THE ECONOMETRIC MODELLING OF ROMANIA'S FOREIGN TRADE WITH DEVELOPING COUNTRIES

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Abstract
In the present paper we analysed the transmission of the variations in the domestic demand and the EUR/RON exchange rate to the imports from developing countries, using a methodology that is based on the analysis of the cointegrating vectors and the error correction vectors. Departing from quartely data for 2007-2017, the cointegration analysis has highlighted the fact that there is a long-term stationary relationship between the variables included in the analysis. The weak exogeneity tests have shown that both domestic demand, and EUR/RON exchange rate are not adjusted if various shocks determine the deviation of imports from developing countries from the long-term equilibrium. In addition, in the short term, the error correction term has a negative sign and is significant. In other words, if in the previous quarter imports from developing countries were higher than the equilibrium level, they will decrease in the current quarter. These results were achieved under the conditions that the investigated period was characterized by the Great Recession and its recovery. In this context, for net importing companies, the share of the loans granted in the total debt accumulated by non-financial corporations increased from 8.99 percent in 2008Q2 to 24 percent in 2017Q2, along with the rise in non-performing loans from 0.07 percent to 6.5 percent. Moreover, at the end of June 2017, the rate of return on capital amounted to 16 percent, compared with 15 percent for the net exporting companies and 17 percent for the whole non-financial corporations sector.

Keywords: Developing countries, Imports, Exports, Exchange rate, Vector Error Correction Model, Granger causality

JEL Classification
C51, E1, F1

Introduction

In Romania, the trade balance with developing countries gradually improved from -4.5 percent of GDP in 2007 to -1.3 percent of GDP in 2012. Subsequently, in 2013, as exports increased and due to structural adjustments, the trade balance with developing countries stood at 0.1 percent of GDP, oscillating over the next 4 years around the average of -1.3 percent of GDP. During 2007-2017, in the case of Romania's foreign trade with developing countries, the export effort remained within the range of 5.8-10.2 percent, while the penetration rate of imports ranged from 9.8-11.3 percent. In addition, it should be noted that the annual change in the value structure of both exports and imports was supported by more than 63 percent of the following 3 groups of goods: machinery and transport equipment; mineral fuels, lubricants and related materials; manufactured goods classified chiefly by materials. In 2017, 51.7 percent of the exports to developing countries were destined for Asia, 7.3 percent for Africa and 2.4 percent for South America. In contrast, on the import side, 67.2 percent of the purchases from developing countries came from Asia.

In this context, this study aims to analyse the relationship between the imports from developing countries and the determinants, using a methodology based on the analysis of the cointegration vectors and error correction vectors. With the discovery of the importance of the stochastic trends of economic variables and the development of the cointegration analyses, models have been developed to enable separation of the long-term relationship from the short-term dynamics. The long-term relationship also called the cointegration relationship is associated with an economic dependence, while the short-term dynamics represents the adjustment of model towards the long-term relationship. VEC models (vector error correction) allow the separation of long-term components from the short-term components in the data generation process (Păuna, 2007). Integrating short-run dynamics with long-run equilibrium was first investigated by Granger (1986), and then by Engle and Granger (1987). The use of this model has become in the last decade, an empirical approach that makes sense only if the included series have a long-term relationship, meaning they are cointegrated. This means not only that all series should be integrable of order one and that the residual terms to belong to stationary series, but imposes the conditions for there to be at least a linear combination of the basic series that is stationary (Albu et al., 2003). According to Juselius &Toro (2005), the cointegration property is invariant to changes in the set of information. Any result obtained by using the cointegration technique on the base variables of the model could also be obtained in the case of a more extensive analysis. Thus, the vector error correction model allows us to answer important questions in order to adopt commercial policy measures, such as: "How do imports from developing countries respond to the variation on the domestic demand in the short term?"

The paper is structured as follows: Section 2 presents the econometric model used. Section 3 describes the data used, the results provided by the econometric model and their interpretation. Section 4 includes the final conclusions.

The econometric model

In the present paper we opted to use the Johansen cointegration procedure in order to investigate the existence of a common stochastic trend between the imports from developing countries and the determinants. In this regard, we followed the procedure described by Enache (2015), that is based on a Vector Autoregression model of order p (VAR(p)) with the following standard representation:

$$Z_t = A_1Z_{t-1}+A_2Z_{t-2}+\ldots+A_pZ_{t-p} +e_t \qquad (1)$$

where:

Z_t is a (nx1) vector of variables that are integrated of order one;

$A_1, A_2,\ldots,A_p$ are (nxn) coefficient matrices;

e_t is a (nx1) vector of errors with $E(e_t) =0$ and the covariance matrix that is positely defined invariant in time $E(e_te_t')=\Sigma_e$ (white noise).

