Investigating the Causal Relationship between International Trade Inflows and Outflows Based on a Modified Granger Test

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Abstract

Public finance theory states that government must take joint decision against the desired level of taxes and spending together. This means that there is a bidirectional causal relationship between government revenues and expenditures, implying a mechanism which allows for rapid adjustments of the two variables. This synchronization hypothesis could, also, be applied to the components of current account in order to analyze the synchronization between inflows and outflows of international trade. In the case where the two time series are cointegrated, classical Granger causality test could reveal distorted results. Consequently, it can be used a modified Granger test based on cointegration equation between the two variables. The aim of this paper is to investigate the causal relationship between exports and imports of Romanian current account, according to the methodology of Engle and Granger (1987). The results could reveal some insights related to the formation of current account deficit, based on the adjustments of inflows caused by changes in outflows, or, otherwise.

Keywords: Granger causality, cointegration, international trade, current account deficit, synchronization hypothesis

JEL classification: C22, F10, F32

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1. Introduction

Investigation of current account components is based on a forward-looking dynamic saving-investment perspective. This intertemporal model was used by Bardhan (1967), Hamada (1969), Bruno (1970), Buiter (1981), Obstfeld (1982), Sachs (1981), Svensson and Razin (1983), and extended by Obstfeld and Rogoff (1995, 1996). According to this model, private and public saving must equal the sum of investment and net exports. Also, net exports and net investment income by domestic residents and net transfers define the current account balance. Thereby, international flows of good and services must be matched by international flows of funds and the intertemporal constraint is represented by the parity between national saving and international flows of funds for investments at home and abroad.

Starting with this model, many studies investigate the determinants and the dynamics of current account in order to assure long term external sustainability. There is a strong relationship between current account positions and external debt because the current account deficits are financed by external loans, foreign direct investments and other domestic instruments (domestic loans, privatization revenue). Those are important for emerging countries which deal with an increasing deficit between international trade inflows and outflows, fiscal deficit and public and external indebtness.

The evolution of these variables and the economic growth in correlation with other macroeconomic and political variables may conduct to various risks such as insolvency, illiquidity, external vulnerability of a country. Those are the effects of the absence of the fiscal and external sustainability which involve strong fiscal adjustments in order to assess consistent fiscal consolidation

There are many studies analyzing the relationship between fiscal and current account balance, considered as being "twin deficits" or "twin divergence" (Kim, Roubini, 2008). This relation was investigated, mostly, using the following approaches: (i) Mundell–Fleming–Dornbusch model (Bryant et al., 1988; and Taylor, 1993); (ii) dynamic stochastic general equilibrium models (for example, Baxter, 1995; Kollmann, 1998; Betts and Devereux, 2000b; and McKibbin and Sachs, 1991); (iii) equation with government spending and the current account as variables in order to examine the long run relationship between fiscal balance and current account balance in different exchange rate regimes; (iv) Global Economic Model for US, Japan, Germany and UK (Peeters, 1999); (v) standard neoclassical growth model extended to open economy (Mariano and Villanueva, 2005); (vi) cointegration (Bagnai and Carlucci, 2003); (vii) VAR, Granger causality tests, ECM (Bachman,1992; Aqeel, and Nishat, 2000; Corsetti, and Müller, 2006; Marinheiro, 2008). These techniques where used in order to identify: (i) if fiscal balance has a significant impact on external imbalances which is called "twin deficits"; (ii) if external imbalances influences fiscal balance, called by Summers (1988) current account targeting; (iii) if these variables are determined simultaneously; (iv) if the two variables are independent.

The relationship between fiscal and current account balance deficit has also been tested taking into consideration other variables such as exchange rates, interest rate, government saving, money supply, government employment, the average tax and social security contribution rates, imports, export for different countries. The results conduct to conflicting conclusions such as: (i) evidence for twin deficits in the case of US (Bachman, 1992; Rosenweigh and Tallman, 1993; Dibooğlu, 1997; Bartolini and Lahiri, 2006), in the case of Greece (Vamvoukas, 1999), in the case of Indonesia, Malaysia, Philippines and Thailand (Baharumshah, Lau and Khalid, 2006); (ii) evidence for current account targeting in the case of OECD countries (Kearney and Monadjemi,

1990), in the case of Philippines, India, Indonesia and Korea (Anoruo and Ramchander, 1998), in the case of Indonesia and Pakistan (Khalid and Teo, 1999); (iii) by-directional causality between fiscal balance and external imbalances for US data (Darrat, 1988); (iv) no relationship between fiscal deficit and external imbalances in Australia (Winner, 1993).

