Economic Analysis between Gross Domestic Product and Foreign Trade in Romania

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ABSTRACT

Foreign trade is considered a major component of sustainable economic growth. The links between it and the gross domestic product (GDP) have been analyzed in numerous specialized economic works. The developed econometric models have demonstrated the strong connection, both in the short and long term, between these macroeconomic components.

This paper demonstrates once again the long-term and short-term links between these variables by using the VECM (vector error correction) econometric model on the annual GDP, Export and Import data with Romanian agricultural products from the period 1995-2020.

Keywords: *GDP, trade balance, trade efficiency, export, import*
JEL Classification: *F19*

1. INTRODUCTION

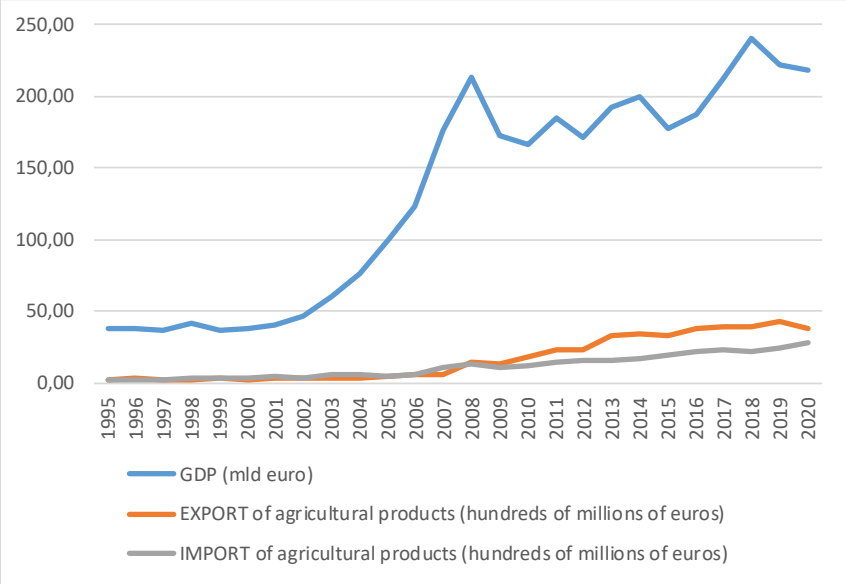
Economic growth is one of the most treated topics in the literature due to the major impact it has on the population of a country. Many studies have tested the dynamics of various factors (export, import) and the process of economic growth (GDP dynamics).

For the three data series, stationarity (unit root test - Dickey-Fuller Augmented), cointegration (Johansen cointegration test) and causality between variables (Granger test and Wald test) were tested.

For the regression equations, generated with the VECM model, the following residue tests were performed: residue normality test (Jarque-Bera test - distribution histogram), residue correlation test (Breusch-Godfrey test) and heteroskedasticity (Breusch-Godfrey test) Pagan-Godfrey and the ARCH test).

Evolution of GDP, exports and imports of agricultural products

Figure 1



Source: author's calculation based on http://unctadstat.unctad.org/wds/TableViewer/tableView.aspx and http://statistici.insse.ro:8077/tempo-online/#/pages/tables/insse-table

2. ECONOMIC ARGUMENTATION / LITERATURE REVIEW

The relationship between economic growth (GDP) and external trade (export and import) has long been one of the most debated aspects of international economic development, with a special focus on research. Fundamental economic theories show the contribution of exports to economic growth through the element called the multiplier effect of foreign trade (Tekin, 2012). At the same time, the increase of exports generates an increase of the degree of economic opening, because the respective economies will be able to absorb more quickly the technology of the more developed countries (Hart, 1983). Increasing global factor productivity will positively influence, in the long run, the rate of economic growth. At the same time, trade (import) allows faster access to high technologies, which is an important factor for sustainable economic growth.

