Current Account Adjustments and Real Exchange Rates in the European Transition Economies

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Abstract
One of the key outcomes of open economy macroeconomics refers to a crucial importance of an investment-saving relation affecting a current account determination. However, despite a relative diversity in exchange rate regimes in European transition economies, there is still a substantial potential to analyze price effects of real exchange rate dynamics on current account adjustments. Rigorous investigation of relative changes in real exchange rates leading paths and associated adjustments in current accounts may reveal causal relationship between real exchange rate dynamics and international competitiveness in order to observe its redistributive effects. This purpose is even more significant provided that economic crisis has intensified cross-country expenditure shifting effects that still provide quite diverse and thus spurious effects on current account adjustments.
In the paper we analyze main aspects of current account adjustments in European transition economies. Our main objective is to observe a relationship between real exchange rate dynamics and current account adjustments (in countries with different exchange rate arrangements). From estimated VAR model we calculate responses of the current account to the real exchange rate (REER calculated on CPI and ULC base) shock. To provide more rigorous insight into the problem of the current account adjustments according to real exchange rate dynamics we estimate the model for each particular country employing data for two subsequent periods 2000-2007 and 2000-2012.

Keywords: current account adjustments, real exchange rate dynamics, economic growth, economic crisis, vector autoregression, impulse-response function

JEL Classification: C32, F32, F41

1. Introduction

Macroeconomic stability and overall performance of European transition economies during last two decades has been significantly determined by the exchange rates development. Large diversity in exchange rate regimes employed by individual countries and subsequent policy adjustments reflected overall improvements in macroeconomic performance and accelerated convergence toward western European countries during this period.

Relative importance of the exchange rate regime choice in determining international competitiveness of transition economies seems to be a frequently discussed area (particularly for understanding a wide variety of unique features of the transition process) not only by policy-makers but also academics trying to find some supportive considerations from empirical evidence on different samples of a wide variety of countries. At the same time it is necessary to highlight key outcomes of open economy macroeconomics emphasizing a crucial importance of an investment-saving relation affecting current account adjustments (intertemporal model).

Almost immediately after the beginning of the transition process countries from the past Eastern block has become a very attractive destination for foreign investors; the fact that even emphasizes the huge demand of this investments-intensive process for internal sources of a capital. However, persisting low domestic capital base put countries from the past Eastern block into the risk of lagging recession and thus it seems to be a crucial reason of early efforts toward capital account liberalization. At the same time, associated capital account surpluses (foreign capital inflows) helped transition economies to finance current account deficits. As quickly rising net debtors, countries from the past Eastern block had to avoid significant

external imbalances in order to reduce pressures on their foreign exchange reserves. Persisting current account imbalances thus represented one of most crucial risks associated with overall sustainability of rigid exchange rate regimes (either hard or soft pegged) in most countries (despite Romania and Slovenia that employed floating exchange rate regime during the whole period since the beginning of the transition process).

At later stages of the transition process European transition economies successfully improved conditions for maintaining their overall macroeconomic stability (in all countries from the past Eastern block the initiation of this period refers to the beginning of the 21th century). As a result, most countries with soft pegged exchange rate regimes gradually increased flexibility of employed exchange rate arrangements and thus improved overall maneuverability of the exchange rate leading path (Mirdala, 2013). It seems that associated policy adjustments helped to increase fundamental interconnections between macroeconomic performance and exchange rate dynamics. Accelerated convergence toward western European countries associated with high real output growth rates implied increased intention to reduce excessive internal (fiscal deficit) and external imbalances (the current account deficit) to maintain fast economic growth (Siničáková et al., 2011).

High real output growth rates, EU membership as well as euro adoption perspectives strengthened appreciation pressures on nominal exchange rates in all European transition economies but countries with pegged exchange rate arrangements (Bulgaria, Estonia, Latvia and Lithuania) (Stavarek, 2012). Despite a relative diversity in exchange rate regimes in all ten countries there is still a substantial potential to analyze price effects of (externally (nominal) or internally (real) determined) real exchange rate dynamics on current account adjustments. Rigorous investigation of relative changes in real exchange rates leading paths and associated adjustments in current accounts may reveal causal relationship between real exchange rate and international competitiveness in order to observe its redistributive effects (Rusek, 2013). This purpose is even more significant provided that economic crisis has intensified redistributive effects that still provide quite diverse and thus spurious effects on current account adjustments. Even though the contemporary evidence on empirical validity of causal relationship between the real exchange rate and the current account seems to be limited (Arghyrou and Chortareas, 2008), we emphasize challenges addressed to the phenomenon of internal devaluation (Armingeon and Baccaro, 2012) and wide range of its direct and indirect effects in Eurozone member countries (in general, principles and associated effects of internal devaluation may be applied in countries with rigid exchange rate arrangements too).

Despite the fact, there seems to be no real prospective alternative to euro adoption for European transition economies, we emphasize disputable effects of sacrificing monetary sovereignty in the view of positive effects of exchange rate volatility and exchange rate based adjustments in the country experiencing sudden shifts in the business cycle. On the other hand, due to existing diversity in exchange rate arrangements in European transition economies in the pre-ERM2 period there seems to be two big groups of countries - "peggers" (Bulgaria, Estonia, Latvia, Lithuania) and "floaters" (Czech republic, Hungary[1], Poland, Romania, Slovak republic, Slovenia). Effects of real exchange rates dynamics on current account adjustments in both groups of countries can be conventionally interpreted as the crucial contribution in understanding fixed versus flexible exchange rates dilemma (Mirdala, 2013). At the same time, macroeconomic effects of different exchange rate arrangements during the crisis period may provide a better insight into suitability of the relative exchange rate volatility in each individual economy during sudden changes in the business cycle.

In the paper we analyze main aspects of current account adjustments in European transition economies. Our main objective is to observe a relationship between real exchange

[1] Hungarian forint operated during pre-crisis period in de facto fixed peg regime, but due to substantial range for fluctuations provided by wide horizontal bands it was included in the group of countries, so called "floaters"

rate dynamics (in countries with different exchange rate arrangements) and current account adjustments. From employed VAR model we estimate responses of the current account to the real exchange rate (REER calculated on CPI and ULC base) shock. To provide more rigorous insight into the problem of current account adjustments according to real exchange rate dynamics we estimate the model for each particular country employing data for two subsequent periods 2000-2007 (pre-crisis period) and 2000-2012 (extended period). In both models for each country we alternate both CPI and ULC based REER. We suggest that a comparison of results for models with different time period is crucial to understand redistributive effects of the economic crisis in the view of changes in real exchange rates determination capabilities in the group of ten countries from the past Eastern block.

Following the introduction, we provide brief overview of theoretical concepts referring to the relationship between the real exchange rate dynamics and current account adjustments in Section 2. In Section 3 we provide an overview of the current empirical evidence about current account adjustments and real exchange rates dynamics. While the area of our research seems to be well documented in current empirical literature it seems that effects of real exchange rates on current accounts are unclear or even puzzled. In Section 4 we observe main trends in the current account development in European transition economies and highlight some stylized facts about common implications resulted from its determination. In Section 5 we provide a brief overview of the VAR model (recursive Cholesky decomposition is employed to identify structural shocks) we employ to investigate responses of the current account to negative one standard deviation REER shocks. In Section 6 we discuss main results.

2. Exchange Rates Dynamics and Current Account Adjustments

Exchange rate unexpected fluctuations determine economic development of countries the way quite similar to any other type of exogenous shocks. Unpredicted volatility in exchange rate short-run path (Bratu, 2011) affects macroeconomic performance the way that may be a subject of academic as well as economic policy discussions. Overall exposure of countries to negative implications of exchange rate volatility represents one of areas of empirical investigations related to the fixed versus flexible exchange rate dilemma. Rigorous analysis of various aspects of exchange rate fluctuations in terms of macroeconomic performance causal effects is considered to be a crucial outcome of not only exchange rate determining potential but also key information for exchange rate policy or policy decisions related to exchange rate regime shifts.

Exchange rate appreciation (depreciation) may suppress economic activity in country causing foreign prices of goods to decrease in comparison with domestic prices of goods. As a result, exchange rate appreciation and subsequent decrease in foreign competitiveness of domestic goods on foreign as well as domestic markets shifts expenditures from domestic goods to goods produced abroad (Mirdala, 2012). Negative impact of exchange rate appreciation on the current account is significantly determined not only by a shift in demand preferences but also by the ability of domestic economy to shift unused production capacities to more perspective areas with growing potential.

