Sources of exchange rate volatility in the european transition economies (effects of economic crisis revealed)

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Abstract:

Negative macroeconomic performance issues represent one of the key effects of crisis period. Due to many economic crisis related side effects countries became more vulnerable to various types of endogenous and exogenous shocks. Exchange rates of the European transition economies became much more volatile as a result of increased uncertainty on the financial markets as well as changed behavior of structural shocks affecting exchange rates path during the crisis period. As a result we expect a contribution of the structural shocks to the exchange rates path has changed.

In the paper we analyze sources of exchange rate fluctuations in the European transition economies. We estimate the contribution of nominal, supply and demand shocks to NEER and REER variability implementing SVAR methodology. Long run restrictions are applied to unrestricted VAR model to identify structural shocks. Variance decomposition and impulse-response functions are computed for each individual country for the period 2000-2007 and 2000-2011. Comparison of results for both periods is crucial for identification of the role of economic crisis in determining exchange rate volatility in the European transition economies.

Keywords: exchange rates, exogenous structural shocks, structural vector autoregression, variance decomposition, impulse-response function

JEL Classification: C32, E52

1. Introduction

Current economic crises deteriorated overall macroeconomic performance of the European transition economies. At the same it caused their exchange rates to become much more volatile as a result of increased uncertainty on the financial markets as well as changed behavior of structural shocks affecting exchange rates path during the crisis period.

Decreased predictability of (especially) short-term exchange rates path affected not only countries with their own currencies (Bulgaria, Czech republic, Estonia, Latvia, Lithuania, Hungary, Poland and Romania in our sample) but also member countries of the Economic and Monetary Union (EMU) (Slovak republic and Slovenia in our sample). In general, exchange rate stability is considered to be one of the most significant outcomes of the Eurozone membership especially for smaller and opened transition economies. On the other hand economic and debt crisis related problems negatively contributed to the exchange rate stability of the euro. Under such circumstances exogenous character of sudden exchange rate shifts in currency unions become a viable vehicle of undesired external shocks especially in small open economies.

In the paper we analyze sources of exchange rate fluctuations in the European transition economies. We estimate the contribution of nominal, demand and supply shocks to NEER and REER variability implementing SVAR methodology. Long run restrictions are applied to unrestricted VAR model to identify structural shocks. Variance decomposition and impulse-response functions are computed for each individual country for the period 2000-2007 and

2000-2011. Comparison of results for both periods is crucial for identification of the role of economic crisis in determining exchange rate volatility in the European transition economies.

2. Overview of the literature

Empirical studies dealing with effects of structural shocks on the exchange rate leading path are usually based on SVAR methodology. Structural shocks are obviously isolated implementing long-run (rarely short-run) identifying restrictions. Determining forces affecting exchange rate path are then decomposed to temporary and permanent components.

Kutan a Dibooglu (Kutan a Dibooglu, 1998) analyzed sources of exchange rates volatility in Poland and Hungary decomposing nominal and real shocks. Fidrmuc a Korhonen (Fidrmuc a Korhonen, 2001) investigated mutual correlations between supply and demand shocks in the Czech republic, Hungary, Poland and the Slovak republic. Hamori a Hamori (Hamori a Hamori, 2007) analyzed sources (supply, demand and nominal shocks) of nominal and real euro exchange rate movements. Stazka (Stazka, 2006) examined sources of real exchange rates volatility on the sample of nine Central and Eastern European countries. Chowdhury (Chowdhury, 2004) investigated sources (real and nominal shocks) of bilateral exchange rates fluctuations in the selected developing countries vis-a-vis USD. Enders a Bong-Soo (Enders a Bong-Soo, 1997) decomposed sources of real and nominal exchange rates movements to real and nominal components focusing on bilateral exchange rates USD/CAD a JPY/DEM. Lastrapes (Lastrapes, 1992) analyzed sources (nominal and real shocks) of real and nominal Exchange rates fluctuations in U.S.A., Germany, Great Britain, Japan, Italy and Canada. Structural shocks were isolated using short-run identifying restrictions.

3. Econometric model

Vulnerability of the exchange rates to the exogenous shocks came to the center of an academic discussion shortly after a break-down of a Bretton Woods system of fixed exchange rates at the beginning of the 1970s. Uncertainty on the foreign exchange markets together with higher volatility of exchange rates increased a sensitivity of domestic economies to the foreign partners' economic development as well as to the world leading economies' exchange rate movements.