Most experts deem that a country's persistent trade deficit is unfavorable, constituting a deterrent factor for sustainable growth of GDP. In the economic literature there are also more balanced opinions considering as dangerous only deficits caused:

- by loans used to finance current consumption to a greater extent than financing long-term investments
- by reducing labor force employment
- as outcome of intensified inflationist processes.

External trade is considered an important component of sustainable economic growth. The links between it and GDP have been analyzed in many specialized economic papers. The developed econometric models have demonstrated the strong connection, both in the short and long term, between these macroeconomic indicators.

3. RESEARCH METHODOLOGY

Selection of the research method

A VEC model was used to generate the regression equation, after testing the stationarity of the selected series (unit root test - Dickey-Fuller Augmented), cointegration (Johansen cointegration test) and causality between variables (Granger test and Wald test).

Selection of variables

In the study of the economic interdependence between GDP, export and import were used the annual data from 1995-2020 and were considered, in turn, GDP, export and import as dependent variables and the other variables, independent variables, as follows:

- dependent variable: GDP and independent variables: export, import
- dependent variable: export and independent variables: GDP, import
- dependent variable: import and independent variables: GDP, export

Description of variables

Gross domestic product (GDP) is a macroeconomic indicator that reflects the sum of the market value of all goods and services intended for final consumption, produced in all branches of the economy within a country within one year.

The Gross Domestic Product, according to the expenditure method, is:

$$GDP = CF + FBCF + \Delta S + (E - I)$$

where:
CF - final consumption,
GFCF - gross fixed capital formation,
ΔS - stock change,
I - import and
E - export.

Exports of goods and services consist of transactions in goods and services (sales, barter, donations, etc.) made by residents to non-residents.

Imports of goods and services consist of transactions in goods and services (purchases, barter, donations, etc.) made by non-residents to residents.

Theoretical presentation of the proposed analysis

For the three data series (GDP, export and import of agricultural goods) were tested:

- stationarity - unit root test - Dickey-Fuller Augmented,
- cointegration - Johansen cointegration test and
- causal link between variables (Granger test and Wald test).

For the regression equation, generated with the VECM model, were did the residue tests:

- residue normality test (Jaque-Bera test - Distribution histogram),
the residue correlation test (Breusch-Godfrey test) and
- heteroskedasticity (Breusch-Pagan-Godfrey test and ARCH test).

4. DATA ANALYSIS

4.1. Basic statistics

The table below shows the basic statistics (Summary Statistics: max, min, average, and SD values) for each variable in question (average, median, maximum, minimum, standard deviation, etc.):

Basic statistics

Table 1

	GDP	Export	Import
Mean	131.03	16.56	11.17
Median	169.16	9.57	10.42
Maximum	240.35	42.89	27.24
Minimum	35.84	2.12	1.83
Std.Dev.	75.17	15.24	8.03
Skewness	-0.16	0.50	0.45
Kurtosis	1.35	1.57	1.86
Jarque-Bera	3.05	3.33	2.30
Probability	0.22	0.19	0.32
Sum	3406.80	430.59	290.36
Sum Sq. Dev.	141255.5	5805.00	1613.93
Observations	26	26	26

Author's calculation in EViews, based on http://unctadstat.unctad.org/wds/TableViewer/tableView.aspx and http://statistici.insse.ro:8077/tempo-online/#/pages/tables/insse-table

Based on these statistics, we can establish that the value of GDP is between 35.84 billion Euros in 1997 and 240.35 billion Euros in 2018. The average value of this indicator for the period 1995-2020 is 131.03 billion Euros. The values related to the Skewness and Kurtosis tests show us that the considered distribution is not a perfectly symmetrical one, predominating the values located between the average and the maximum of the data series (the median of the series is higher than the average of the series).

For exports, the values are between 2.12 in 1998 and 42.89 in 2019. The average value of this indicator for the period 1995 - 2020 is 16.56. The values related to the Skewness and Kurtosis tests allow us to state that the considered distribution is not a perfectly symmetrical one, predominating the values located between the minimum and the average of the data series (the median of the series is much lower than the average of the series).