While traditional approaches emphasize negative effects of exchange rate appreciation on the real output in the domestic economy, alternative approaches (Mendoza, 1992) highlight the presence of some positive implications. Exchange rate appreciation causes prices of exports to rise while it is generally expected the prices of imports are going to decrease. Considering lower exports and imports price elasticity (in short period), exchange rate appreciation causes net export to rise due to export of goods increase while import of goods tends to decrease. As a result, real domestic income tends to rise.

At the same time, aggregate supply chain can accelerate a positive impact of an exchange rate appreciation on performance of the domestic economy. In less developed countries with inputs being mainly imported (in general, production of inputs in such countries is expected to be ineffective), exchange rate appreciation reduces costs of domestic companies. As a result, positive effects of costs reduction due to exchange rate appreciation obviously oversize a negative impact of contractionary effects related to an increase in prices of domestic tradable goods.

Finally we may conclude that exchange rate appreciation causes the current account deficit (due to net export deficit) and reduction in costs of production. Similarly, exchange rate depreciation causes an increase in net exports and an increase in costs of production. Combined effects of demand and supply channels determine the overall capabilities of exchange rate volatility to determine an adjustments in real output and level of prices (Stavarek, 2013).

3. Overview of the Literature

Bussiere, Fratzscher and Muller (2004) analyzed the current account determination in 33 countries employing an intertemporal approach via regression analysis considering effects of fiscal stance of government as well as real exchange rate deviations. Authors suggest that current account balances of countries included in the model are close to their structural current account positions confirming a validity of the intertemporal approach. Arghyrou and Chortareas (2008) investigated dynamics of current account adjustments and the role of real exchange rates in the current account determination in the EMU. Despite a limited evidence of most theoretical models in explaining causal relationship between real exchange rates and the current account, authors confirmed above relationship with significant validity and subject to non-linear effects. Lee a Chinn (Lee a Chinn, 2006) analyzed implications of real exchange rate fluctuations on the current account development in 7 most developed industrial countries. Authors suggest that while the variation in the current account is mostly determined by temporary shocks, permanent shocks seem to be much more crucial in explaining the variation in the real exchange rate. At the same time, their results confirmed validity of the intertemporal opened economy model. Sek a Chuah (Sek a Chuah, 2011) explored causality between the exchange rate changes and the current account adjustments in 6 Asian countries. Authors surprisingly conclude that the current account did not change much expected after the crisis. They suggest it is due to adjustments that authorities made in countries' financial policies to reduce the excessive exchange rates volatility. Obstfeld a Rogoff (Obstfeld a Rogoff, 2005) focused their investigation on estimation of effects of global current account imbalances reduction on exchange rates (USD, EUR and Asian currencies) equilibrium path in the model with alternative scenarios. Gruber and Kamin (2005) estimated panel regression models employing data for 61 countries to observe the current account determination. However, their results did not provide supportive evidence for large U.S. deficits nor large Asian surpluses.

4. Overview of Main Trends in Current Account Imbalances

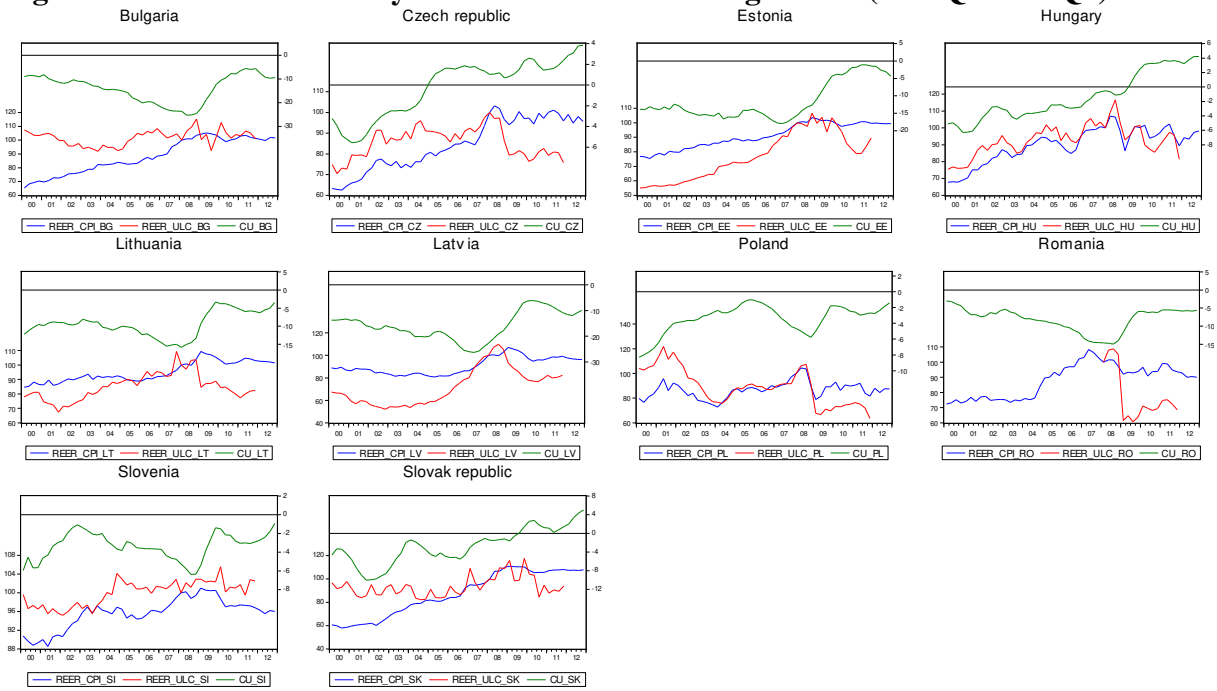
During the first decade since the initiation of the transition process at the beginning of the 1990s European transition economies experienced periods of excessive current account deficits. In line with intertemporal approach it is clear that current account deficits reflect a negative trend in investment-saving ratio. While current account adjustments reveal crucial and generally expected implications of the continuously rising international economic and financial integration of European transition economies (increased indebtedness, lacking competitiveness, fiscal imbalances[2], foreign capital inflows, etc.), there seems to be still

[2] Problems of persisting fiscal imbalances (fiscal deficits) seem to be much more frequent in countries with

enough room to investigate partial effects of dynamic changes in key current account determinants to observe associated current account adjustments.

Figure 1 provides a brief overview of main trends in real exchange rates and current accounts in ten European transition economies. To provide more rigorous overview of dynamics and volatility in real exchange rates, we employed quarterly data for real effective exchange rates (REER) calculated on the CPI (consumers' price index) and ULC (unit labor costs) basis. Inclusion of REER calculated using different price deflators reveals more precise picture about changes in relative international competitiveness of countries from the grouo of the past Eastern block.

Figure 1 Current Account Dynamics and Real Exchange Rates (2000Q1-2012Q4)



Note: Endogenous variables: CPI based real effective exchange rate (REER_CPI) and ULC based real effective exchange rate (REER_ULC) are expressed as indexes (left axis in figures) (2008 = 100). Current account is expressed as percentage share in GDP (CU) (right axes in figures).
Source: Compiled by author based on data taken from IMF - International Financial Statistics (May 2013). Time series for CPI and ULC based REER we drawn from REER database ver. 29 (Darvas, Z., November 2012).