The aim of this paper is not concerned with the relationship between fiscal and external balance, but with the relationship between current account components. Large current account deficits might generate distortions due to their impact on fiscal balance and exchange rate. Even for EU countries which operate under Maastricht Treaty constraints, current account imbalance could be a big problem. The convergence criteria refer only to the fiscal balance and public debt, but make no specification for international trade. This could be misleading, and governments could foul themselves by letting current account not closely supervised.

Therefore, based on *fiscal synchronization hypothesis* we shall investigate the causal relationship between exports and imports according to the methodology proposed by Engle and Granger (1987). The results could reveal some insights related to the formation of current account deficit, based on the adjustments of inflows caused by changes in outflows, or, otherwise. This analysis is, also, helpful, to show the adjustment reaction of current account components to different stimuli. We shall use Romania's case in order to formulate our conclusions.

This paper is structured as follows. Following a brief review of literature, it will be presented how fiscal synchronization hypothesis could be adapted in order to investigate the nexus between international trade inflows and outflows (Section 2). Section 3 presents the Modified Granger Test, which will be used, further, on empirical testing. Section 4 reveals the main findings of this study, and section 5 highlights the concluding remarks.

2. Fiscal synchronization hypothesis and current account

The nexus between total government revenues and total government expenditures is a much debated issue within Public Finance. According to von Furstenberg, Green, and Jeong (1986), this relationship could be investigated by taking into consideration the following approaches: (1) *tax and spend* approach states that government revenues must lead and control government spending (Friedman, 1978); (2) *spend and tax* approach is a more pro-Keynesian case and affirms that government spending must cause government revenues; (3) *fiscal synchronization hypothesis* is based on Barro's work from1974 on tax smoothing and points out that government must take joint decision against the desired level of taxes and spending together.

The previous approaches could be, also, applied to current account components in order to investigate if imports adjust due to changes in exports, or otherwise, depending on the sense of the two flows.

Taking into consideration that large current account deficits could affect fiscal position and have a serious impact on fiscal sustainability on long run, we consider useful to analyze the existing causal relationship between international inflows and outflows. Most of the studies investigate the causal relationships between export/import and growth or income (see in that sense, Jung and Marshall, 1985; Chow, 1987; Bahmani-Oskooee and Alse, 1993; Howard, 2002; Jordaan and Eita, 2007; Doraisami, 1996; Chang et al., 2000). But, we focus our analysis only on the relationship between imports and exports in order to reveal some insights related to the formation of current account deficit, based on the adjustments of inflows caused by changes in outflows, or, otherwise.

Our investigation follows *synchronization hypothesis* previous mentioned, which states that when the causality relationship between the two variables is bidirectional, on long term, then changes in imports should be balanced by simultaneous changes in exports. This means that there

is a mechanism (implying several tools, e.g. exchange rate) which allows for rapid adjustments between international trade inflows and outflows. Otherwise, when the causality relationship runs from exports to imports (*tax and spend* approach), then imports should adjust with the amount of exports changes, and when the causality relationship runs from imports to exports, then exports should be influence by the amount of imports.

3.Modified Granger Test for investigating synchronization hypothesis

The main method of investigating synchronization hypothesis is based on classical causality Granger test (see for instance, Manage and Marlow, 1986; Anderson, Wallace, Myles and Warner, 1986; Ram, 1988).

A *causality test* reveals if lagged values of one variable could improve the estimation of other variable. For instance, variable X_t Granger causes variable Y_t, if past values of variable X goes to a better estimation of variable Y. In fact, Granger causality test represents a weak test for establishing if one variable is exogenous or not (see Enders, 1995).

But, Engle and Granger (1987) showed that in the case of cointegrated time series, Granger causality test is not so relevant and could give some distorted results. Therefore, they suggested an adjusted causality test which takes into consideration the cointegration relationship between two variables.

When two variables X and Y are integrated of order d, the cointegration relation between X and Y is represented by the following equation:

$$Y_t = \beta \cdot X_t + \varepsilon_t \qquad (1)$$

where:

β = parameter;

ε_t = error term which has to be stationary (integrated of order 0).