Imports have values between 1.83 in 1995 and 27.24 in 2020. The average value of this indicator for the period 1995-2019 is 11.17. The values related to the Skewness and Kurtosis tests allow us to state that the considered distribution is almost symmetrical (the median of the series is close to the average of the series).

4.2. Stationary and integration series tests

Series Stationarity Test (Unit Root Test - Dickey-Fuller Augmented)

1. Unit root test for GDP series in level

a. Series in level, model without constant and without trend

Unit root test without constant and without trend

Table 2

Null Hypothesis: D(GDP) has a unit root
Exogenous: None
Lag Length: 3 (Automatic – based on SIC, maxlag=12

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.480309	0.0134
Test critical values:	1% level	-2.589531	
	5% level	-1.944248	
	10% level	-1.614510	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(GDP,2)
Method: Least Squares
Date:01/10/22 Time: 10:38
Sample (adjusted): 1995 2020
Included observation: 25 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob
D(GDP(-1))	-0.336736	0.135764	-2.480309	0.0150
D(GDP(-1),2)	-0.402145	0.134316	-2.994016	0.0035
D(GDP(-2),2)	-0.308602	0.122368	-2.521914	0.0134
D(GDP(-3),2)	-0.317283	0.097903	-3.240779	0.0017

R-squared	0.415182	Mean dependent var	-0.163158
Adjusted R-squared	0.395903	S.D. dependent var	647.9767
S.E. of regression	503.6314	Akaike info criterion	15.32276
Sum squared resid	23081657	Schwarz criterion	15.43029
Log likelihood	-723.8311	Hannan-Quinn criter	15.36621
Durbin-Watson stat	2.036466		

Author's calculation in EViews, based on http://unctadstat.unctad.org/wds/TableViewer/tableView.aspx and http://statistici.insse.ro:8077/tempo-online/#/pages/tables/insse-table

The value of the ADF test is -2.480309, higher than the critical threshold in the DF distribution for the 1% level (-2.589531). We reject the null hypothesis.

b. Series in level, the model with a constant:

Unit root test with a constant

Table 3

Null Hypothesis: GDP has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic – based on SIC, maxlag=12

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		1.764290	0.9997
Test critical values:	1% level	-3.497727	
	5% level	-2.890926	
	10% level	-2.582514	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(GDP)
Method: Least Squares
Date:01/10/22 Time: 10:50
Sample (adjusted): 1995 2020
Included observation: 25 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob
GDP(-1)	0.012802	0.007256	1.764290	0.0808
C	-129.1668	214.1636	-0.603122	0.5478

R-squared	0.031092	Mean dependent var	237.9091
Adjusted R-squared	0.021103	S.D. dependent var	510.5735
S.E. of regression	505.1574	Akaike info criterion	15.30761
Sum squared resid	24752845	Schwarz criterion	15.36004
Log likelihood	-755.7268	Hannan-Quinn criter	15.32882
F-statistic	3.112720	Durbin-Watson stat	1.722480
Prob(F-statistic)	0.080831		

Author's calculation in EViews, based on http://unctadstat.unctad.org/wds/TableViewer/tableView.aspx and http://statistici.insse.ro:8077/tempo-online/#/pages/tables/insse-table

The value of the ADF test is 1.764290, higher than the critical threshold in the DF distribution for the level of 5% (-2.890926). We do not reject the null hypothesis: the GDP series in level has a unit root, in the model with a constant. The probability attached to the null hypothesis is 0.9997.

c. Series in level, trendy model:

Unit root test

Table 3

Null Hypothesis: GDP has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic – based on SIC, maxlag=12