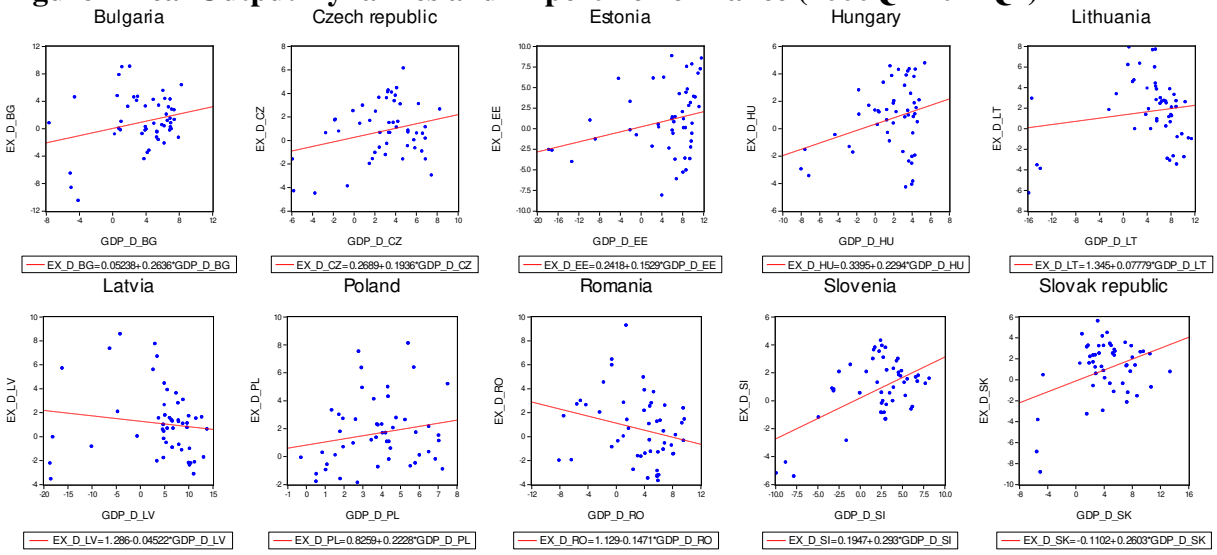
Individual countries experienced current account deficits during the most of the period of intensified convergence (since the beginning of 2000s) toward western European countries. It seems that countries with tightly managed exchange rates (Bulgaria, Slovenia and Baltic countries) and lacking overall macroeconomic performance (Romania as well as Bulgaria) experienced excessive current account deficits with generally negative outlook during the most of the pre-crisis period. At the same time we have observed significant trend in CPI and ULC based REER[3] discrepancies in most countries revealing asynchronous effects of processes determining internally caused changes in the relative external competitiveness.

Figure 2 depicts mutual relationship (simple linear regression) between real output dynamics and export performance in European transition economies. In most countries economics growth seems to have positive effect on export performance. While the size of associated multipliers revealing propensity to export differs in each individual country,

weak nominal anchor that is why Baltic countries and Bulgaria experienced much "healthier" fiscal stance of the general government.
[3] Times series for ULC based REER in Romania till 2008 are missing in the source of our dataset.

overall competitiveness of export industries seems to be crucial for export to catch up with high real output growth rates especially during the pre-crisis period.

Figure 2 Real Output Dynamics and Export Performance (2000Q1-2012Q4)



Note: Endogenous variables: Export performance (EX_D) is expressed as the relative change in the percentage share of export of goods on GDP. Real output dynamics (GDP_D) is expressed as annual percentage change of the real output.
Source: Compiled by author based on data taken from IMF - International Financial Statistics (May 2013).

It seems that export performance is not necessarily associated with the overall size and total openness of particular economies (i.e. Poland doesn't seem to lag behind much smaller economies). At the same time, export performance of Baltic countries is quite low considering high growth rates of real output during the most of the pre-crisis period. Associated excessive current account deficits under rigid exchange rate arrangements thus reveal questions about effects of real exchange rates shifts (internally determined) and accompanied current account adjustments (see Section 6).

Final remark relates to revealed negative relationship between export performance and real output growth rates in two countries (Latvia and Romania). However, reasons for such a misleading causality seem to be country specific. While generally considered as small open economy, Latvia's export-to-GDP ratio increased only slowly during the pre-crisis period and significantly lagged behind real output growth rates (marginal propensities to export were also significantly smaller in comparison to import ones). Romania as much bigger and less opened economy suffered from low export performance during nearly whole pre-crisis period. While lower share of external demand (in comparison with domestic components of total expenditures) in large economies is obvious, excessive current account deficits and associated distortions between relative dynamics in domestic and foreign demand reflects large potential in improving competitiveness and attractiveness of exports. Regardless of revealed mutual relationships between export performance and real output growth rates our suggestions seem to be reasonable for all countries with persisting excessive current account deficits.

Table 1 reveals detailed results of correlation relationships between export performance and real output dynamics in European transition economies. In general, we have observed strong relationships between both categories during the first sub-period (2000-2002) (Czech republic, Estonia and Poland) and at the end of pre-crisis period (Hungary, Romania and Slovenia).

At the same time, negative correlation coefficients in the second and third sub-period (2006-2008) (Czech republic, Latvia and Slovak republic) result from high real output growth

rates negatively affecting export-to-GDP ratio and thus negatively affected averaged results for the whole group of countries. Significant increase in the ratio during the third sub-period (2006-2008) is determined especially with an increased foreign demand associated with EU membership (8 of 10 countries entered EU in 2004, Bulgaria and Romania in 2007).

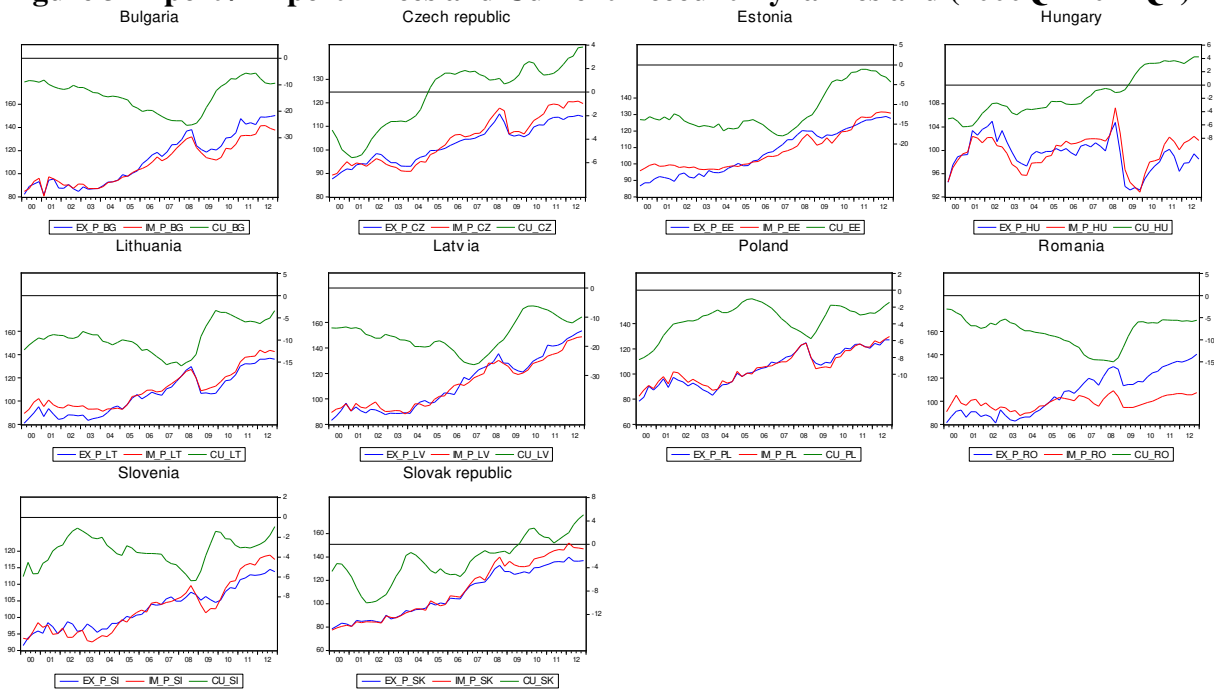
Table 1 Real Output Dynamics and Export Performance (2000Q1-2012Q4)

	2000-2002	2003-2005	2006-2008	2009-2012
Bulgaria	0.41	0.43	0.31	0.10
Czech republic	0.92	-0.54	0.89	0.82
Estonia	0.73	0.39	-0.27	0.35
Hungary	0.48	0.33	0.88	0.55
Lithuania	0.35	0.42	0.21	-0.09
Latvia	0.31	-0.44	-0.69	-0.75
Poland	0.87	0.52	0.37	0.82
Romania	-0.26	0.46	0.69	-0.11
Slovak republic	-0.49	-0.54	0.45	0.49
Slovenia	-0.02	0.68	0.67	0.83
average	**0.23**	**0.10**	**0.28**	**0.30**

Note: Data represents coefficients of mutual correlations between real output dynamics and export performance.
Source: Author's calculation.