Main contribution to the analysis of structural exogenous shocks is addresses to Byoumi and Eichegreen (1993) who pioneered an identification scheme of underlying supply and demand shocks using technique introduced by Blanchard and Quah (1989). Their model considered two types of structural shocks (supply shocks and demand shocks) hitting an economy. So called primitive shocks were identified using long-run restrictions based on long-run neutrality of the real output to demand shocks, while it is suggested the supply shocks have permanent influence on the real output development (Fidrmuc-Korhonen, 2001).

The methodology we use in our analysis to recover nominal (liquidity), demand and supply shocks is based upon a SVAR model introduced by Clarida and Gali (1994), which implements a long-run identifying restrictions to the unrestricted VAR models pioneered by Blanchard and Quah (1989).

Unrestricted form of the model is represented by the following infinite moving average representation:

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

where X_t is a vector of the endogenous macroeconomic variables, $A(L)$ is a polynomial variance-covariance matrix (represents impulse-response functions of the shocks to the elements of X) of lag-length l, L is lag operator and ε is a vector of identically normally distributed, serially uncorrelated and mutually orthogonal white noise disturbances (vector of reduced form shocks in elements of X). The vector X_t of the endogenous variables of the model consists of the following three elements: real exchange rate (er_r), nominal exchange rate (er_n) and real output (y_r).

In our tri-variate model we assume three exogenous shocks that determine endogenous variables - nominal shock (ε_n), demand shock (ε_d) and supply shock (ε_s). Our model then becomes

$$\begin{bmatrix} \Delta er_{rt} \\ \Delta er_{nt} \\ \Delta y_{rt} \end{bmatrix} = \sum_{i=0}^{\infty} \begin{bmatrix} a_{11i} & a_{12i} & a_{13i} \\ a_{21i} & a_{22i} & a_{23i} \\ a_{31i} & a_{32i} & a_{33i} \end{bmatrix} \begin{bmatrix} \varepsilon_{nt} \\ \varepsilon_{dt} \\ \varepsilon_{st} \end{bmatrix} \tag{2}$$

The framework of the model implies that only supply shocks have a permanent effect on all endogenous variables. Demand shocks have permanent effect on the real and nominal exchange rate while its impact on the real output is only temporary. Nominal shocks have permanent effect only on the nominal exchange rate while its impact on the real exchange rate and the real output is considered to be temporary. Identification of temporary impacts of selected exogenous shocks on the endogenous variables is represented in the model by the following long-run identifying restrictions

$$\sum_{i=0}^{\infty} a_{11i} = 0, \sum_{i=0}^{\infty} a_{31i} = 0, \sum_{i=0}^{\infty} a_{32i} = 0 \tag{3}$$

The model defined by equations (2) and (3) we estimate using a vector autoregression. Each element of X_t can be regressed on lagged values of all elements of X. Using B to represent these estimated coefficients, the estimated equation becomes

$$\begin{aligned} X_t &= B_1 x_{t-1} + B_2 x_{t-2} + \dots B_n x_{t-n} + e_t = \sum_{i=1}^{n} B_i L^i X_t + e_t = B(L) X_t + e_t \\ &= \left(I - B(L)\right)^{-1} e_t \\ &= \left(I + B(L) + B(L)^2 + \dots\right) e_t \\ &= e_t + D_1 e_{t-1} + D_2 e_{t-2} + D_3 e_{t-3} + \dots \end{aligned} \tag{4}$$

where e_t represents the residuals from the equations in the vector autoregression.

In order to convert equation (4) into the model defined by the equations (2) and (3), the residuals from the vector autoregression, e_t, must be transformed into nominal, demand and supply shocks, ε_t. Imposing $e_t = C\varepsilon_t$, it is clear, that nine restrictions are necessary to define nine elements of the matrix C. Three of these restrictions are simple normalizations, which define the variance of the shocks $\varepsilon_{n,t}$, $\varepsilon_{d,t}$ and $\varepsilon_{s,t}$ (it follows the assumption, that each of the disturbances has a unit variance, $\text{var}(\varepsilon) = 1$. Another three restrictions comes from an assumption that identified shocks are orthogonal. Normalization together with an assumption of the orthogonality implies $C'C = \Sigma$, where Σ is the variance covariance matrix of e_n, e_d and e_s. The final three restrictions, which allow the matrix C to be uniquely defined, reflect the long-run identifying restrictions mentioned in the equation (3). In terms of our vector autoregression model it implies

$$\sum_{i=0}^{\infty}\begin{bmatrix} d_{11} & d_{12} & d_{13} \\ d_{21} & d_{22} & d_{23} \\ d_{31} & d_{32} & d_{33} \end{bmatrix}\begin{bmatrix} c_{11} & c_{12} & c_{13} \\ c_{21} & c_{22} & c_{23} \\ c_{31} & c_{32} & c_{33} \end{bmatrix} = \begin{bmatrix} 0 & . & . \\ . & . & . \\ 0 & 0 & . \end{bmatrix} \tag{5}$$