Equation (1) can be represented in an error correction form, i.e:

$$\Delta Z_t = \Pi Z_{t-1} + \sum_{i=1}^{p-1} \varpi_i \Delta Z_{t-i} + e_t \qquad (2)$$

where:

$$\varpi_i = -\sum_{j=i+1}^{p} A_j \quad \text{and} \quad \Pi = \sum_{i=1}^{p} A_i - I \ .$$

The ϖ_i coefficients contain information on the short-term dynamic deviation, while the Π matrix includes items on the features of the long-term model. The Π matrix rank reveals the presence and number of existing cointegration vectors between the n variables in the Z_t vector. If the Π matrix has a reduced rank r<n, it can be decomposed into α and β matrices of nxr order with rank (α) = rank (β) = r and can be written as Π=αβ'. Under these conditions equation (2) becomes:

$$\Delta Z_t = \alpha\beta' Z_{t-1} + \sum_{i=1}^{p-1} \varpi_i \Delta Z_{t-i} + e_t \tag{3}$$

$$\Delta Z_t = \alpha\eta_{t-1} + \sum_{i=1}^{p-1} \varpi_i \Delta Z_{t-i} + e_t \tag{4}$$

where:

β is the cointegration vector matrix, α is the matrix of the adjustment coefficients reflecting the speed with which ΔX_t converges towards the long-term equilibrium relationship. The cointegration vectors are linear combinations of the variables that are integrated of order one from Z_t which are stationary, so that β'Xt-1=ηt-1 is I(0).

The maximum likelihood estimators of β are determined as the eigen vectors related to the highest r eigenvalues. The eigenvalues of matrix Π $(1 > \hat{\chi}_1 > ... > \hat{\chi}_n > 0)$, equal to the square of the canonical correlation between ΔZ_t and Z_{t-1}, conditioned by ΔZ_{t-1} ,…, ΔZ_{t-n}, are estimated in order to determine the number of cointegration vectors. Thus, the nonzero estimated values indicate the r rank of matrix Π.
In order to identify the number of cointegration vectors, two LR (Likelihood Ratio) tests type were used, namely:

1. The trace test verifies the null hypothesis of the existence of r cointegration vectors, given the alternative of n cointegration vectors (in which the series are stationary), for r=0,1,…,n-1:

$$LR_{trace} = -T \sum_{i=r+1}^{n} \ln(1 - \hat{\chi}_i) \tag{5}$$

2. The maximum eigenvalue test verifies the null hypothesis of the existence of r cointegration vectors, given the alternative of r + 1 cointegration vectors, for r=0,1,…,n-1:

$$LR_{\max} = -T \ln(1 - \hat{\chi}_{r+1}) \tag{6}$$

where T is the number of observations.

The two statistical tests do not follow a chi square distribution in general. Among the authors who calculated the critical values are Johansen and Juselius (1990), Osterwald-Lenum (1992), MacKinnon-Haug-Michelis (1999).
If the co-integration condition is observed, the following can be performed:

- tests suggested by the economic theory of exclusion of variables, that take the form of $[\beta_i] = [0]$ for the variable i. The statistical test is described by the following equation:

$$LR = T\sum_{i=1}^{r} \ln\left(\frac{1-\tilde{\chi}_i}{1-\hat{\chi}_i}\right) \tag{7}$$

where:

$\tilde{\chi}_i$ and $\hat{\chi}_i$ are the eigenvalues in the conditions of the estimation of the cointegration vector matrix with restrictions or no restrictions. The statistical test follows a chi square distribution having a number of degrees of freedom equal to the number of restrictions.

- weak exogeneity tests, which involve testing for the restriction $[\alpha_j]=[0]$ for the variable j, in a manner similar to that used in the exclusion test. If the tested hypothesis is accepted, then the variable j has a weak exogenous character. According to Radu (2010), the weak exogeneity of a variable implies that there is no loss of information relevant to the interest parameters of the model when their estimation is made conditional on the variable in question, a process generating the latter not being specified.