Crisis period cooled down overall demand (both domestic and foreign). As a result, mutual relationship between export performance and real output growth rates strengthened.

Figure 3 Export / Import Prices and Current Account Dynamics and (2000Q1-2012Q4)



Note: Endogenous variables: Export prices (EX_P) and import prices (IM_P) are expressed as indexes (left axis in figures) (2005 = 100). Current account (CU) is expressed as percentage share in GDP (CU) (right axes in figures).
Source: Compiled by author based on data taken from IMF - International Financial Statistics (May 2013).

Figure 3 reflects mutual relationships between current account dynamics and price level of exports and imports in European transition economies. In general, an increase in terms of trade (prices of export-to-import ratio) is usually associated with the current account improvement provided low price elasticity of exports and imports. However, persisting

increase in terms of trade (due to exchange rate or domestic prices shifts) is obviously followed by deterioration in international competitiveness especially with increasing lag.

Relative prices of exports and imports did not seem to follow common trend. Detailed information on averaged export-to-import prices ratios reveals table 2. Most countries (as well as the whole group of countries) experienced general improvements in term of trade over time. It seems that decreased price competitiveness of international trade was associated with drop in export performance and real output growth rates relationships during the second sub-period (2003-2005). However, steady deterioration in terms of trade did not seem to affect this relationship in the third sub-period (2006-2008).

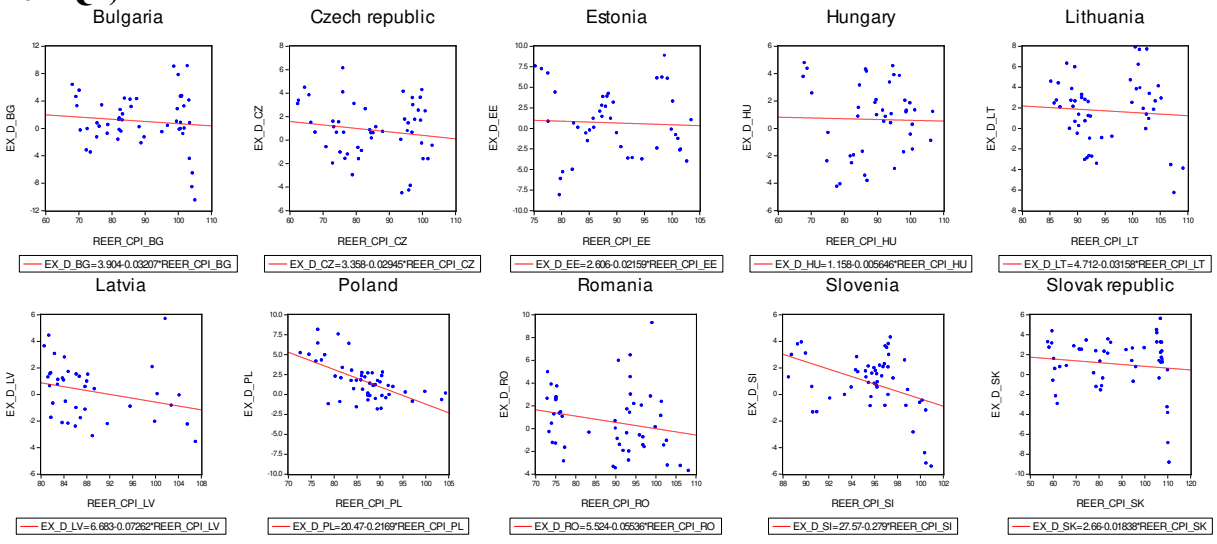
Table 2 Terms of Trade (2000Q1-2012Q4)

	2000-2002	2003-2005	2006-2008	2009-2012
Bulgaria	0.98	1.00	1.04	1.08
Czech republic	1.00	1.01	0.98	0.96
Estonia	0.92	0.99	1.04	0.99
Hungary	1.01	1.01	0.99	0.98
Lithuania	0.91	0.97	0.99	0.96
Latvia	0.97	1.00	1.01	1.03
Poland	0.96	0.98	1.00	1.00
Romania	0.90	0.97	1.15	1.26
Slovak republic	1.01	1.00	0.97	0.93
Slovenia	1.00	1.02	1.00	0.97
average	**0.97**	**0.99**	**1.02**	**1.01**

Note: Data represents ratios of export-to-import price indexes.
Source: Author's calculation.

Substantial decrease in demand for both foreign exports and domestic imports during the crisis period resulted in decrease in terms of trade and thus slightly improved price competitiveness of international trade in the whole group of countries.

Figure 4 Export Performance and Real Exchange Rate (CPI based) Dynamics (2000Q1-2012Q4)



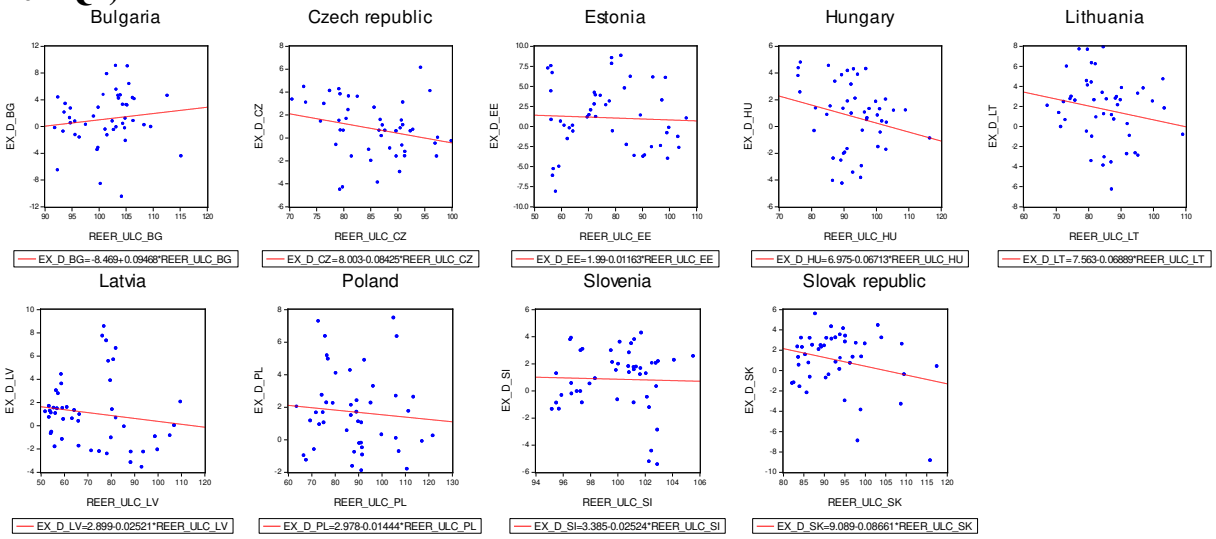
Note: Endogenous variables: Export performance (EX_D) is expressed as the relative change in the percentage share of export of goods on GDP. CPI based real effective exchange rate (REER_CPI) is expressed as index (2008 = 100).
Source: Compiled by author based on data taken from IMF - International Financial Statistics (May 2013). Time series for CPI based REER we drawn from REER database ver. 29 (Darvas, Z., November 2012).

Figure 4 reveals mutual relationships (simple linear regression) between export performance and CPI based REER in European transition economies. It is clear that an increase (appreciation) in REER was associated with a decrease in export performance in (though with different intensity) all countries.

As a result, price elasticity of exports provides vital information to investigate the relative contribution of changes in international competitiveness to the overall attractiveness of exports on foreign markets (see Section 6 for more rigorous results for current account adjustments after CPI based REER shifts). While being identified as a generally low (but still significant), sensitivity of export performance to CPI based REER appreciation seems to be the highest in Poland and Slovenia.

Figure 5 reveals mutual relationship between export performance and ULC based REER in European transition economies. In comparison with the figure 4 we have revealed some interesting implications of internally adjusted NEER according to the average costs of labor per unit of output.