The cointegration relation between two variables could be tested according to (1), but it could be taken into account an intercept according to equations (2) and (3):

$$X_t = \alpha_0 + \beta_0 \cdot Y_t + \varepsilon_t \quad (2)$$

$$Y_t = \alpha_1 + \beta_1 \cdot X_t + \mu_t \quad (3)$$

Using Johansen cointegration test, it could be revealed the existence of a long run equilibrium relation between the two variables, as it follows from the equations below:

$$X_t - \beta_0 \cdot R_t - \alpha_0 = \varepsilon_t \quad (2')$$

$$Y_t - \beta_1 \cdot R_t + \alpha_1 = \mu_t \quad (3')$$

The error term of each of previous equation will be used in the adjusted Granger causality test. A classical causality test investigates if past values of a variable could improve the estimation of other variable, according to the following equations:

$$\Delta Y_t = C_0 + \alpha_0 \cdot \Delta X_t + \sum_{i=1}^{n} \alpha_i \cdot \Delta X_{t-i} + \sum_{j=1}^{n} \beta_j \cdot \Delta Y_{t-j} + u_t$$

$$\Delta X_t = C_1 + \delta_0 \cdot \Delta Y_t + \sum_{i=1}^{n} \delta_i \cdot Y_{t-i} + \sum_{j=1}^{n} \rho_j \cdot \Delta X_{t-j} + v_t$$

(4)

where:

α_i, β_i =capture the influence of current and past values of variable X/ Y on variable Y;

δ_j, ρ_j = capture the influence of current and past values of variable X/ Y on variable X.

If α_i and δ_j are zero, it means that there is no causality relation between the two variables and, consequently, past values of them could be used to estimate the current value. If α_i is different from zero, then it could be used past values of X in order to improve the estimation of Y, and if δ_j is different from zero, then it could be used past values of Y, in order to improve the estimation of X. In the case when both α_i and δ_j are different from zero, then, there is a bi-

directional causality and both of the variables could be estimated using past values of each other. The last case is consistent with synchronization hypothesis.

Engle and Granger (1987) suggested that for cointegrated variables, the causality between them should be investigated using a modified standard test based on (4) and on error terms estimated from (2) and (3), as follows:

$$\Delta Y_t = C_0 + \alpha_0 \cdot \Delta X_t + \sum_{i=1}^{n} \alpha_i \cdot \Delta X_{t-i} + \sum_{j=1}^{n} \beta_j \cdot \Delta Y_{t-j} + \lambda_0 \cdot ECT_1 + u_t$$

$$(4')$$

$$\Delta X_t = C_1 + \delta_0 \cdot \Delta Y_t + \sum_{i=1}^{n} \delta_i \cdot \Delta Y_{t-i} + \sum_{j=1}^{n} \rho_j \cdot \Delta X_{t-j} + \lambda_1 \cdot ECT_2 + v_t$$

where: ECT_1 represents ε_t from equation (2'), and ECT_2 represents μ_t from equation (3').

This supplementary term represents the error correction mechanism based on which it is re-established the long term equilibrium relationship between the two variables. According to (4'), it is tested the null hypothesis, H_0: α_i and/or $\lambda_0 = 0$, against H_1: α_i and/or $\lambda_0 \neq 0$, which could confirm one of the three hypothesis mentioned at the beginning of this study.

This methodology was successfully applied for government expenditures and revenues by Miller and Russek, (1990), Owoye (1995), Fasano and Wang (2002), and, also, could be applied on exports and imports if they are cointegrated like in Romania's case.

3. Testing synchronization hypothesis on current account components: Romania's case

Romania represents an interesting case to be discussed. Romania's economic growth bases mainly on consumption. Unfortunately, national production is not able to keep the pace with the dynamic of aggregate demand. Consequently, individuals growing needs have to be satisfied mostly on imported goods. As could be easily notice from the figure below, starting 1991, Romania's current account deficit has grown significantly (see Figure 1):

