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22 December 2014

Online at https://mpra.ub.uni-muenchen.de/62547/
MPRA Paper No. 62547, posted 04 Mar 2015 15:16 UTC

INVESTIGATION ON THE RELATIONSHIP BETWEEN ROMANIAN FOREIGN TRADE AND INDUSTRIAL PRODUCTION

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Abstract: This paper investigates the interactions among the Romanian industrial production, exports and imports after the adhesion to European Union. We employ monthly values testing for the Granger Causality between the variables in a Vector Autoregression framework. Our results indicate significant causalities among the variables, especially the one from the returns of exports to the returns of the industrial production index. We could consider these findings as an argument in favor of the Exports-Led Growth Hypothesis.

Key Words: Industrial Production, Exports, Imports, Granger Causality

JEL classification code: *F40, F43, O40, O49*

1. Introduction

In the last decades, in the context of increasing trade openness, the relationship between the outputs of the economic activity and the foreign trade became a key aspect of the macroeconomic decisions. In the specialized literature there were revealed the complex interactions between the variables of the economic output and the variables of the foreign trade.

The exports could influence the performances of the national economy by various channels. The so-called “Learning by Exporting” mechanism highlights the improvement of firms’ performances due to exports activities (Clerides et al., 1998; Bernard and Bradford Jensen, 1999; Wagner, 2007; Damijan and Kostevc, 2010; Boermans, 2012; De Loeckera, 2013). Beside that, the increase of exports could favor the economic growth by other channels: by offering the economies of scale opportunities, by increasing the real wages, which could stimulate the domestic demands, or by providing foreign currency used in importing the capital goods (McKinnon, 1964; Balassa, 1978; Helpman and Krugman, 1985; Grossman and Helpman, 1991; Rivera - Batiz and Romer, 1991). Such channels supported the so-called "Exports-Led Growth Hypothesis" (ELGH) which is largely used in designing macroeconomic strategies (Michaely, 1977; Balassa, 1978; Krueger, 1978; Feder, 1982; Findlay, 1984; Balassa, 1985; Bhagwati, 1988; Edwards, 1998; Buffie, 1992; Frankel and Romer, 1999). Some studies revealed a reverse causality from economic growth to exports, materialized in so-called "Growth - Led Exports Hypothesis" (GLEH). Some circumstances of the economic growth such as the increase of productivity or the management efficiency growth could lead to the improvement of the domestic competitiveness, stimulating the raise of exports (Krugman, 1984; Bhagwati, 1988; Barro, 1991). The interactions between the exports and the economic growth were confirmed by several empirical researches (Tyler, 1981; Kavoussi, 1984; Jung and Marshall, 1985; Chow, 1987; Hsiao, 1987; Ram, 1987; Afxentiou and Serletis, 1991; Ahmad and Kwan, 1991; Bahmani - Oskoee et al., 1991; Bahmani – Oskoee and Alse, 1993; Henriques and Sadorsky, 1996; Thornton, 1996; Xu, 1996; Lawrence and Weinstein, 1999; Ramos, 2001; Awokuse, 2007; Bahmani - Oskoee, 2009; Pop Silaghi, 2009; Gurgul and Lach, 2010; Ray, 2011; Saad, 2012; Thirunavukkarasu and Sivapalan, 2014).

The imports could influence the economic growth, as the so-called "Imports-Led Growth Hypothesis" (ILGH) stipulates, by facilitating the transfer of the research and development knowledge, by providing raw materials for the industrial production or by providing foreign technology (Grossman and Helpman, 1991; Coe and Helpman, 1995; Lee, 1995; Lawrence and Weinstein, 1999; Humpage, 2000; Mazumdar, 2000; Awokuse, 2007; Chen, 2009; Kim et al., 2009; Azgun and Servinc, 2010). Some studies revealed that the economic growth could also stimulate the imports, as the so-called "Growth -Led Imports Hypothesis" (GLIH) stipulates, by increasing the demand for the raw materials necessary for the industrial production or by the increase of the real wages, which could lead to the demands of some imported goods (Findlay, R. 1984; Barro, 1991; Edwards, 1998; Frankel and Romer, 1999; Chen, 2009; Gurgul and Lach, 2010). Both ILGH and GLIH were confirmed by the results of several empirical researches (Esfahani, 1991; Lawrence and Weinstein, 1999; Ramos, 2001; Awokuse, 2007; Azgun and Servinc, 2010; Gurgul and Lach, 2010; Thirunavukkarasu and Sivapalan, 2014).

