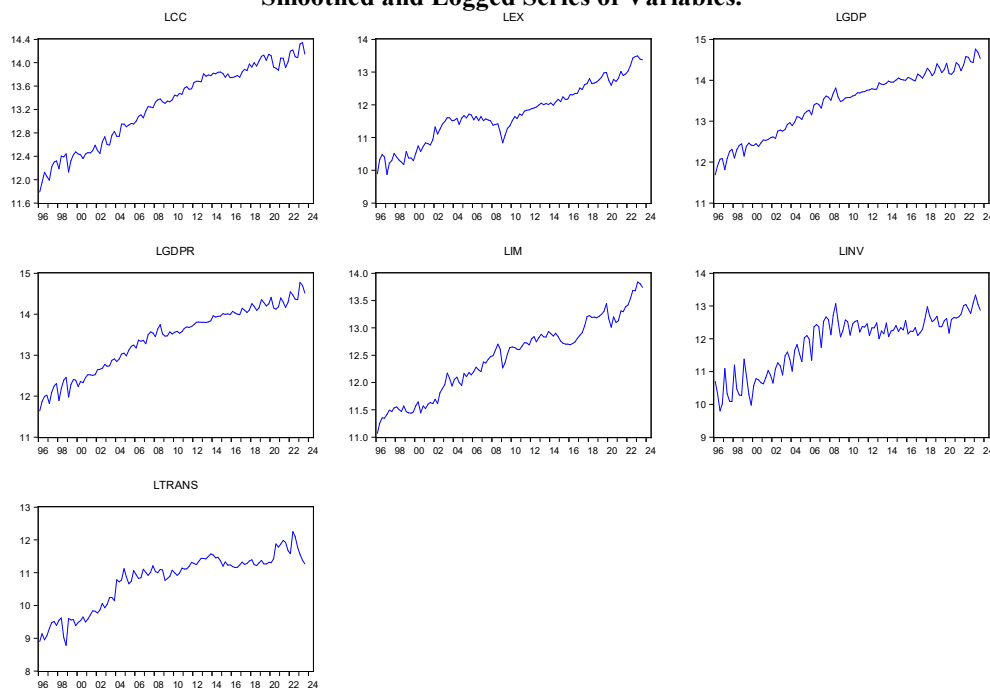
According to the results of the Breusch-Pagan-Godfrey Heteroskedasticity Test, the residuals of the model are homoscedastic (Obs*R-squared=6.181835, Prob. Chi-Square = 0.5187). The Breusch-Godfrey Serial Correlation LM Test results show that the residuals

are not autocorrelated (Obs*R-squared=5.361750, Prob. Chi-Square = 0.0685). The results of the Jarque-Bera Normality Test indicate that the residuals follow a normal distribution (Prob. JB = 0.304724). According to the Ramsey Reset Test, the model specification is correct (Prob. F-stat = 0.1949) (Table 2). There is no multicollinearity in the model, as the VIF for all explanatory variables is less than 5.

Table 2

Estimated Coefficients of the Regression Model and Residual Tests

	Dependent Variable: D(LGDPR)		
Variables	**Coefficient**	**Variables**	**Coefficient**
C	0.061684*[6.637949]		
D(LTRANS(-2))	0.083710***[1.867219]	D(LGDPR(-1))	-0.617452*[-8.611452]
D(LINV(-1))	0.051404**[2.400609]	D(LGDPR(-2))	-0.704968*[-10.18915]
D(LEX(-4))	0.144950*[2.895828]	D(LGDPR(-3))	-0.624819*[-8.497375]
Adjusted R-sq.	0.650075		
F-statistic	28.86632		
Prob(F-statistic)	0.000000		
Heteroskedasticity Test: Breusch-Pagan-Godfrey		**Breusch-Godfrey Serial Correlation LM Test**	
Obs*R-squared	6.181835	Obs*R-squared	5.361750
Prob. Chi-Square(7)	0.5187	Prob. Chi-Square(2)	0.0685
Jarque-Bera Normality Test		**Ramsey RESET Test**	
Jarque-Bera	2.376696	F-statistic	1.703432
prob(JB)	0.304724	Probability	0.1949

*1% **significance** level, **5% level, ***10% level, and t-statistics in [ ]

The estimates obtained using the method of Least Squares provide the basis to conclude that a 1% increase in gross investments leads to a 0.05% increase in economic growth in the following quarter, while a 1% increase in exports contributes to a 0.15% increase in economic growth four quarters later, ceteris paribus. In the short run, personal remittances from abroad do not have a statistically significant effect on economic growth at the 5% level, but they have a significant effect at the 10% level (a 1% increase in external personal remittances leads to a 0.08% increase in economic growth two quarters later at the 10% significance level).