Final three long-run restrictions allows the matrix C to be uniquely defined and the nominal, demand and supply shocks to be correctly identified - recovered from the residuals of the estimated VAR model. The system is now just-identified and can be estimated using structural vector autoregression, so that we can compute variance decomposition that represents the contribution of each shock to the variability in each endogenous variable (we do this for the real output only) and impulse-response functions that represent the short-run dynamics of each endogenous variable (we do this for the real output only) in response to all identified structural shocks.

If the exogenous structural shocks are correctly identified, we might expect the following results:

- In the short-run a positive relative nominal shocks leads to NEER and REER depreciation. In the long run, there should be no effect on the REER path.
- In the short-run NEER and REER should appreciate after a positive relative demand shock. If the shock is permanent, REER should appreciate after a positive demand shock in the long-run.
- The effect of a positive relative supply to REER and NEER path should be ambiguous in the short-run, while in the long-run we expect an ambiguous effect only on REER.

4. Data and results

The methodology we use in our analysis to recover nominal (liquidity), demand and supply shocks is based upon a SVAR model introduced by Clarida and Gali (1994), which implements a long-run identifying restrictions to the unrestricted VAR models pioneered by Blanchard and Quah (1989).

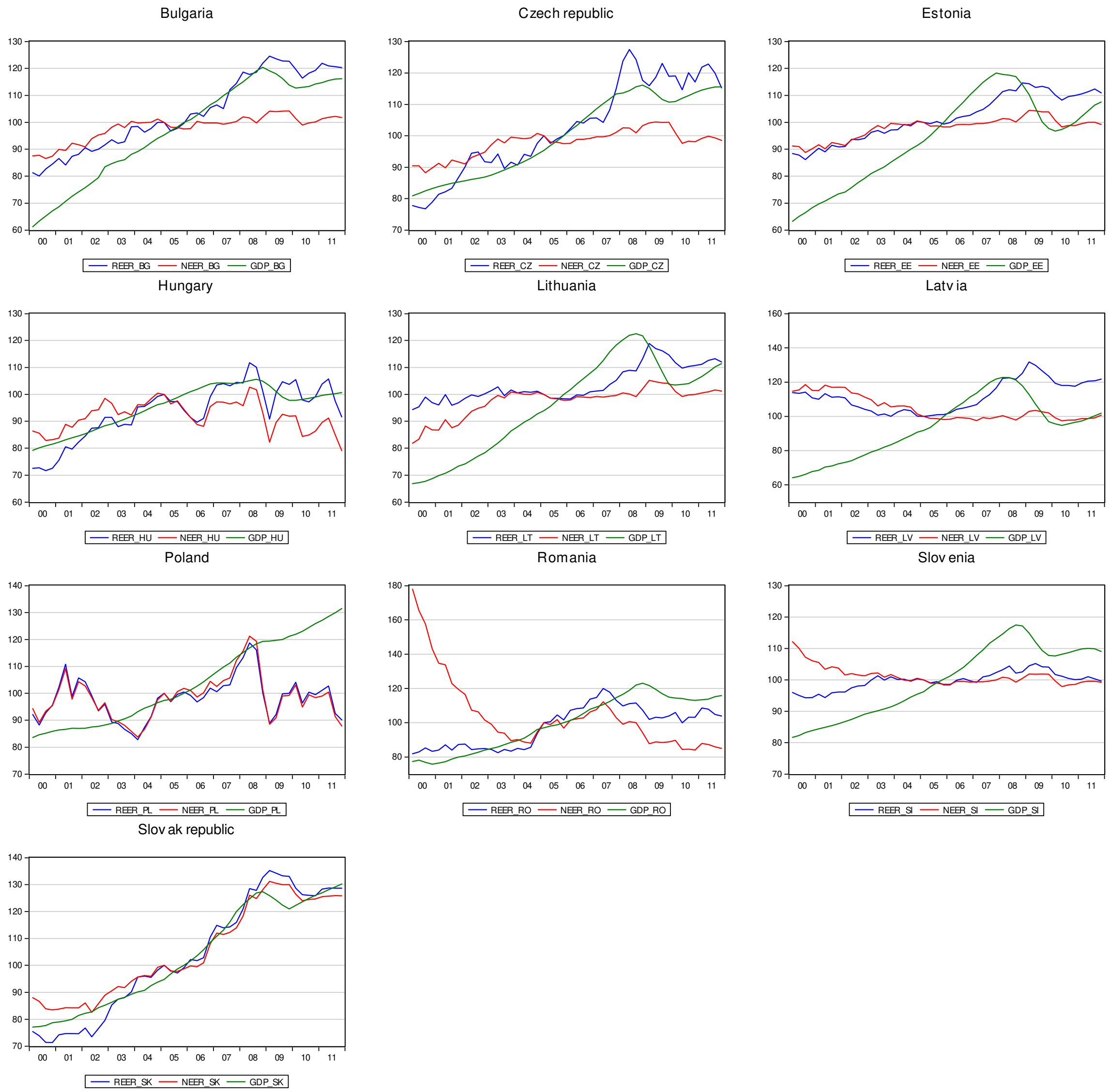
In order to estimate our model consisting of three endogenous variables for ten European transition economies (Bulgaria, Czech republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovak republic, Slovenia) we use the quarterly data ranging from 2000Q1 to 2011Q4 (48 observations) for the real effective exchange rates[1], nominal effective exchange rates[2] and real GDP (figure 1). Time series for the annual real GDP calculated on the quarter base are seasonally adjusted. Time series for all endogenous variables were drawn from IMF database (International Financial Statistics, August 2012).