The Granger causality can also be studied. Thus, the Granger causality test (1969) shows whether there is statistical relationship between the data series of the variables X and Z. It can be said that X causes Granger on Z, where a forecast of Z made based on the past values of Z and X is better than a forecast made only based on Z values from the previous period. The Granger test is based on the following regression equations:

$$Z_t = \alpha_1 + \sum_{i=1}^{p} a_{1j} Z_{t-i} + \sum_{j=1}^{p} b_{1j} X_{t-j} + u_{1t} \tag{8}$$

$$X_t = \alpha_2 + \sum_{i=1}^{p} a_{2j} Z_{t-i} + \sum_{j=1}^{p} b_{2j} X_{t-j} + u_{2t} \tag{9}$$

which assumes that errors, u_{1t} and u_{2t}, are uncorrelated. Testing the null hypothesis *X does not Granger cause Z*, i.e. H_0: $\sum_{j=1}^{p} b_{1j} = 0$, is performed using the F test.

Data description and model estimation

The empirical analysis examines the reaction of the imports from developing countries to the different shocks in the economy of Romania. The variables that were considered are:

- Imports from developing countries, millions of lei, average prices of 2005 (IMP);
- Domestic demand, millions of lei, average prices of 2005 (ABS);
- EUR/RON exchange rate, average prices of 2005 (CV).

The data series have a quarterly frequency, cover the time interval 2007-2017 and were obtained from the databases of the National Bank of Romania and EUROSTAT. All series have been adjusted to eliminate seasonal factors using a mobile average procedure. Also, all series have been logarithmic. The variables were tested to identify the presence of unit roots using the Augmented Dickey-Fuller test (1979) and the Phillips-Perron (1988) test. The results are presented in table no. 1, from which it can be observed that all variables are first order integrated.

Table no. 1 Tests of Stationarity

	Augmented Dickey-Fuller test		Phillips Perron test	
	Level	First difference	Level	First difference
IMP	-2.463	-5.305*	-3.178	-5.309*
ABS	-0.813	-6.639*	-0.834	-6.622*
CV	-1.951	-8.250*	-2.499	-9.268*

**null hypothesis of unit root existence is rejected at the 1 percent level*

Next, a VAR model was estimated to determine the optimal number of lags to identify a possible long-term equilibrium relationship between the imports from developing countries, the domestic demand and the EUR/RON exchange rate. It took into account the Akaike (1974, 1976) and Hannan Quinn (1979) information criteria that selected 4 lags (table no. 2). Under these conditions, a VEC model with 3 lags of difference was estimated (Neagu & Mărgărit, 2005).

Table no. 2 Criteria for choosing the number of lags

Lag	LogL	LR	FPE	AIC	SC	HQ
0	121.7905	NA	1.20e-07	-7.424406	-7.286993	-7.378858
1	170.9370	86.00636	9.78e-09	-9.933562	-9.383911*	-9.751368
2	181.8262	17.01438	8.84e-09	-10.05164	-9.089748	-9.732798
3	196.5949	20.30694	6.44e-09	-10.41218	-9.038052	-9.956695
4	212.0888	18.39909*	4.67e-09*	-10.81805*	-9.031687	-10.22592*

** 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

Applying the Johansen test (see *Johansen & Juselius*, 1990) for lag 3 highlighted the presence of a cointegration relationship between imports from developing countries, domestic demand and EUR/RON exchange rate at a significance level of 5 percent (table no. 3). The results of multivariate tests on residual terms are generally satisfactory. Residual errors are homoscedastic (a probability of 0.4987), are not auto correlated of the 1st and 2nd order (0.9353 and 0.7377 probabilities for LM tests with 1 and respectively 2 lags) and are normally distributed (a probability of 0.0742 for Jarque Bera multivariate test).

Table no. 3 Johansen Cointegration Test

Null hypothesis	J_{trace}	J_{max}
r=0	45.02623	33.99266
	(0.0004)	(0.0005)
r ≤ 1	11.03357	10.53906
	(0.2094)	(0.1789)
r ≤ 2	0.494512	0.494512
	(0.4819)	(0.4819)

Note: probabilities are in paranthesis ( )

The obtained cointegration relationship (t-statistics in [ ]):

IMP = - 45.758 +3.644*ABS – 3.922*CV
[-3.196] [2.872]

The cointegration relationship shows that at the level of long-term equilibrium, a 1 percent increase in domestic demand leads to a 3.6 increase in imports from developing countries. The over-unity coefficient of domestic demand was obtained when the ratio between investments and final consumption stood at an average level of 34.2 percent during the period 2007-2017, the maximum of 41.5 percent being recorded in 2008, amid the increase of the credit granted to the private sector and the increase of budget expenditures. The depreciation of the national currency by 1 percent leads to a 3.9 percent decrease in imports from developing countries. According to Financial Stability Report of the National Bank of Romania (2008), the risk of depreciation of the national currency lies with the net importing companies selling products on the domestic market and for which the elasticity of the demand in relation to the sales price is higher than one (cannot fully transfer the effect of further depreciation to the customer).
The adjustment speed of the long-term equilibrium is -0.213 (with t-statistic -3.593), which shows that the accommodation of the imports from developing countries to the long-term relationship with the determinants is achieved in about 5 quarters. The results of the weak exogeneity tests show that both the domestic demand and the EUR/RON exchange rate are weak exogenous, indicating that the two variables determine the imports from developing countries and not the reverse (table no. 4).