Figure 5 Export Performance and Real Exchange Rate (ULC based) Dynamics (2000Q1-2012Q4)



Note: Endogenous variables: Export performance (EX_D) is expressed as a percentage share of export of goods on GDP. ULC based real effective exchange rate (REER_ULC) is expressed as index (2008 = 100).
Source: Compiled by author based on data taken from IMF - International Financial Statistics (May 2013). Time series for ULC based REER we drawn from REER database ver. 29 (Darvas, Z., November 2012).

In general, export performance of European transition economies seems to be more sensitive to competitiveness effects associated with changes in labor costs in comparison with consumer prices (excepting for Estonia, Poland and Slovenia) through real exchange rate dynamics (see Section 6 for more rigorous results for current account adjustments after ULC based REER shifts). Moreover, we have examined a positive relationship between ULC based REER and export performance in Bulgaria. As a result, deterioration in price competitiveness due to labor costs increase did not seem to have the negative impact on export performance in Bulgaria. Because time series for the ULC based REER for Romania were not available our suggestion reflects just our finding in Bulgaria - increase in costs of labor should not be necessarily followed by the deterioration in international competitiveness associated with REER appreciation in low income countries.

5. Econometric Model

VAR models represent dynamic systems of equations in which the current level of each variable depends on past movements of that variable and all other variables involved in

the system. Residuals of vector ε_t represent unexplained movements in variables (effects of exogenous shocks hitting the model); however as complex functions of structural shocks effects they have no economic interpretation. Structural shocks can be still recovered using transformation of the true form representation into the reduced-form by imposing a number of identifying restrictions. Applied restrictions should reflect some general assumptions about the underlying structure of the economy and they are obviously derived from economic theory. There are two general (most used) approaches to identify VAR models. (I) Cholesky decomposition of innovations implies the contemporaneous interactions between exogenous shocks and the endogenous variables are characterized by a Wald causal chain. Ordering of endogenous variables then reflects expected particular economy structure following general economic theory assumptions. However, the lack of reasonable guidance for appropriate ordering led to the development of more sophisticated and flexible identification methods - (II) structural VAR (SVAR) models. Identifying restrictions implemented in SVAR models reflect theoretical assumptions about the economy structure more precisely.

We employ a VAR methodology to analyze effects of real exchange rate dynamics on current account adjustments in European transition economies. Cholesky decomposition of variance-covariance matrix of reduced-form VAR residuals is implemented to estimate effects of real exchange rate dynamics on current accounts improvements.

True model is represented by the following infinite moving average representation:

$$X_t = A_0\varepsilon_t + A_1\varepsilon_{t-1} + A_2\varepsilon_{t-2} + \ldots = \sum_{i=0}^{\infty} A_i\varepsilon_{t-i} = \sum_{i=0}^{\infty} A_i L^i\varepsilon_t = A(L)\varepsilon_t \qquad (1)$$

where X_t represents n x 1 a vector including endogenous variables of the model, $A(L)$ is a n x n polynomial consisting of the matrices of coefficients to be estimated in the lag operator L representing the relationship among variables on the lagged values, ε_t is n x 1 vector of identically normally distributed, serially uncorrelated and mutually orthogonal errors (white noise disturbances that represent the unexplained movements in the variables, reflecting the influence of exogenous shocks):

$$E(\varepsilon_t) = 0, \quad E(\varepsilon_t\varepsilon_t') = \Sigma_\varepsilon = \mathrm{I}, \quad E(\varepsilon_t\varepsilon_s') = [0] \quad \forall t \neq s \qquad (2)$$

Vector X_t consists of six endogenous variables - real output $(y_{r,t})$, money supply (m_t), core inflation (p_t), short-term nominal interest rates $(ir_{n,t})$, real exchange rate $(er_{r,t})$ and current account (cu_t). In the six-variable VAR model $(X_t = [y_{r,t}, m_t, p_t, ir_{n,t}, er_{r,t}, cu_t,])$ we assume six exogenous shocks that contemporaneously affects endogenous variables - demand shock $(\varepsilon_{y,t})$, nominal shock $(\varepsilon_{m,t})$, inflation shock $(\varepsilon_{p,t})$, monetary policy shock $(\varepsilon_{ir_n,t})$, exchange rate shock $(\varepsilon_{er_r,t})$ and current account shock $(\varepsilon_{cu_n,t})$.

Structural exogenous shocks from equation (1) are not directly observable due to the complexity of information included in true form VAR residuals. As a result, structural shocks cannot by correctly identified. It is then necessary to transform true model into following reduced form

$$X_t = C(L)Y_{t-1} + e_t \qquad (3)$$

where $C(L)$ is the polynomial of matrices with coefficients representing the relationship among variables on lagged values and e_t is a n x 1 vector of normally distributed errors (shocks in reduced form) that are serially uncorrelated but not necessarily orthogonal:

$$E(e_t)=0, \quad \Sigma_u = E(e_t e_t') = A_0 E(\varepsilon_t \varepsilon_t') A_0' = A_0 A_0', \quad E(e_t e_s') = [0] \quad \forall t \neq s \tag{4}$$

Relationship between reduced-form VAR residuals (e_t) and structural shocks (ε_t) can be expressed as follows:

$$e_t = A_0 \varepsilon_t \tag{5}$$

As we have already noted at the beginning of the section we implement a Cholesky identification scheme to correctly identify structural shocks. In order to identify our model there must be exactly $n^2 - \left[\left(n^2 - n\right)/2\right]$ relationships among endogenous variables of the model, where *n* represents a number of variables. We have to impose $\left(n^2 - n\right)/2$ restrictions on the matrix A_0 based on the Cholesky decomposition of the reduced-form VAR residual matrix that define matrix A_0 as a lower triangular matrix. The lower triangularity of A_0 (all elements above the diagonal are zero) implies a recursive scheme (structural shocks are identified through reduced-form VAR residuals) among variables (the Wald chain scheme) that has clear economic implications and has to be empirically tested as any other relationship. Identification scheme of the matrix A_0 implies that particular contemporaneous interactions between some exogenous shocks and some endogenous variables are restricted reflecting causal (distribution) chain of interaction transmission. It is clear that the Wald causal chain is incorporated via convenient ordering of variables.

Considering lower triangularity of a matrix A_0 the equation (5) can be rewritten as follows:

$$\begin{bmatrix} e_{y_r,t} \\ e_{m,t} \\ e_{p,t} \\ e_{ir_n,t} \\ e_{er_r,t} \\ e_{cu,t} \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 \\ a_{21} & 1 & 0 & 0 & 0 & 0 \\ a_{31} & a_{32} & 1 & 0 & 0 & 0 \\ a_{41} & a_{42} & a_{43} & 1 & 0 & 0 \\ a_{51} & a_{52} & a_{53} & a_{54} & 1 & 0 \\ a_{61} & a_{62} & a_{63} & a_{64} & a_{65} & 1 \end{bmatrix} \begin{bmatrix} \varepsilon_{y_r,t} \\ \varepsilon_{m,t} \\ \varepsilon_{p,t} \\ \varepsilon_{ir,t} \\ \varepsilon_{er_r,t} \\ \varepsilon_{cu,t} \end{bmatrix} \tag{6}$$

Correct identification of exogenous structural shocks reflecting Cholesky ordering of variables denotes following assumptions:

- Real output doesn't contemporaneously respond to the shock from any other endogenous variable of the model.
- Money supply doesn't contemporaneously respond to inflation, interest rates, exchange rate and current account shocks, while it is contemporaneously affected only by the real output shock.
- Inflation doesn't contemporaneously respond to interest rates, exchange rate and current account shocks, while it is contemporaneously affected by real output and money supply shocks.
- Interest rates don't contemporaneously respond to exchange rate and current account shocks, while it is contemporaneously affected by real output, money supply and inflation shocks.

- Exchange rate doesn't contemporaneously respond to the current account shock, while it is contemporaneously affected by real output, money supply, inflation and interest rates shocks.
- Current account is contemporaneously affected by shocks from all of endogenous variables of the model.

After initial period endogenous variables may interact freely without any restrictions.