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

[1] Real effective exchange rates are the same weighted averages of bilateral exchange rates adjusted by relative consumer prices.

[2] Nominal effective exchange rates are calculated as geometric weighted averages of bilateral exchange rates.

Figure 1 REER, NEER and GDP in the European Transition Economies



Note: Endogenous variables - real effective exchange rate (REER), nominal effective exchange rate (NEER) and gross domestic product (GDP) are expressed as indexes (2005 = 100).
Source: Compiled by author based on data taken from IMF - International Financial Statistics (August 2012).

A. Unit Root Test

The augmented Dickey-Fuller (ADF) and the Phillips-Perron (PP) tests were computed to test the endogenous variables for the unit roots presence. Results of unit root tests are summarized in the table 1 (detailed results of unit root are not reported here to save space. Like any other results, they are available upon request from the author).

Both ADF and PP tests indicate that all variables are non-stationary on the values so that the null hypothesis of a unit root cannot be rejected for any of the series. Testing variables on the first differences indicates the time series are stationary so that we conclude that the variables are I(1).

Table 1 Unit Root Tests

Country	Model	Order of integration of endogenous variables					
		REER		**NEER**		**GDP**	
		ADF	PP	ADF	PP	ADF	PP
Bulgaria	A	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)
	B	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)
Czech republic	A	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)
	B	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)
Estonia	A	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)
	B	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)
Latvia	A	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)
	B	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)
Lithuania	A	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)
	B	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)
Hungary	A	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)
	B	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)
Poland	A	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)
	B	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)
Romania	A	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)
	B	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)
Slovak republic	A	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)
	B	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)
Slovenia	A	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)
	B	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)

Source: Author's calculations.

B. Cointegration Test

Because endogenous variables have a unit root on the values it is necessary to the test the time series for cointegration using the Johansen and Juselius cointegration test. The test for the cointegration was computed using two lags as recommended by the AIC (Akaike Information Criterion) and SIC (Schwarz Information Criterion). Results of cointegration tests are summarized in the table 2 (detailed results of cointegration tests are not reported here to save space. Like any other results, they are available upon request from the author).

The results of the Johansen cointegration tests confirmed the results of the unit root tests for both models (models A and B) in the Czech republic, Lithuania and Hungary only. Trace statistics and maximum eigenvalue statistics (both at 0.05 level) in these two countries indicate that there is no cointegration among the endogenous variables of the model. One test statistics indicates that we cannot however denote the rejection of the null hypothesis about no cointegration among variables (indicating the existence of one cointegrating relationship) for model A (Bulgaria, Estonia, Poland, Romania and Slovak republic) and model B (Bulgaria, Latvia, Romania, Slovak republic and Slovenia). An increase in the length of the lag to three lags resulted in the loss of the cointegrating relationship among variables in all countries indicating that any linear combination of two variables is nonstationary process.