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.381831	0.8605
Test critical values:	1% level	-4.053392	
	5% level	-3.455842	
	10% level	-3.153710	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(GDP)
Method: Least Squares
Date: 01/11/22 Time: 12:52
Sample (adjusted): 1995 2020
Included observation: 25 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
GDP(-1)	-0.038400	0.027790	-1.381831	0.1702
C	690.2619	478.8670	1.441448	0.1527
@TREND("1995")	12.97427	6.803923	1.906880	0.0595
R-squared	0.066452	Mean dependent var		237.9091
Adjusted	0.047003	S.D. dependent var		510.5735
S.E. of regression	498.4298	Akaike info criterion		15.29064
Sum squared resid	23849498	Schwarz criterion		15.36928
Log likelihood	-753.8865	Hannan-Quinn criter.		15.32245
F-statistic	3.416754	Durbin-Watson stat		1.699051
Prob(F-statistic)	0.036860			

Author's calculation in EViews, based on http://unctadstat.unctad.org/wds/TableViewer/tableView.aspx and http://statistici.insse.ro:8077/tempo-online/#/pages/tables/insse-table

The value of the ADF test is -1.381831, higher than the critical threshold in the DF distribution for the level of 5% (-3.455842). We do not reject the null hypothesis: the GDP series in level has a unit root, in the trend model. The probability attached to the null hypothesis (unit root) is 0.8605.

2. The series in the first difference

$$d(GDP_t) = GDP_t - GDP_{t-1}$$

a) the series in the first difference, the model without constant and without trend

Unit root test

Table 4

Null Hypothesis: D(GDP) has a unit root
Exogenous: None
Lag Length: 3 (Automatic – based on SIC, maxlag=12

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.480309	0.0134
Test critical values:	1% level	-2.589531	
	5% level	-1.944248	
	10% level	-1.614510	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(GDP,2)
Method: Least Squares
Date: 01/11/22 Time: 14:52
Sample (adjusted): 1995 2020
Included observation: 25 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(GDP(-1))	-0.336736	0.135764	-2.480309	0.0150
D(GDP(-1),2)	-0.402145	0.134316	-2.994016	0.0035
D(GDP(-2),2)	-0.308602	0.122368	-2.521914	0.0134
D(GDP(-3),2)	-0.317283	0.097903	-3.240779	0.0017
R-squared	0.415182	Mean dependent var		-0.163158
Adjusted R-squared	0.395903	S.D. dependent var		647.9767
S.E. of regression	503.6314	Akaike info criterion		15.32276
Sum squared resid	23081657	Schwarz criterion		15.43029
Log likelihood	-723.8311	Hannan-Quinn criter.		15.36621
Durbin-Watson stat	2.036466			

Author's calculation in EViews, based on http://unctadstat.unctad.org/wds/TableViewer/tableView.aspx and http://statistici.insse.ro:8077/tempo-online/#/pages/tables/insse-table

For the series d(GDP) calculated by simply differentiating the series in level, the ADF test does not argue in favor of the unit root hypothesis. The value of the ADF test is -2.480309, lower than the critical threshold in the DF distribution for the level of 5% (-1.944248). In fact, the probability attached to the hypothesis (unit root) is 0.0134, less than 5%.

The ADF test rejects the unit root hypothesis for the level series, but finds no arguments in favor of the unit root hypothesis for the series calculated in the first difference. We say that the GDP series is non-stationary, integrated by order 1, symbolic I (1).

ADF test

Table 5

Variable	Exogenous					
	Non		Constant		Trend	
	ADF test	Critical value 1%	ADF test	Critical value 5%	ADF test	Critical value 5%
GDP	-2.480309	-2.589531	1.764290	-2.890926	-1.381831	-3.455842
d(GDP)	-2.480309	-1.944248	it's not necessary			

Author's calculation in EViews, based on http://unctadstat.unctad.org/wds/TableViewer/tableView.aspx and http://statistici.insse.ro:8077/tempo-online/#/pages/tables/insse-table

Tests for residue diagnosis

- Autocorrelation of errors

The residue correlation test (Breusch-Godfrey test) shows that the errors are not correlated (does not reject the null hypothesis: there is no error correlation - Prob. Chi-Square(1)=0.06>0.05):