Figure 1 **Dynamics of current account positions (% of GDP), during 1991-2007**
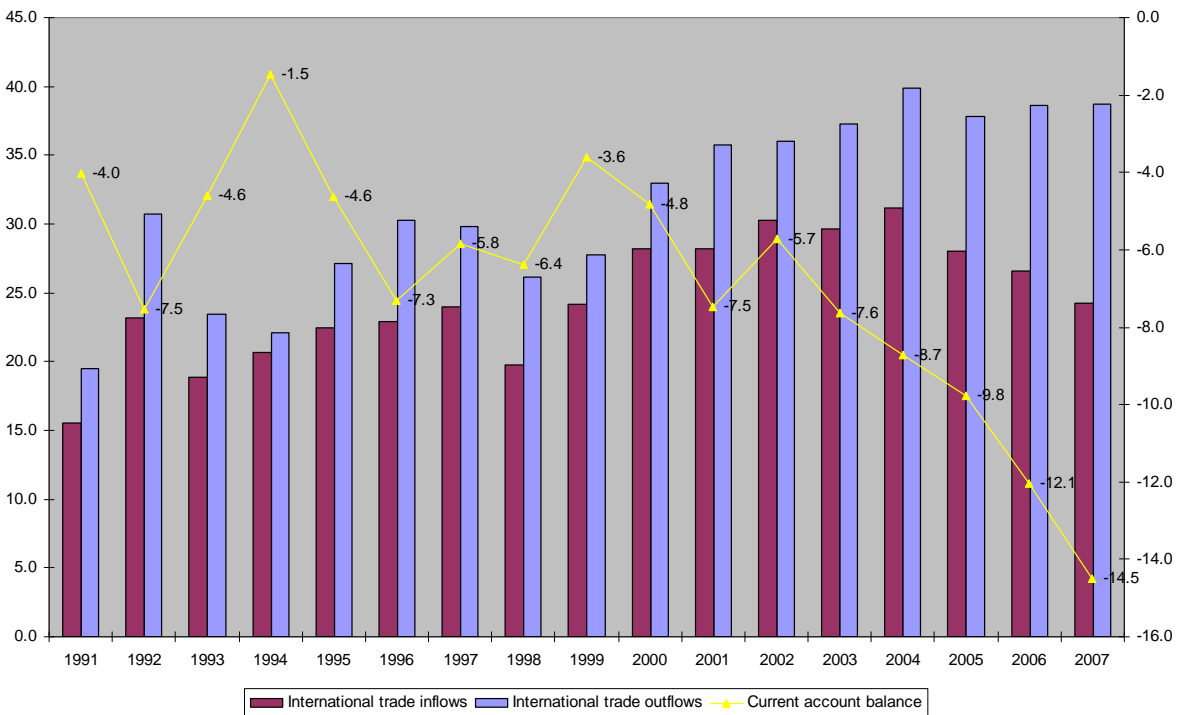
Source: data available from Romanian National Institute of Statistics

Large current account deficit could, also, influence fiscal position. If we analyze the evolution of fiscal and current account balance during 1991-2007, we could notice the common trend of the two indicators (see Figure 2).

Figure 2 **Evolution of current account and fiscal balance (% of GDP), during 1991-2007**
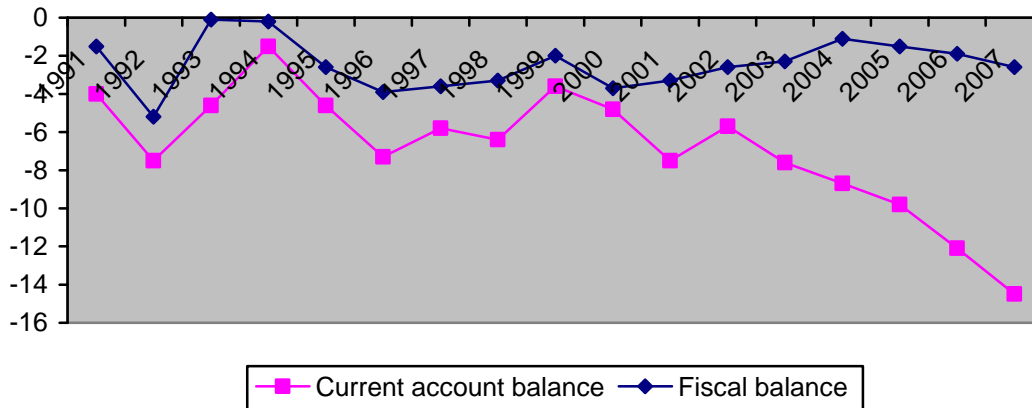
Source: data available from Romanian National Institute of Statistics

But, starting 2003, current account deficit has deteriorated in the context of RON depreciation versus EURO and of wage increase overtaking productivity and gains. Even if fiscal deficit is kept under the limit imposed by Maastricht Treaty, this situation could not continue on long run and reflect the need for important adjustment in next few years.

Romania's case could serve as an example for the other countries which based their economic growth on consumption, and on imported goods. If exports do not adjust rapidly to growing imports, this could generate large imbalances that could affect fiscal position and sustainability on long run.

Therefore, we consider useful to investigate the nexus between international trade inflows and outflows based on causality tests. Testing the existence of cointegration is not sufficient to reveal the speed of the adjustment and how imports/exports react to changes of exports/imports.