The analysis of the relationship between the foreign trade and the outputs of the economic activity has to take into consideration the interactions between exports and imports. Besides the influence through economic growth, there are other channels, such as the fact that many exported goods are produced with imported raw materials (Husted, 1992; Arize, 2002; Irandoust and Ericsson, 2004; Herzer and Nowak - Lehmann, 2005; Narayan and Narayan, 2005; Konya and Singh, 2008; Mukhtar and Rasheed, 2010).

The main indicator employed to describe the outputs of the economic activity to the national level is the Gross Domestic Product (GDP). This variable is also largely used to commensurate the economic growth and the standard of living. However, its use has some limitations, especially the fact that in general it is not calculated to frequencies less than a trimester. An alternative to GDP could be considered the industrial production which reflects the outputs of the industrial sector. This indicator is calculated monthly and it could be used to forecast the GDP.

In this paper we approach the relationship between the Romanian foreign trade and the output of economic activity after the adhesion to European Union. Due to the relative short period of time we employ monthly values of the exports, imports and of the industrial production. We investigate the interactions among these variables in a Vector Autoregression (VAR) framework which allows us to test the Granger causalities. The rest of the paper is organized as it follows: the second part described the data and methodology employed to investigate the interactions between the foreign trade and the industrial production, the third part presents the empirical results and the fourth part concludes.

2. Data and Methodology

In our investigation about the relationship between foreign trade and industrial production we employed monthly values of the industrial production index, provided by the National Institute of Statistics (NIS) from Romania, and of exports and imports, provided by the National Bank of Romania (NBR). Our sample of data covers a period of time from January 2007 to December 2013.

NIS adjusts the industrial production index in accordance to the seasonality and the number of the working day on a month while NBR provide the nominal values of the exports and imports expressed in euro. In order to transpose the exports and imports to forms which are compatible to the industrial production index we adjust them to seasonality (using ARIMA technique) and to the number of the working day on a month. Then we express them in the national currency, deflating and normalizing them. For all three variables we calculate the simple returns using the notations:

- retindpr, as the simple return of the industrial production index;

- retexp, as the simple return of the exports;

- retimp, as the simple return of the imports.

As a preliminary stage of the VAR analysis we investigate the stationarity of the three returns by performing the Augmented Dickey – Fuller (ADF) unit root tests with intercept as deterministic term (Dickey & Fuller, 1979). We use the Akaike Information Criteria to select the numbers of lags of the ADF regressions (Akaike, 1973).

As we mentioned before, we reveal the interactions among the three returns by employing VAR models (Sims, 1980; Lütkepohl, 2011). The three equations of a VAR model used in this investigation are described by the formula:

$$Y_t = c + \Pi_1 \times Y_{t-1} + ... + \Pi_k \times Y_{t-k} ... + \Pi_p \times Y_{t-p} + \varepsilon_t \qquad (1)$$

where:

- Y_t = ($retindpr_t$, $retexp_t$, $retimp_t$)’ is the vector of the three dependent variables;

- c is an (3x1) vector of the constant terms;

- Π_k are the (3x3) coefficient matrices ($1 \le k \le p$);

- p is the number of lags;

- ε_t is an (3x1) vector of the error terms.

The numbers of lags of the VAR models are selected by three information criteria:

- the Akaike Information Criterion (AIC) proposed by Akaike (1973);

- the Schwarz Bayesian Information Criterion (BIC) proposed by Schwarz (1978);

- the Hannan-Quinn Information Criterion (HQC) proposed by Hannan and Quinn (1979).

In the VAR framework we test for the Granger causalities among the three returns (Granger 1969; Granger, 1988).

3. Empirical Results

3.1. Stationarity Analysis

We perform the ADF tests on the returns of exports, imports and industrial production. The results, presented in the Table 1, indicate the stationarity of all returns.

Table 1 - Results of the ADF tests for the three returns

Return	Number of lags	Test statistics
retindpr	3	-3.17528***
retexp	2	-4.9792***
retimp	2	-4.3709***

Note: *** means significant at 0.01 levels.