Table 2 Johansen and Juselius Cointegration Tests

Country	Number of cointegrating equations			
	Model A		Model B	
	trace stat.	max eigvalue stat.	trace stat.	max eigvalue stat.
Bulgaria	1	0	1	0
Czech republic	0	0	0	0
Estonia	0	1	0	0
Latvia	0	0	1	0
Lithuania	0	0	0	0
Hungary	0	0	0	0
Poland	1	0	0	1
Romania	1	0	0	1
Slovak republic	1	0	1	0
Slovenia	0	0	0	1

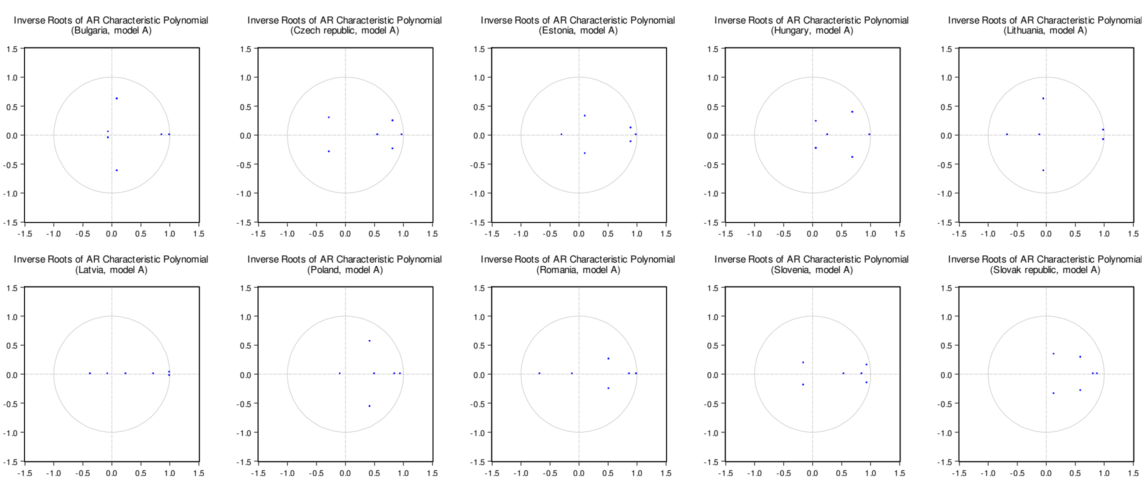
Source: Author's calculations.

C. VAR Stability

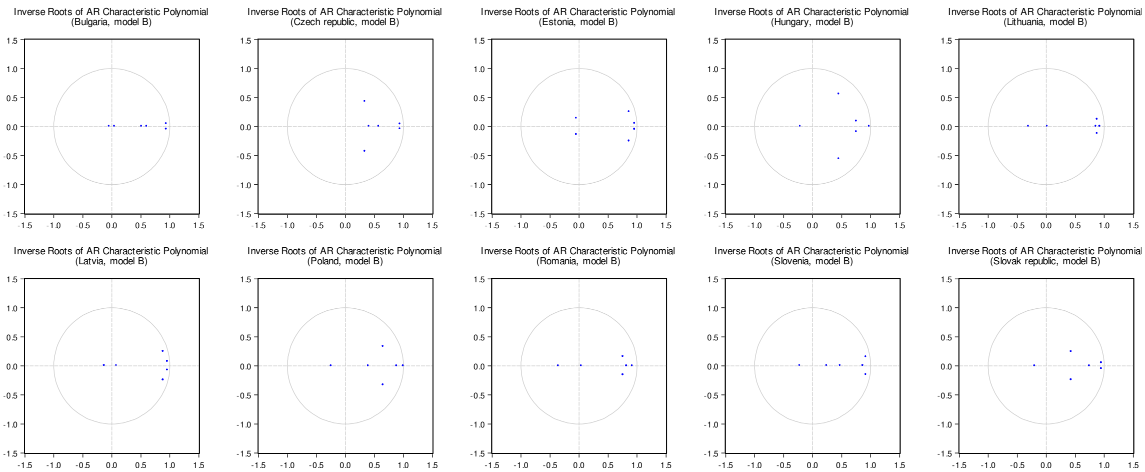
To test the stability of the VAR model we also applied a number of diagnostic tests. We found no evidence of serial correlation, heteroskedasticity and autoregressive conditional heteroskedasticity effect in the disturbances. The model also passes the Jarque-Bera normality test, so that errors seem to be normally distributed. The VAR models seem to be stable also because the inverted roots of the model for each country lie inside the unit circle (figure 2).

Figure 2 VAR Stability Condition Check

Model A



Model B



Source: Author's calculation.