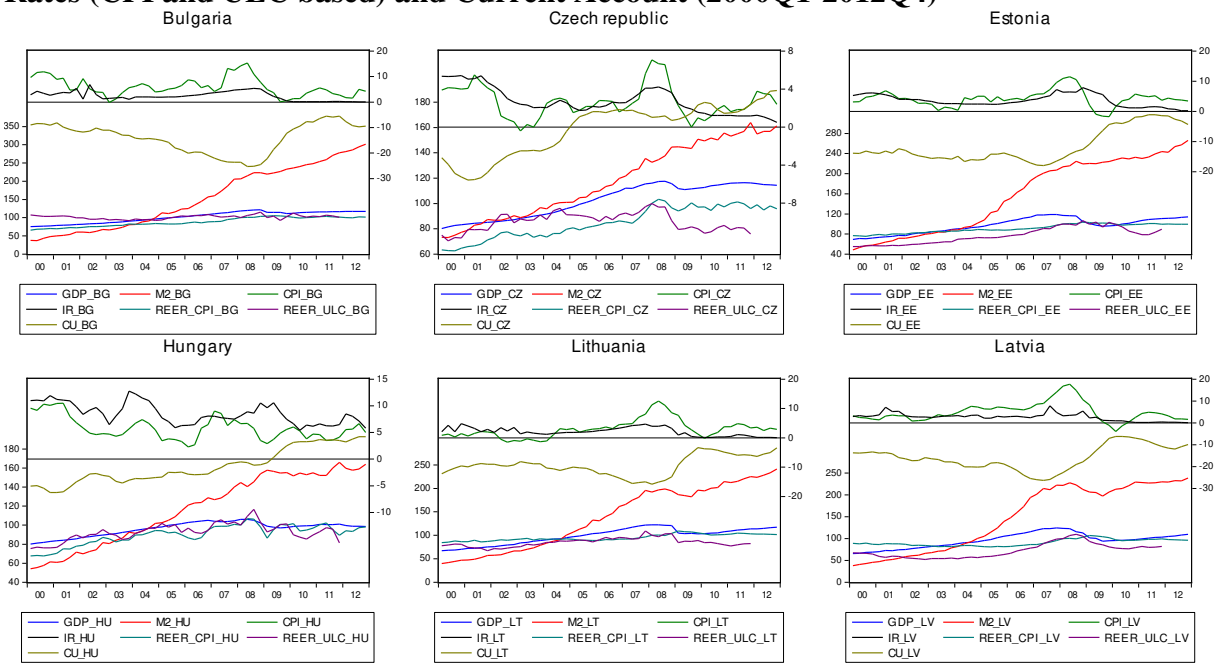
Estimated VAR model is used to compute impulse response functions to analyze responses of the current account to the negative one standard deviation real exchange rate shock in European transition economies. To check the robustness of empirical results we estimate the model considering different ordering of the endogenous variables in models with time series for two different periods (pre-crisis period - model A (2000Q1-2007Q4) and extended period - model B (2000Q1-2012Q4)):

- model A1, B1 $\left(X_t = \left[y_{r,t}, m_t, p_t, ir_{n,t}, er_{r,t}, cu_t\right]\right)$
- model A2, B2 $\left(X_t = \left[y_{r,t}, er_{r,t}, m_t, ir_{n,t}, p_t, cu_t\right]\right)$
- model A3, B3 $\left(X_t = \left[y_{r,t}, p_t, m_t, ir_{n,t}, er_{r,t}, cu_t\right]\right)$

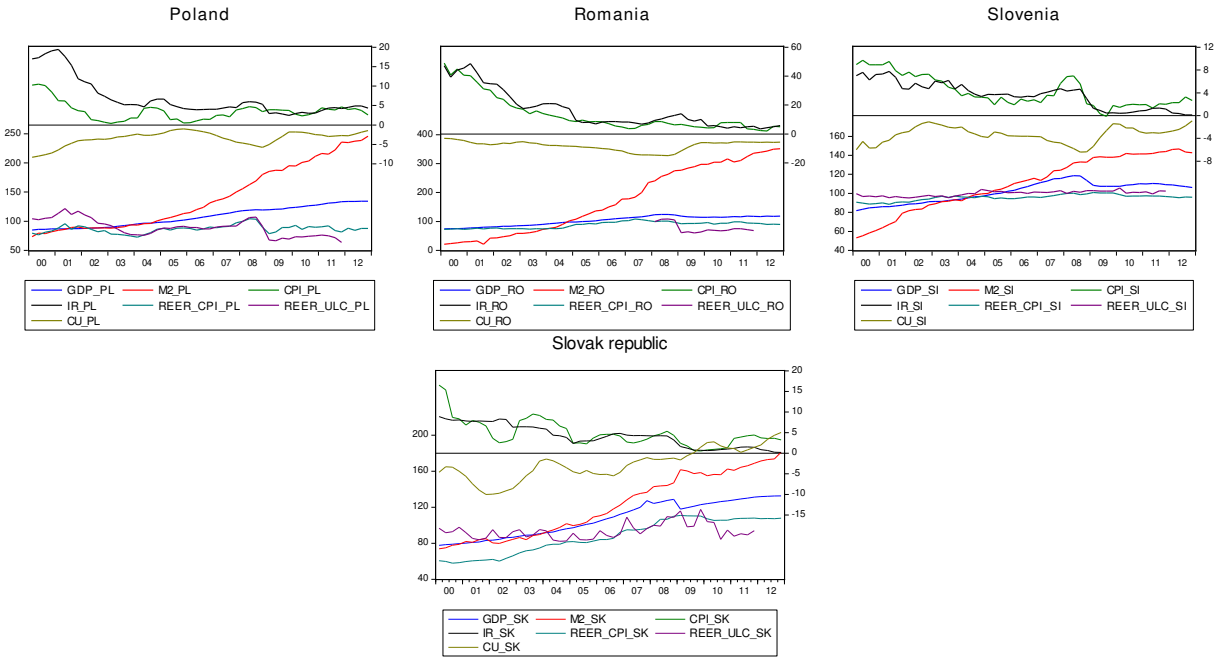
6. Data and Results

To estimate effects of real exchange rate dynamics on current account adjustments in European transition economies we employed quarterly data for period 2000Q1-2007Q4 (model A) consisting of 32 observations and for period 2000Q1-2012Q4 (model B) consisting of 52 observations for the following endogenous variables - real output (nominal GDP deflated by GDP deflator), money supply (monetary aggregate M2), inflation (core inflation), short-term interest rates (interbank offered rates with 3 months maturity[4]), real exchange rate (both CPI and ULC based real effective exchange rate) and balance of payment's current account (Figure 6).

Figure 6 Real Output, Money Supply, Inflation, Interest Rates, Real Effective Exchange Rates (CPI and ULC based) and Current Account (2000Q1-2012Q4)



[4] Short-term interest rates in Estonia, Slovak republic and Slovenia we replaced by EURIBOR after euro adoption in each particular country (2007, 2009 and 2011).



Note: Endogenous variables - real output (GDP), money supply (M2) and real effective exchange rate (REER) are expressed as indexes (left axis in figures) (2005 = 100). Inflation (INF) and interest rates (IR) are expressed in percentage (right axis in figures).
Source: Compiled by author based on data taken from IMF - International Financial Statistics (May 2013).

Estimation of two models is in line with the primary objective of the paper to reveal a relationship between real exchange rate dynamics and current account adjustments considering possible implications of the crisis period on estimated results. Time series for real output, money supply, inflation, interest rates and current account were drawn from IMF database (International Financial Statistics, May 2013). Time series for CPI and ULC based REER we drawn from REER database ver. 29 (Darvas, Z., November 2012). Time series for real output, money supply, inflation and current account were seasonally adjusted.

To correctly identify exogenous shocks hitting the model as well as to compute impulse-response functions it is necessary VAR model to be stationary. To check stationarity of the model it is necessary to test the time series for unit roots and cointegration.

A. Testing Procedures

Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests were computed to test endogenous variables for the unit roots presence. Both ADF and PP tests indicate that most of variables are non-stationary on values so that the null hypothesis of a unit root presence cannot be rejected for any of time series. Testing variables on first differences indicates that time series are stationary. We may conclude that variables are integrated of order 1 I(1).

Because there are endogenous variables with a unit root on values it is necessary to test time series for cointegration using the Johansen and Juselius cointegration test (we found reasonable to include variables I(0) for testing purposes following economic logic of expected results). The test for the cointegration was computed using three lags as recommended by the AIC (Akaike Information Criterion) and SIC (Schwarz Information Criterion).