To examine the long-run relationship between personal remittances from abroad and economic growth, a Vector Autoregression (VAR) model was initially constructed, including real GDP, personal remittances from abroad, exports (endogenous variables), and imports (exogenous variable). Based on LR, FPE, AIC, SC, and HQ criteria, models with lags of 3, 4, 7, and 8 were suggested. VAR models with these lags were constructed, and based on minAIC, the model with 8 lags was selected as the best model. The characteristic polynomial of the VAR model shows that all roots have absolute values smaller than one, thus satisfying the stability condition (Figure 3).

The results of the Granger causality test were used to examine the presence of causality between the variables. The test revealed unidirectional causality between personal remittances from abroad and economic growth, with remittances driving changes in economic growth (Chi-sq = 15.85299, Prob(Chi-sq) = 0.0445). However, economic growth does not lead to changes in remittances (Chi-sq = 10.77362, Prob(Chi-sq) = 0.2149). Additionally, there is bidirectional causality between economic growth and exports (Table 3).

Roots of the Characteristic Polynomial of the VAR Model
Inverse Roots of AR Characteristic Polynomial
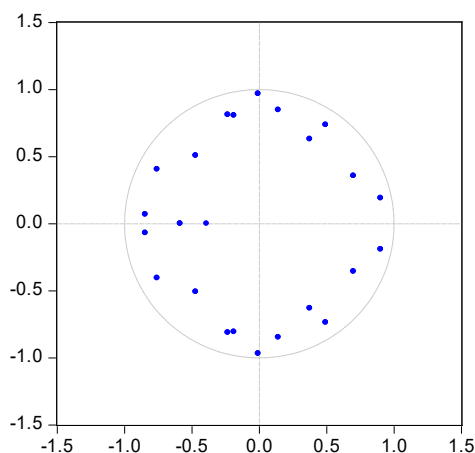
Source: calculations of authors.

Table 3

Granger Causality Test

Dependent variable: D(LGDPR)				Dependent variable: D(LTRANS)			
Excluded	Chi-sq	df	Prob.	Excluded	Chi-sq	df	Prob.
D(LTRANS)	15.85299	8	0.0445	D(LGDPR)	10.77362	8	0.2149
D(LEX)	16.28726	8	0.0384	D(LEX)	27.61006	8	0.0006
All	29.20345	16	0.0226	All	38.57280	16	**0.0013**
Dependent variable: D(LEX)							
Excluded	Chi-sq	df	Prob.				
D(LGDPR)	15.66155	8	0.0475				
D(LTRANS)	14.01428	8	0.0475				
All	26.82112	16	**0.0435**				

To assess the existence of a long-run relationship between the variables, the Johansen cointegration test was applied. Both the Trace and Max-eigenvalue tests indicate the presence of cointegration (Table 4).

Table 4

Johansen Cointegration Test

Hypothesized No. of CE(s)	Trace Statistic	0.05 Critical Value	Max-Eigen Statistic	0.05 Critical Value
None *	52.59072	29.79707	24.51845	21.13162
At most 1 *	28.07227	15.49471	21.81159	14.26460
At most 2 *	6.260675	3.841466	6.260675	3.841466
	Trace and Max-eigenvalue tests indicate 3 cointegrating eqn(s) at the 0.05 level			

* denotes rejection of the hypothesis at the 0.05 level

Based on the results of the cointegration test, a VEC model was constructed (Table 5).