Breusch-Godfrey Serial Correlation LM Test:

Table 6

F-statistic	2.515305	Prob. F(2,68)	0.0883
Obs*R-squared	5.510686	Prob. Chi-Square(2)	0.0636

Author's calculation in EViews, based on http://unctadstat.unctad.org/wds/TableViewer/tableView.aspx and http://statistici.insse.ro:8077/tempo-online/#/pages/tables/insse-table

- Homoscedasticity of random errors

Breusch-Pagan-Godfrey and ARCH tests show that errors are not heteroscedastic (do not reject the null hypothesis: errors are homoscedastic):

- Breusch-Pagan-Godfrey test (Prob. Chi-Square(4)=0.07>0.05)

Heteroskedasticity Test: Breusch-Pagan-Godfrey

Table 7

F-statistic	1.830721	Prob. F(12,67)	0.0605
Obs*R-squared	19.75406	Prob. Chi-Square(12)	0.0719
Scaled explained SS	13.93166	Prob. Chi-Square(12)	0.3051

Author's calculation in EViews, based on http://unctadstat.unctad.org/wds/TableViewer/tableView.aspx and http://statistici.insse.ro:8077/tempo-online/#/pages/tables/insse-table

- ARCH test (Prob. Chi-Square(1)=0.97>0.05)

Heteroskedasticity Test: ARCH

Table 8

F-statistic	0.032735	Prob. F(2,75)	0.9678
Obs*R-squared	0.068029	Prob. Chi-Square(2)	0.9666

Author's calculation in EViews, based on http://unctadstat.unctad.org/wds/TableViewer/tableView.aspx and http://statistici.insse.ro:8077/tempo-online/#/pages/tables/insse-table

- *Random errors have normal distribution*

5. CONCLUSIONS

The series stationarity tests (Unit root test - Dickey-Fuller Augmented) indicated that the series are not stationary and become stationary after the first differentiation (export, import), respectively after the second differentiation (GDP). The series cointegration test (Johansen test) indicates the presence of 4 cointegration equations. The Granger short-term causality test shows that there are two-way influence relations between imports and GDP and imports. Unidirectional relations exist between: export and import (export influences import and not vice versa).

Even if it is not the best indicator of human well-being, GDP remains the most complex and accurate tool for judging a nation's well-being. In Romania, the consumption of expensive imported finished products will continue and the cheap basic products will be exported.

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ANNEXES

Annex 1

Dickey-Fuller unit root test Augmented for the GDP data series

a) GDP gross data series

- autoregressive process with non-zero mean

Unit root test

Table 9

Null Hypothesis: GDP has a unit root Exogenous: Constant Lag Length: 8(Automatic – based on SIC, maxlag=10)			
		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.566452	0.4757
Test critical values:	1% level	-3.920350	
	5% level	-3.065585	
	10% level	-2.673460	
*MacKinnon (1996) one-sided p-values.			

Author's calculation in EViews, based on http://unctadstat.unctad.org/wds/TableViewer/tableView.aspx and http://statistici.insse.ro:8077/tempo-online/#/pages/tables/insse-table

- autoregressive process with non-zero mean and trend

Unit root test

Table 10

Null Hypothesis: GDP has a unit root Exogenous: Constant, Linear Trend Lag Length: 10(Automatic – based on SIC, maxlag=10)			
		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-10.04755	0.0000
Test critical values:	1% level	-4.800080	
	5% level	-3.791172	
	10% level	-3.342253	
*MacKinnon (1996) one-sided p-values.			