Following the results of the unit root and cointegration tests we estimated the model using the variables in the first differences so that we can calculate variance decompositions and impulse-response functions for all ten countries from the group of the European transition economies. In line with the main objective of the paper we focus on interpretation of the structural shocks contribution to the REER and NEER conditional variance. At the same time we analyze responses of REER and NEER on the positive one standard deviation nominal, demand and supply shocks. We also observe effects of economic crisis on the structural shocks determination potential in the European transition economies by comparing the results for models estimated using time series for two different periods - model A (2000Q1-2007Q4) and model B (2000Q1-2011Q4).

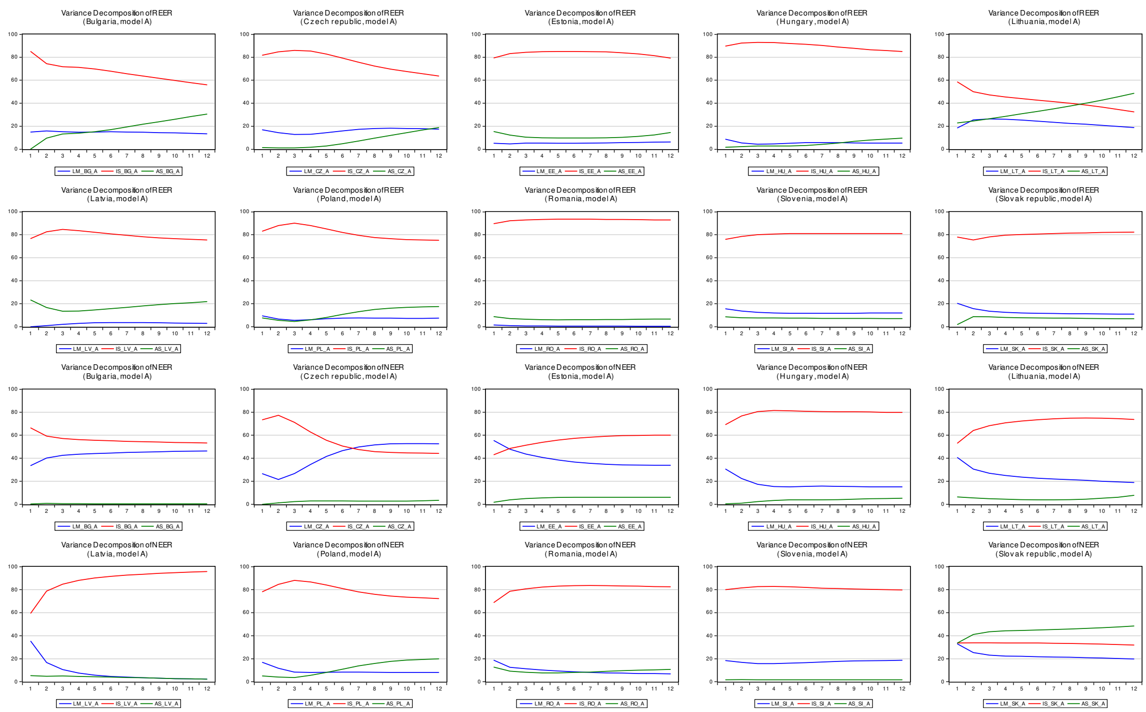
D. Variance Decomposition

The figure 3 shows the estimated contribution of the structural shocks to the REER and NEER conditional variance in the European transition economies during the pre-crisis period. It seems to be clear that dominant part in immediate deterministic effect to the REER leading path during the pre-crisis period comes from *demand shock* in all ten countries. While in the Estonia, Hungary, Latvia, Romania, Slovenia and the Slovak republic the contribution of the shock remained relatively stable even in the medium term, its role slightly decreased in Bulgaria, the Czech republic, Lithuania and Poland over time. At the same time the role of *nominal shock* seems to be quite stable and of a minor importance in determining REER path in all countries. While the contribution of the *supply shock* seems to be similarly low, its effect increases in Bulgaria, the Czech republic, Lithuania, Latvia and Poland in medium term.

Slightly different picture indicate the variance decomposition of NEER. Percent short-run NEER variance due to *demand shock* seems to be similarly high in all countries but the Slovak republic. Reduced (in comparison to REER) but still significant seems to be contribution of demand shock to NEER variability in Bulgaria, the Czech republic and Estonia. In Lithuania and Latvia the long-run role of demand shock to NEER leading path seems to be higher (in comparison to REER). The role of *nominal shock* in determining NEER variability seems to be stable while following slightly decreasing trend over time in all countries but Bulgaria and the Czech republic. Finally, contribution of *supply shock* to the NEER conditional variance seems to be negligible in the Czech republic and Hungary, while its role slightly increases in the long period in Poland. In the Slovak republic the supply seems to be quite important in determining NEER leading path even in the short period.