3.2. The number of lags selection

We select the number of lags for the VAR models using the three criteria: AIC, BIC and HQC. We take into consideration a maximum 5 number of lags. The criteria values, presented in the Table 2, indicate different numbers of lags:

- for the Akaike Information Criterion, 3 lags;

- for the Schwarz Bayesian Information Criterion, 1 lag;

- for the Hannan - Quinn Information Criterion, 2 lags.

We employ VAR models for each of the number of lags selected by the three criteria.

Table 2 - The optimum number of the lags for the VAR models

Number of lags	Criterion		
	AIC	BIC	HQC
1	17.179600	17.542171*	17.324744
2	16.982579	17.617078	17.236581*
3	16.967497*	17.873923	17.330356
4	17.136674	18.315029	17.608391
5	17.143326	18.593609	17.723901

Note: The asterisks indicate the best values of the respective information criteria.

3.3. Analysis in a VAR(1) framework

The Table 3 reports the first equation (with retindpr as dependent variable) of VAR(1) model. We found significant coefficients for the first lagged values of retindpr and retexp.

Table 3 - The first equation (with retindpr as dependent variable) of VAR(1) model

Variable	*Coefficient*	*Std. Error*	*t-ratio*	*p-value*
const	0.561461	0.507738	1.1058	0.27221
retindpr_1	0.839185***	0.0802259	10.4603	0.00001
retexp_1	0.42201***	0.13028	3.2392	0.00176
retimp_1	0.13258	0.119069	1.1135	0.26893
Adjusted R-squared	0.588502			
F(3, 78)	39.61396			
P-value(F)	0.00001			

Note: *** means significant at 0.01 levels.

For the second equation (with retexp as dependent variable) of VAR(1) model we found a significant coefficient for the first lagged value of retexp (Table 4).

Table 4 - The second equation (with retexp as dependent variable) of VAR(1) model

Variable	*Coefficient*	*Std. Error*	*t-ratio*	*p-value*
const	0.4512	0.637287	0.7080	0.48105
retindpr_1	0.118795	0.100695	1.1797	0.24169
retexp_1	0.61368***	0.16352	3.7529	0.00033
retimp_1	0.160548	0.14945	1.0743	0.28602
Adjusted R-squared	0.176145			
F(3, 78)	6.772764			
P-value(F)	0.000406			

Note: *** means significant at 0.01 level.

The parameters of the third equation (with retimp as dependent variable) of the VAR(1) model are presented in the Table 5. We found significant coefficients for the first lagged values of retindpr and retexp.

Table 5 - The third equation (with retimp as dependent variable) of VAR(1) model

Variable	*Coefficient*	*Std. Error*	*t-ratio*	*p-value*
const	-0.360805	0.698072	-0.5169	0.60672
retindpr_1	0.24798**	0.1103	2.2482	0.02738
retexp_1	0.465641**	0.179117	2.5996	0.01116
retimp_1	-0.0871174	0.163704	-0.5322	0.59613
Adjusted R-squared	0.168614			
F(3, 78)	6.475880			
P-value(F)	0.000569			

Note: ** means significant at 0.05 levels.

In the framework of VAR(1) we test for the Granger causality among the returns. The results, presented in the Table 6, indicate the following causalities:

- from retindpr to retimp;

- from retexp to retindpr and retimp;

- from retimp to retindpr.

Table 6 - Granger causality tests in the VAR(1) framework

Null hypothesis	F-statistic	p-value
retindpr do not Granger-cause retexp	1.8599	0.1746
retindpr do not Granger-cause retimp	3.0461	0.0829
retexp do not Granger-cause retindpr	12.5357	0.0005
retexp do not Granger-cause retimp	4.7290	0.0311
retimp do not Granger-cause retindpr	2.9647	0.0871
retimp do not Granger-cause retexp	1.6177	0.2053

3.4. Analysis in a VAR(2) framework

For a VAR(2) model, the parameters of the first equation (with retindpr as dependent variable) are presented in the Table 7. The results consisted in significant coefficients of the first lagged values of retindpr and retexp.