The causality relationship between international trade inflows and outflows for the Romanian current account is investigated based on Granger Modified Test presented in the previous section, because the two variables are cointegrated of order I (see Table 1). The tests run

on quarterly data on exports and imports spanned on 1998 and 2005, according to the information

provided by National Bank of Romania. The tests were applied on real level of the variables. The

results of ADF stationarity test are presented in the table below:

Table 1
Integration order for imports and exports[*)]

Variable	ADF Test Statistic	1% Critical Value	5% Critical Value	10% Critical Value
IMP_fx [i)]	-3.39	-4.29	-3.56	-3.21
EXP_fx [i)]	-2.41	-4.29	-3.56	-3.21
Δ IMP_fx [ii)]	-3.74	-2.64	-1.95	-1.62
Δ EXP_fx [ii)]	-4.05	-2.64	-1.95	-1.62

[*)]Critical values for 1%, 5%, and 10% depends on the option choose: intercept or trend and intercept.
[i)]It was considered intercept and. [ii)]No intercept and no trend.
Number of observations: 32
IMP_fx: natural logarithm for imports in 1991: 1-st quarter prices
EXP_fx: natural logarithm for exports in 1991: 1-st quarter prices
ΔIMP_fx: first difference on imports
ΔEXP_fx: first difference on exports

Using Johansen cointegration test, we identified the existence of a long run equilibrium

relation between imports (*IMP*) and exports (*EXP*), and error correction terms from (2') and (3')

result from the equations below:

$$IMP_t - 1.05 \cdot EXP_t + 0.04 = \varepsilon_t \qquad (5)$$

$$EXP_t + 0.95 \cdot IMP_t + 0.04 = \mu_t \qquad (6)$$

Following Engle and Granger (1987), we will estimate (4') using error correction terms

from equations (5) and (6) and OLS method. The results are presented in the table below:

Table 2
Adjusted causality test between exports and imports

Explanatory variables	Regression 1: Dependent variable ΔIMP_t	Regression 2: Dependent variable ΔEXP_t
C	0.01 [1.39] (0.17)	0.33 [1.71] (0.09)
ΔIMP_t		0.34 [3.72] (0.00)
ΔEXP_t	0.60 [3.37] (0.02)	
ΔIMP_{t-1}	-0.54 [-3.75] (0.00)	0.26 [1.94] (0.06)
ΔEXP_{t-1}	0.43 [1.40] (0.17)	-0.36 [-2.38] (0.02)
ECT_{1t-1}	-0.52 [-1.87] (0.07)	
ECT_{2t-1}		-0.03 [-1.64] (0.11)
Statistics	R-sq: 0.74 F-stat: 17.87 Prob: 0.00	R-sq: 0.29 F-stat: 2.57 Prob: 0.06
[ ]: t-statistic ( ): probability		

The results from the table above show that there is no synchronization between Romanian international trade inflows and outflows, nor a causal relationship between the two variables. From the estimations of the 1-th regression, it could be easily seen that imports could be estimated using current values of exports (positive relation) and past values of imports (negative relation), but there is no clear distinction how inflows or outflows influences one on another.

The existence of a cointegration relationship between exports and imports reveals there, on long run, there is an error correction mechanism which conducts to equilibrium, but, it seems that there is no mechanism which allows for rapid adjustments between international trade inflows and outflows. This situation could conduct to fiscal balance deterioration on long run and could affect fiscal sustainability. The findings, also, reveal that fiscal adjustments will be needed in the next few years.

4. Concluding remarks

There are many studies investigated to the relationship between fiscal balance and current account deficit. The aim of this paper is not concerned with the relationship between fiscal and external balance, but with the relationship between current account components. Large current account deficits might generate distortions due to their impact on fiscal balance and exchange rate. Therefore, based on *fiscal synchronization hypothesis* we investigated the causal relationship between exports and imports based on a Modified Granger Test. We find this test useful because it reveals if there is a mechanism (implying several tools, e.g. exchange rate) which allows for rapid adjustments between international trade inflows and outflows. The absence of such mechanism could conduct to a deterioration of current account balance and influence fiscal sustainability on long run.

The empirical test run on Romania's case show that there is no synchronization between international trade inflows and outflows, nor a causal relationship between the two variables.

The existence of a cointegration relationship between exports and imports reveals there, on long run, there is an error correction mechanism which conducts to equilibrium, but, it seems that there is no mechanism which allows for rapid adjustments between international trade inflows and outflows. This situation could conduct to fiscal balance deterioration on long run and could affect fiscal sustainability. The findings, also, reveal that fiscal adjustments will be needed in the next few years.

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