Results of Johansen cointegration tests confirmed our results of unit root tests. Both trace statistics and maximum eigenvalue statistics (both at 0.05 level) indicate that there is no cointegration among endogenous variables of the model.

To test the stability of VAR models we also employed a number of diagnostic tests. We found no evidence of serial correlation, heteroskedasticity and autoregressive conditional heteroskedasticity effect in disturbances. The model also passes the Jarque-Bera normality

test, so that errors seem to be normally distributed. VAR models seem to be stable also because inverted roots of the model for each country lie inside the unit circle. Detailed results of time series testing procedures are not reported here to save space. Like any other results, they are available upon request from the author.

Following results of the unit root and cointegration tests we estimated the model using variables in first differences so that we can calculate impulse-response functions for all ten European transition economies. Following the main objective of the paper we focus on interpretation of responses of the current account to the negative one standard deviation real exchange rate (decrease in REER) shock. To observe effects of changes in relative competitiveness associated with REER sudden shifts on current account adjustments we estimate models with CPI and ULC based REER separately.

We also observe effects of the crisis period on the exchange rate determination potential in European transition economies by comparing results for estimated models using time series for two different periods - model A (2000Q1-2007Q4) and model B (2000Q1-2012Q4). Changed ordering of variables didn't seem to affect results of the analysis. Considering that impulse-response functions are not very sensitive to the ordering of endogenous variables we present results of both models (model A1 and B1) with default ordering of endogenous variables (detailed results for models A2, A3, B2, B3 are available upon request from the author).

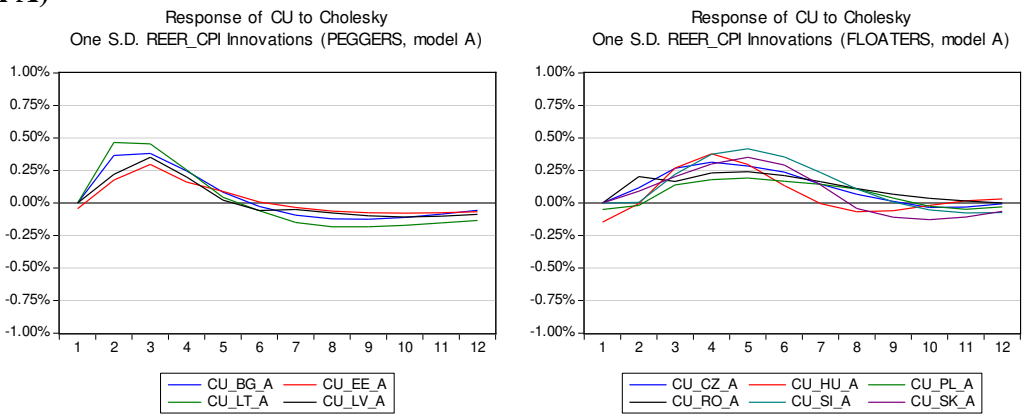
B. Impulse-Response Functions

In order to analyze effects of real exchange rate dynamics on current account adjustments in European transition economies we estimate responses of current account to the negative (devaluation or depreciation) one standard deviation real exchange rate shock employing quarterly data for two subsequent periods 2000-2007 (model A) and 2000-2012 (model B). Results seem to be sensitive to origins of real exchange rate dynamics.

While REER in the group of "peggers" is determined only by internal factors of international competitiveness (prices, labor costs, etc.), REER in the group of "floaters" is determined also by NEER dynamics and thus providing much more flexibility for the cross-country expenditure shifting.

In the figure 7 we summarize results of impulse-response functions of current accounts to negative (depreciation) real effective exchange rate (CPI based) shocks in the model with time series for the pre-crisis period (model A1) in European transition economies.

Figure 7 Responses of Current Account to REER (CPI based) Shocks (2000Q1-2007Q4) (Model A)



Note: Curves represent responses of current account (CU) to the negative (depreciation) one standard deviation real exchange rate (CPI based) shock in each country from the group of European transition economies.
Source: Author's calculation.

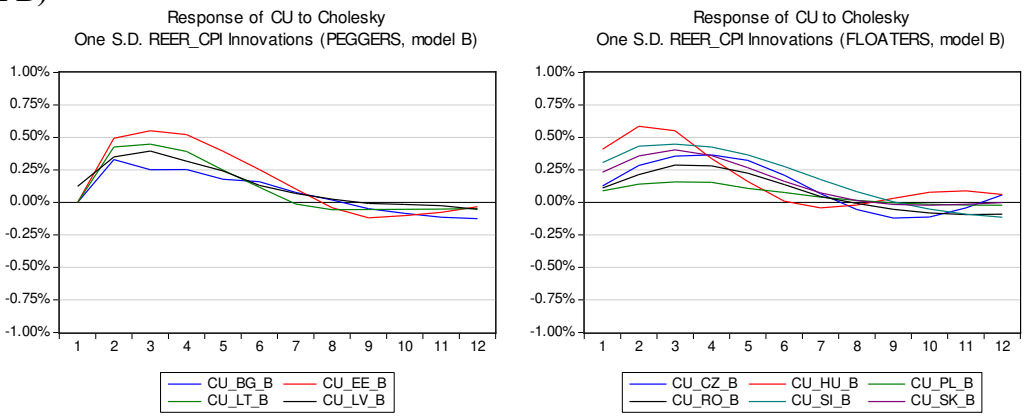
Estimates of current account responsiveness to the Cholesky negative one standard deviation REER shock (depreciation or devaluation of the real exchange rate) reveals interesting implications of increased price-determined competitiveness in European transition economies during the pre-crisis period. Unexpected shift (decrease) of REER was followed by the current account improvement in each individual country.

However, we have observed some differences in the path of the current account response in both groups of countries. In the group of "peggers" current account improved within a one quarter lag. A positive effect of the real exchange rate shock culminated between second and third quarter after the shock and subsequently steadily decreased. Its positive redistributive effect completely died out till the end of the fifth quarter. Exchange rate shock seems to be neutral in the long run in determining current account adjustments.

On the other hand, responses of the current account to the negative real exchange rate shock in the group of "floaters" revealed some implications of the nominal exchange rate flexibility. Initial adjustment in the current account after the shock seems to be less dynamic. At the same time, an improvement in current account dynamics was quite similar in its intensity but much more durable (more than one year). Positive effect of the real exchange rate decrease on the current account died out during one year since the sixth quarter. Similarly, effect of the shock seems to be neutral in the long run.

In the figure 8 we summarize results of impulse-response functions of current accounts to negative (depreciation) real effective exchange rate (CPI based) shocks in the model with time series for the extended period (model B1) in European transition economies.

Figure 8 Responses of Current Account to REER (CPI based) Shocks (2000Q1-2012Q4) (Model B)



Note: Curves represent responses of current account (CU) to the negative (depreciation) one standard deviation real exchange rate (CPI based) shock in each country from the group of European transition economies.
Source: Author's calculation.

Current account adjustments followed by the negative real exchange rate shock revealed generally similar effect of increased price competitiveness during the extended period (temporary improvement in the current account balance). However, current account response provides some differences in its key characteristics. Loading phase of the current account improvement seems to be reduced in both groups of countries. Positive effects of the exchange rate shock peaked during the second half of the year since the shock in the group of "peggers". At the same time, the overall durability of current account improvements slightly increased (positive effect on the current account died out till the end of the second year since the shock).

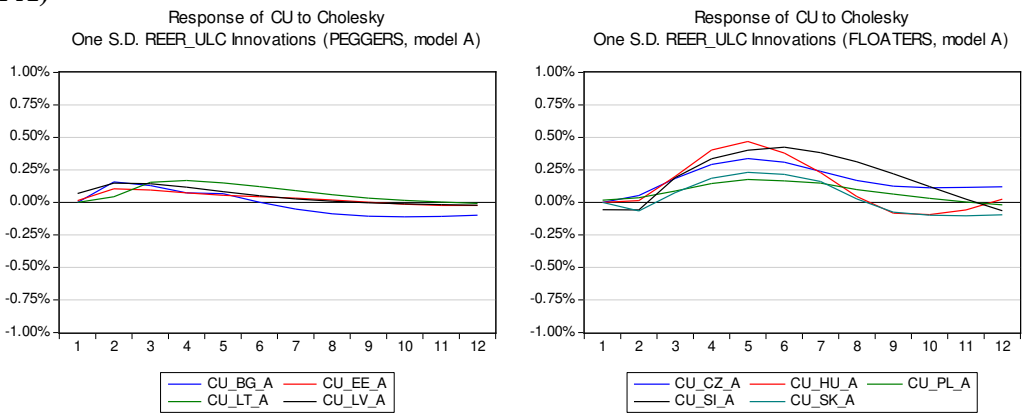
Current accounts in the group of "floaters" improved immediately after the negative exchange rate shock, though with different intensity. While the short-term positive effect

(within first year after the shock) on the current account slightly increased, its durability markedly decreased. In both groups of countries the overall effect of the shock in the long run seems to be neutral in the model with time series for extended period too.