Table 7 - The first equation (with retindpr as dependent variable) of VAR(2) model

Variable	*Coefficient*	*Std. Error*	*t-ratio*	*p-value*
const	0.596093	0.525491	1.1344	0.26031
retindpr_1	0.687225***	0.149189	4.6064	0.00002
retindpr_2	0.170687	0.140792	1.2123	0.22924
retexp_1	0.362669**	0.150267	2.4135	0.01827
retexp_2	-0.120133	0.143809	-0.8354	0.40620
retimp_1	0.1385	0.126669	1.0934	0.27776
retimp_2	0.0980927	0.125237	0.7833	0.43598
Adjusted R-squared	0.587120			
F(6, 74)	19.96017			
P-value(F)	0.00001			

Note: ***, ** mean significant at 0.01 and 0.05 levels, respectively.

The Table 8 reports the parameters of the second equation (with retexp as dependent variable) of VAR(2) model. We find significant coefficients for the first and second lagged values of retindpr and retexp.

Table 8 - The second equation (with retexp as dependent variable) of VAR(2) model

Variable	*Coefficient*	*Std. Error*	*t-ratio*	*p-value*
const	0.712532	0.627288	1.1359	0.25967
retindpr_1	0.450942**	0.178089	2.5321	0.01346
retindpr_2	0.307335*	0.168066	1.8287	0.07148
retexp_1	0.873086***	0.179376	4.8674	0.00001
retexp_2	0.356956**	0.171667	2.0793	0.04105
retimp_1	0.137409	0.151207	0.9087	0.36643
retimp_2	-0.186312	0.149498	-1.2463	0.21660
Adjusted R-squared	0.249513			
F(6, 74)	5.432906			
P-value(F)	0.000106			

Note: ***, **, * mean significant at 0.01, 0.05 and 0.1 levels, respectively.

For the third equation (with retimp as dependent variable) of the VAR(2) model resulted significant coefficients for the first lagged values of retindpr and retexp (Table 9).

Table 9 - The third equation (with retimp as dependent variable) of VAR(2) model

Variable	*Coefficient*	*Std. Error*	*t-ratio*	*p-value*
const	-0.384	0.712926	-0.5386	0.59176
retindpr_1	0.564722***	0.202402	2.7901	0.00670
retindpr_2	-0.267844	0.19101	-1.4022	0.16502
retexp_1	0.60667***	0.203865	2.9759	0.00395
retexp_2	0.0008673	0.195103	0.0044	0.99646
retimp_1	-0.16601	0.17185	-0.9660	0.33718
retimp_2	-0.145442	0.169908	-0.8560	0.39476
Adjusted R-squared	0.187858			
F(6, 74)	4.084157			
P-value(F)	0.001360			

Note: ***, **, * mean significant at 0.01, 0.05 and 0.1 levels, respectively.

For a VAR(2) model resulted the following Granger causalities:

- from retindpr to retexp and retimp;

- from retexp to retindpr (Table 10).

Table 10 - Granger causality tests in the VAR(2) framework

Null hypothesis	F-statistic	p-value
retindpr do not Granger-cause retexp	4.1742	0.0172
retindpr do not Granger-cause retimp	2.4456	0.0901
retexp do not Granger-cause retindpr	2.4199	0.0924
retexp do not Granger-cause retimp	2.2476	0.1092
retimp do not Granger-cause retindpr	0.1703	0.8436
retimp do not Granger-cause retexp	1.7877	0.1708

3.5. Analysis in a VAR(3) framework

The Table 11 reports the parameters of the first equation (with retindpr as dependent variable) of the VAR(3) model. We found significant coefficients for the first and third lagged values of the retindpr.

Table 11 - The first equation (with retindpr as dependent variable) of VAR(3) model

Variable	*Coefficient*	*Std. Error*	*t-ratio*	*p-value*
const	0.839658	0.535091	1.5692	0.12111
retindpr_1	0.626653***	0.161726	3.8748	0.00024
retindpr_2	0.193528	0.166105	1.1651	0.24794
retindpr_3	0.0938201**	0.151099	0.6209	0.53667
retexp_1	-0.340548	0.1667	-2.0429	0.04483
retexp_2	-0.0876565	0.170846	-0.5131	0.60952
retexp_3	0.100308	0.152243	0.6589	0.51214
retimp_1	0.178904	0.129923	1.3770	0.17290
retimp_2	0.185855	0.130672	1.4223	0.15938
retimp_3	0.175673	0.130281	1.3484	0.18187

Adjusted R-squared	0.613846
F(9, 70)	14.95351
P-value(F)	0.00001

Note: ***, **, * mean significant at 0.01, 0.05 and 0.1 levels, respectively.