In the figure 3 we summarize variance decomposition of REER and NEER for the model with pre-crisis time series (model A) in the European transition economies.

Figure 3 Variance Decomposition of REER and NEER (2000Q1-2007Q4)



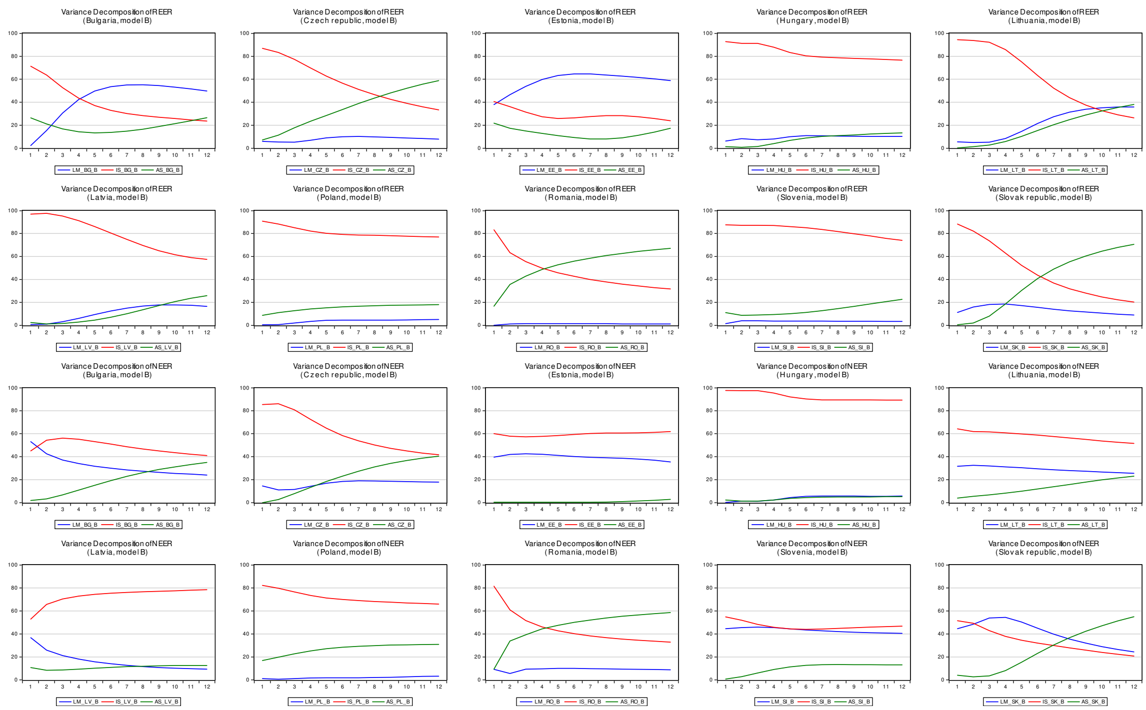
Note: Curves represents relative contribution of structural shocks to the REER and NEER conditional variance in each individual country from the group of the European transition economies.
Source: Author's calculation.

The figure 4 shows the estimated contribution of the structural shocks to the REER and NEER conditional variance in the European transition economies during the extended period. Immediate contribution of *nominal shock* to the REER and NEER conditional variability slightly decreased (but with significant exception in Slovenia and the Slovak republic when decomposing NEER variance). The role of the shock seems to be reduced even in the long run in all countries but Bulgaria (REER), Estonia (REER), Lithuania (REER) and Latvia (REER). Quite different effect of the crisis period we observed from the variance decomposition of REER and NEER due to *demand shock*. While the overall effect of the shock remained notably high even with increased lag since the shock in Hungary and Poland, its effect was significantly reduced in the long period in Bulgaria (REER), the Czech republic (REER), Estonia (REER; in short period too), Lithuania (REER - though short-run contribution significantly increased, NEER), Latvia (REER - though short-run contribution slightly increased), Romania (REER, NEER), Slovenia (NEER) and the Slovak republic (REER). Reduction in the contribution of shock we also observed from decomposing variance of NEER in Poland. At the same time the contribution of *supply shock* to the REER variability markedly increased in the Czech republic, Romania and the Slovak republic especially in the long run (the effect was also present from decomposing variance of NEER in

Bulgaria, the Czech republic, Lithuania, Poland, Romania, Slovenia and the Slovak republic) while it remained stable and low in Estonia, Hungary and Latvia.