Comparison of current account adjustments followed by CPI based REER shocks in European transition economies for both periods revealed several crucial implications. Current accounts in both groups of countries seem to be vulnerable to effects associated with real exchange rates (determined by relative consumer prices) dynamics with clearly distinct patterns. During the pre-crisis period, current accounts in the group of "floaters" seem to be more vulnerable to unpredicted real exchange rate shocks. Despite slightly delayed load of the positive effect (in comparison with countries from the group of "peggers") its durability was obviously higher. Our results for the extended period suggest increased short-term exposure of current accounts of both groups of countries, though markedly higher in the group of "floaters", to the exchange rate shocks but with reduced durability of positive effects.

In the figure 9 we summarize results of impulse-response functions of current accounts to negative (depreciation) real effective exchange rate (ULC based) shocks in the model with time series for the pre-crisis period (model A1) in European transition economies.

Figure 9 Responses of Current Account to REER (ULC based) Shocks (2000Q1-2007Q4) (Model A)



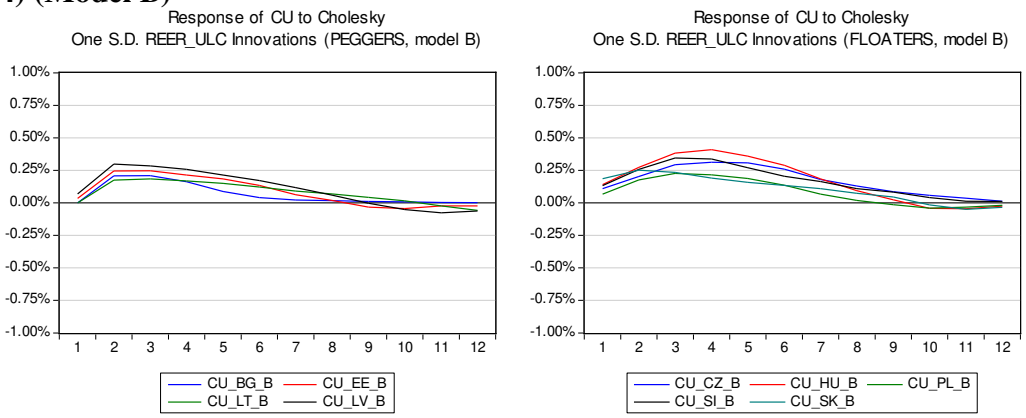
Note: Curves represent responses of current account (CU) to the negative (depreciation) one standard deviation real exchange rate (ULC based) shock in each country from the group of European transition economies.
Source: Author's calculation.

Negative exchange rate shock was followed by the current account improvement in all ten European transition economies. However, our results revealed some clear differences among countries from both groups. In countries from the group of "peggers" the current account improved just for a short period of time. Intensity of current account adjustments was significantly lower after the negative ULC based REER shock in comparison with the CPI based REER shock. Beside a long-run neutrality of the exchange rate shock, its durability seems to differ in each individual country from the group (the positive effect on the current account died out within sixth and tenth quarter after the shock).

Quite different results were investigated in countries from the group of "floaters". Despite generally higher improvement in current accounts (effect of the shock culminated during the first half of the second year after the shock) we have observed slightly lagged response immediately after the shock (countries experienced the current account improvement with approximately two quarters lag). The overall durability of the positive effect was generally higher in comparison with the previous group of countries.

In the figure 10 we summarize results of impulse-response functions of current accounts to negative (depreciation) real effective exchange rate (ULC based) shocks in the model with time series for the extended period (model B1) in European transition economies.

Figure 10 Responses of Current Account to REER (ULC based) Shocks (2000Q1-2012Q4) (Model B)



Note: Curves represent responses of current account (CU) to the negative (depreciation) one standard deviation real exchange rate (ULC based) shock in each country from the group of European transition economies.
Source: Author's calculation.

Crisis period affected the pattern of current account adjustments following after the negative real exchange rate shock. In both groups of countries we have investigated a short-term improvement in current accounts. Despite identified differences between pre-crisis and extended period, our results revealed quite similar effects of the crisis period on current account adjustments initiated by both CPI and ULC based real exchange rate shocks. In countries from the group of "peggers" it seems that the short-term improvement in current accounts increased while the overall durability of the exchange rate shock did not change at all. On the other hand, the overall load time of the current accounts improvement (despite a slightly reduced intensity) due to negative exchange rate shock in countries from the group of "floaters" was clearly reduced. Due to drop in the length of the lagged response it seems, that current accounts in countries with flexible exchange rate arrangements became more vulnerable to sudden exchange rate shifts during the crisis period[5].

Comparison of current account adjustments followed by ULC based REER shocks in European transition economies for both periods revealed several crucial implications. The overall exposure of current accounts to sudden real exchange rate shocks increased in both groups of countries during the crisis period. At the same time it seems that current account improvements occurred with reduced lag in both groups of countries. On the other hand, real exchange rate shocks affected current account adjustments with generally higher intensity in countries from the group of "floaters".

7. Conclusion

Real exchange rates determined current accounts in all ten European transition economies in the line with economic theory (despite relatively limited empirical evidence) in both pre-crisis and extended periods. However, we have observed some specific implications

[5] Despite the euro adoption by Slovenia (2007), Slovak republic (2009) and Estonia (2011) our results for current account adjustments followed by negative CPI and ULC based REER shocks suggests that the responsiveness pattern of the current account for these three countries better suit to results observed for countries from the group of "floaters". It seems that the real exchange rate determination potential of these three new EMU member countries was not affected by its pegging to euro.

of distortionary effects caused by unexpected real exchange rate shifts during the crisis period that may be a subject of further academic discussions focusing on wide causalities of the economic crisis. Our results also revealed possible causality between exchange rate arrangements and the way that the exchange rate shock affects current account adjustments. Thus, our investigations may be a relevant contribution to the fixed versus flexible exchange rate dilemma that seems to be a crucial part of discussions related to the wide variety of implications associated with sacrificing monetary sovereignty in Eurozone candidate countries from the group of European transition economies.

Comparison of current account adjustments followed by CPI based REER shocks in European transition economies for both pre-crisis and extended periods revealed several crucial implications. Current accounts in both groups of countries seem to be vulnerable to effects associated with real exchange rates (determined by relative consumer prices) dynamics. During the pre-crisis period, current accounts in the group of "floaters" seem to be more vulnerable to unpredicted real exchange rate shocks. Despite slightly delayed load of the positive effect (in comparison with countries from the group of "peggers") its durability was obviously higher. Our results for the extended period suggest increased short-term exposure of current accounts of both groups of countries, though markedly higher in the group of "floaters", to exchange rate shocks but with reduced durability of positive effects.

The overall exposure of current accounts to sudden ULC based REER real exchange rate shocks increased in both groups of countries during the crisis period. At the same time it seems that current account improvements occurred with reduced lag in both groups of countries (in comparison with the pre-crisis period). On the other hand, real exchange rate (determined by unit labor costs) shocks affected current account adjustments with generally higher intensity in countries from the group of "floaters".

Improvements in current accounts followed by exchange rate shocks in European transition economies seems to be sensitive not only to the exchange rate arrangement[6] but also to processes determining internal changes in the relative competitiveness (relative dynamics in consumer prices and labor costs). As of changes in the relative international competitiveness and associated cross-country expenditures shifts our results suggest that they are more vulnerable to adjustments in consumer prices than labor costs.

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[6] However, this effect seems to be disputable and thus needs more empirical investigation though we suggest it is still contributive provided relatively convenient explanation of implications associated with the exchange rate regime choice.

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