Table no. 4 Weak exogeneity test

	Value of the test	Probability
Δ ABS	1.5897	0.2217
Δ CV	2.1367	0.1259

Note: The Wald statistic follows an χ^2 (1) distribution, under the null hypothesis according to which the m variable is weak exogenous

Furthermore, we analysed the possible connection between short-term dynamics of the imports from developing countries, the domestic demand and the EUR/RON exchange rate. In this regard, we estimated a short-term restricted error correction model which has the following form:

$$\Delta IMP_t = a_0 + \sum_{i=1}^{2} \alpha_i \Delta IMP_{t-i} + \sum_{i=1}^{2} \beta_i \Delta ABS_{t-i} + \sum_{i=1}^{2} \gamma_i \Delta CV_{t-i} + \lambda EC_{t-i} + e_t \quad (10)$$

Using a general-to-specific methodology (see *Campos et al*, 2005) and eliminating insignificant lags, we obtained the restricted model in table no. 5.
At it can be seen, the Adjustment Speed to the equilibrium is -0.1038 (with a t-statistic of -1.7649), which shows that if in the previous quarter imports from developing countries were higher than the equilibrium level, they will decrease in the current quarter. The imports from developing country are influenced in the short term both by the change in the domestic demand and in the EUR/RON exchange rate, the 2 variables determining how the shock is transmitted to the real economy and the financial system, influencing the macroeconomic balances. The estimated model passed the set of diagnostic tests. The residues are not auto correlated, they are normally distributed and are homoscedastic.

Table no. 5 Restricted error correction model

Dependent variable D(IMP); Method: Least Square;
Sample (adjusted): 2008Q1 2017Q4; Included observations: 40 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Constant	-1.2058	0.6805	-1.7718	0.0881
Δ ABS_{t-1}	1.7686	0.5173	3.4193	0.0021
Δ CV_{t-1}	-1.5269	0.7246	-2.1071	0.0449
EC_{t-1}	-0.1038	0.0588	-1.7649	0.0893
R- squared	0.548	Q-stat(8)	2.191 [0.268]	
Sum squared resid	0.249	ARCH(8)	0.562 [0.794]	
Log likelihood	33.83	White	1.053 [0.534]	
F-statistic	5.261	Jarque Bera	2.252 [0.324]	
Prob (F-statistic)	0.001			

Note: t-statistics in [ ]

The following are the results of the Granger causality test (table no. 6).

Table no. 6 The Granger causality test

	IMP	ABS	CV
IMP		**0.00885**	**0.04250**
ABS	**0.00148**		0.76412
CV	0.23103	0.14951	

Notes: 1. The basic tested hypothesis is: the variable on the line is not Granger caused by the variables on the columns 2. The figures represent the probability (p-value). 3.The figures in bold indicate the rejection of the basic hypothesis at a significant level of 5 percent

The Granger causality test indicated that influences of both the domestic demand and the exchange rate on the imports from developing countries have a predictable character.

Conclusions

In the present paper we analysed the transmission of the variations in the domestic demand and the EUR / RON exchange rate to the imports from developing countries, during 2007 Q1-2017 Q4. Using the Johansen multivariate procedure, we identified the presence of a single cointegration vector between the variables included in the analysis. On the long-term equilibrium level, the cointegrating relationship indicates that the imports from developing countries are positively influenced by the increase of the domestic demand and negatively affected by the depreciation of the national currency. The weak exogeneity tests have shown that there is a unidirectional causal relationship between domestic demand and imports from developing countries, on the one hand, and between EUR/RON exchange rate and imports from developing countries, on the other hand. The investigation of the short-term dynamics, using a restricted error correction model, revealed that the adjustment speed to the short term equilibrium is – 0.1038 (with a t-statistic of -1.7649). The Granger causality test illustrated that the efects of both the domestic demand and the EUR/RON exchange rate on the imports from developing countries have a regular character.

Romania provides technical assistance to developing countries to include trade in their government policies. In this context, in 2017, for this category of countries, the penetration rate of imports was 10.22 percent, while the export effort amounted to 8.02 percent. Furthermore, both trade openness and import cover stand at 16.74 percent and 76.54 percent respectively.

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