Author's calculation in EViews, based on http://unctadstat.unctad.org/wds/TableViewer/tableView.aspx and http://statistici.insse.ro:8077/tempo-online/#/pages/tables/insse-table

Annex 2

VAR Lag Order Selection

Table 11

Criteria
Endogenous variables: DGDP DFBCF DEXPBS DIMPBS
Exogenous variables: C
Date: 01/11/22 Time: 16:17
Sample: 1995 2020
Included observations: 25

Lag	LogL	LR	FPE	AIC	SC	HQ
	-2718.963	NA	1.86e+24	67.23366	67.35190	67.28110
	-2649.069	131.1584	4.92e+23	65.90295	66.49417	66.14016
	-2552.480	171.7153*	6.74e+22*	63.91308*	64.97728*	64.34005*

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

Author's calculation in EViews, based on http://unctadstat.unctad.org/wds/TableViewer/tableView.aspx and http://statistici.insse.ro:8077/tempo-online/#/pages/tables/insse-table

Annex 3

VECM model: 1st order differentiated data, 1st order delay and a cointegration equation.

Table 12

Vector Autoregression Estimates
Data: 01/12/22 Time: 11:56
Sample (adjusted): 1995 2020
Included observation: 25 after adjustments
Standard errors in () & t-statistics in []

	GDP	Import	Export
GDP(-1)	1.058294	0.015738	0.012658
	(0.28763)	(0.01978)	(0.03959)
	[3.67933]	[0.79574]	[0.31971]
GDP(-2)	-0.195332	0.016963	0.027321
	(0.26412)	(0.01816)	(0.03635)
	[-0.73956]	[0.93402]	[0.75151]
IMPORT(-1)	3.913094	0.627381	0.421049
	(3.91909)	(0.26948)	(0.53944)
	[0.99847]	[2.32809]	[0.78053]
IMPORT(-2)	-0.799562	-.458253	-0.168640
	(3.92644)	(0.26999)	(0.54045)
	[-0.20364]	[-1.69731]	[-0.31203]
EXPORT(-1)	-2.202919	0.022384	0.325252
	(2.05379)	(0.14122)	(0.28269)
	[-1.07261]	[0.15850]	[1.15054]
EXPORT(-2)	1.114250	0.276888	0.409588
	(2.10240)	(0.14456)	(0.28938)
	[0.52999]	[1.91533]	[1.41538]
C	9.031726	1.102625	-1.520316
	(10.9752)	(0.75467)	(1.51068)
	[0.82292]	[1.46106]	[-1.00638]
R-squared	0.934848	0.973696	0.972044
Adj. R-squared	0.911853	0.964412	0.962177
Sum sq. resids	7965.917	37.66391	150.9232
S.E. equation	21.64679	1.488464	2.979569
F-statistic	40.65450	104.8800	98.51559
Log likelihood	-103.7130	-39.46231	-56.11913
Akaike AIC	9.226084	3.871859	5.259928
Schwarz SC	9.569683	4.215458	5.603527
Mean dependent	138.8321	11.93140	17.70145
S.D. dependent	72.91032	7.890138	15.32057
Determinant resid covariance (dof adj.)		4827.195	
Determinant resid covariance		1715.568	
Log likelihood		-191.5336	
Akaike information criterion		17.71113	
Schwarz criterion		18.74193	
Number of coefficients		21	

Annex 4

Granger short-term causality test

Table 13

Pairwise Granger Causality Tests
Date: 01/12/22 Time 12:02
Sample: 1995 2022
Lags: 2

Null Hypothesis:	Obs	F-Statistic	Prob.
IMPORT does not Granger Cause EXPORT	25	3.81487	0.0416
EXPORT does not Granger Cause IMPORT		1.07221	0.3631
GDP does not Granger Cause EXPORT	25	5.86659	0.0109
EXPORT does not Granger Cause GDP		0.41409	0.6671
GDP does not Granger Cause IMPORT	25	0.97483	0.3963
IMPORT does not Granger Cause GDP		0.36831	0.6970

Author's calculation in EViews, based on http://unctadstat.unctad.org/wds/TableViewer/tableView.aspx and http://statistici.insse.ro:8077/tempo-online/#/pages/tables/insse-table