The parameters of the second equation (with retexp as dependent variable) of the VAR(3) model are presented in the Table 12. Significant coefficients are found for the first lagged values of retindpr, of the first and second lagged values of retexp and of the first lagged values of retimp.

Table 12 - The second equation (with retexp as dependent variable) of VAR(3) model

Variable	*Coefficient*	*Std. Error*	*t-ratio*	*p-value*
const	1.05126	0.643197	1.6344	0.10666
retindpr_1	0.396**	0.1944	2.0370	0.04543
retindpr_2	-0.257625	0.199664	-1.2903	0.20120
retindpr_3	-0.105978	0.181626	-0.5835	0.56143
retexp_1	0.892882***	0.200379	4.4560	0.00003
retexp_2	0.357487*	0.205363	1.7408	0.08612
retexp_3	0.0113064	0.183001	0.0618	0.95091
retimp_1	0.1968	0.156171	1.2602	0.21180
retimp_2	0.262784*	0.157072	1.6730	0.09879
retimp_3	0.230595	0.156603	1.4725	0.14537
Adjusted R-squared	0.274661			
F(9, 70)	4.323848			
P-value(F)	0.000169			

Note: ***, **, * mean significant at 0.01, 0.05 and 0.1 levels, respectively.

The Table 13 reports the parameters of the third equation (with retimp as dependent variable) of VAR(3) model. We found significant coefficients for the first lagged values of retindpr and for the first and third lagged values of retexp.

Table 13 - The third equation (with retimp as dependent variable) of VAR(3) model

Variable	*Coefficient*	*Std. Error*	*t-ratio*	*p-value*
const	-0.374572	0.729095	-0.5137	0.60905
retindpr_1	0.441364**	0.220362	2.0029	0.04906
retindpr_2	-0.247645	0.226329	-1.0942	0.27763
retindpr_3	-0.0265847	0.205881	-0.1291	0.89763
retexp_1	0.445924*	0.227139	1.9632	0.05359
retexp_2	0.189109	0.232789	0.8124	0.41934
retexp_3	0.37369*	0.20744	1.8014	0.07594
retimp_1	-0.190515	0.177027	-1.0762	0.28554
retimp_2	-0.117922	0.178049	-0.6623	0.50995
retimp_3	-0.03992	0.177517	-0.2249	0.82273
Adjusted R-squared	0.227484			
F(9, 70)	3.584801			
P-value(F)	0.001029			

Note: ***, **, * mean significant at 0.01, 0.05 and 0.1 levels, respectively.

In the VAR(3) framework we test for the Granger causality among the returns. The results, presented in the Table 14, indicate the following causalities:

- from retexp to retindpr and retimp;

- from retimp to retindpr.

Table 14 - Granger causality tests in the VAR(3) framework

Null hypothesis	F-statistic	p-value
retindpr do not Granger-cause retexp	1.8184	0.1464
retindpr do not Granger-cause retimp	0.7059	0.5500
retexp do not Granger-cause retindpr	3.3238	0.0215
retexp do not Granger-cause retimp	3.3878	0.0198
retimp do not Granger-cause retindpr	2.3371	0.0761
retimp do not Granger-cause retexp	1.6631	0.1775

Conclusions

In this paper we investigated, by VAR models and by Granger Causality tests, the relationship between the industrial production and the foreign trade of Romania after the adhesion to European Union.

For the three VAR models employed we obtained different forms of interactions among the returns of industrial production index, exports and imports. The values of Adjusted R-squared parameters indicate, for the VAR equations, a significant influence of some factors that were not taken into consideration in the models.

For the Granger Causality tests we also found some differences among the three VAR models. However, the results indicate, for all VAR models, a significant causality from the returns of exports to the returns of the industrial production index. As the industrial production could be considered as a predictor of GDP, we could see this causality as an argument in favor of ELGH.

This investigation could be extended by employing specific categories of imports and exports. We could also introduce in the VAR models other indicators of the national economy outputs.

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