VEC model

Vector Error Correction Estimates			
Cointegrating Eq:	CointEq1		
LGDPR(-1)	1.000000		
LTRANS(-1)	-0.418906		
	(0.07760)		
	[-5.39803]		
LEX(-1)	-0.354128		
	(0.07227)		
	[-4.90023]		
C	-4.762229		
Error Correction:	**D(LGDPR)**	**D(LTRANS)**	**D(LEX)**
CointEq1	-0.159231	-0.421186	-0.247055
	(0.06808)	(0.17208)	(0.11090)
	[-2.33894]	[-2.44766]	[-2.22772]
D(LGDPR(-1))	-0.417769	0.306542	0.062690
	(0.10809)	(0.27322)	(0.17608)
	[-3.86491]	[1.12196]	[0.35602]

Standard errors in ( ) and t-statistics in [ ]

The residuals of the VEC model are homoscedastic (Chi-sq = 353.6423, Prob(Chi-sq) = 0.0521), not autocorrelated (Prob(LM-Statistic) > 0.05), and normally distributed (Jarque-Bera = 11.37375, Prob(Jarque-Bera) = 0.0775). The Error Correction component for real GDP has a negative sign (-0.159) and is statistically significant (t-statistic = -2.33894), indicating that exports and remittances from abroad have a long-run impact on real GDP. The speed of equilibrium restoration is 15.9%. The Error Correction components for remittances and exports are also statistically significant, and there are 3 cointegrating equations.

The objective of our research is to assess the macroeconomic impact of personal remittances from abroad on economic growth; therefore, real GDP is considered as the variable of interest in the cointegration equation. The cointegration equation is:

$$\ln(GDPR)_t = 4.762 - 0.419\ln(Trans)_t - 0.354\ln(Ex)_t \quad (6)$$

In the long run, a 1% increase in remittances from abroad results in a 0.42% rise in economic growth in Armenia, while a 1% increase in the export leads to a 0.35% increase in economic growth.

Based on the VEC model, the following results were obtained for the short run:

- A 1% increase in exports leads to a 0.15% rise in economic growth three quarters later;
- Personal remittances from abroad do not have a significant short-term impact on economic growth;
- A 1% increase in real GDP leads to a 1.08% decrease in remittances from abroad four quarters later, 1.05% decrease five quarters later, and a 1.22% decrease six quarters later.
- The effect of exports on remittances is not straightforward. A 1% increase in exports leads to a 0.52% decrease in remittances one quarter later, a 0.54% decrease three quarters later, and an increase of 0.48% six quarters later and 0.35% seven quarters later.
- Imports do not have a statistically significant impact on remittances from abroad,

whereas an increase in imports by 1% is associated with a 0.6% increase in exports in the current quarter.

Conclusions

Historically, personal remittances from abroad have been a crucial factor in Armenia's economy. To assess the interaction between remittances from abroad and economic growth, ARDL and VEC models were constructed, and the following results were obtained:

- According to the Granger causality test, there is unidirectional causality between remittances from abroad and economic growth. Remittances are the cause of changes in economic growth, while economic growth is not the cause of changes in remittances.

- According to the ARDL and VEC models, in the short term, personal remittances from abroad do not have a significant impact on economic growth in Armenia.

- ***According to the cointegration equation of the VEC model, in the long term, a 1% increase in foreign transfers contributes to a 0.42% increase in Armenia's real GDP, confirming the initial hypothesis.***

- ***The results of the VEC model also confirm the second hypothesis that an increase in the rate of Economic growth reduces the volume of personal remittances from abroad.***

- According to the ARDL model, an increase in gross investment contributes to economic growth.

- According to the Granger causality test, there is bidirectional causality between economic growth and exports. Both the ARDL and VEC models indicate that an increase in exports contributes to economic growth.

- The impact of exports on foreign remittances is not unambiguous: at first it contributes to a decrease in the volume of remittances, but after 6 quarters it increases them. The growth of export rates indicates an increase in production, which, under conditions of a fixed level of technological progress, is accompanied by an increase in employment, thus leading to higher incomes and a reduction in foreign remittances. The further growth of exports means an increase in total demand due to the rise in the living standards of the population, which, in turn, results in an increase in the prices of goods and services. Inflation causes the volume of remittances to start increasing for needy households.

The findings of the research can serve as a foundation for formulating effective macroeconomic policies in Armenia.

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