In the figures 4 we summarize variance decomposition of REER and NEER for the model with extended time series (model B) in the European transition economies.

Figure 4 Variance Decomposition of REER and NEER (2000Q1-2011Q4)



Note: Curves represents relative contribution of structural shocks to the REER and NEER conditional variance in each individual country from the group of the European transition economies.
Source: Author's calculation.

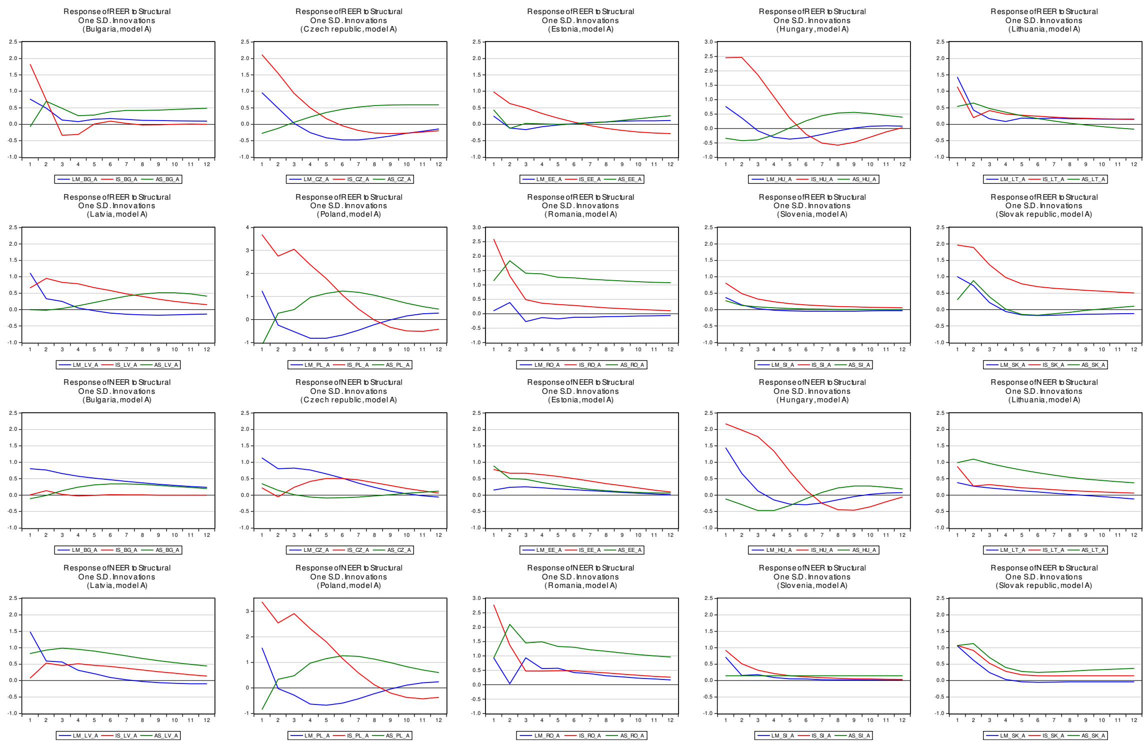
E. Impulse-Response Function

The figure 5 shows estimated responses of REER and NEER to positive structural one standard deviation nominal, demand and supply shocks in the European transition economies during the pre-crisis period. *Nominal shock* caused REER and NEER increase (appreciation). On the other hand it is clear that immediate REER and NEER appreciation seems to be just temporary in all ten countries. While durability and intensity of the positive effect of nominal shock notably differed among countries we also experienced its destabilizing effect in the Czech republic (NEER), Hungary (REER, NEER) and Poland (REER, NEER). Nominal shock seems to be neutral in the long run in determining REER and NEER path as its effect died out in all ten countries in the long period.

As we expected *demand shock* was followed by the immediate REER and NEER appreciation in all countries but Bulgaria (NEER) and the Czech republic (NEER), both with slightly delayed appreciation. Positive influence of demand shock seems to be stronger and more durable in comparison with effect of nominal shock in all countries but Lithuania (REER), Bulgaria (NEER), the Czech republic (NEER), and Latvia (NEER) while its effect died out slightly later (effect of demand shock seems to be more durable in determining REER, NEER) in all countries but Bulgaria (NEER). Effect of the shock seems to be also neutral in the long period in relation to the REER and NEER path.

In the figure 5 we summarize impulse-response functions of REER and NEER for the model with pre-crisis time series (model A) in the European transition economies.

Figure 5 Responses of REER and NEER to Structural Shocks (2000Q1-2007Q4)



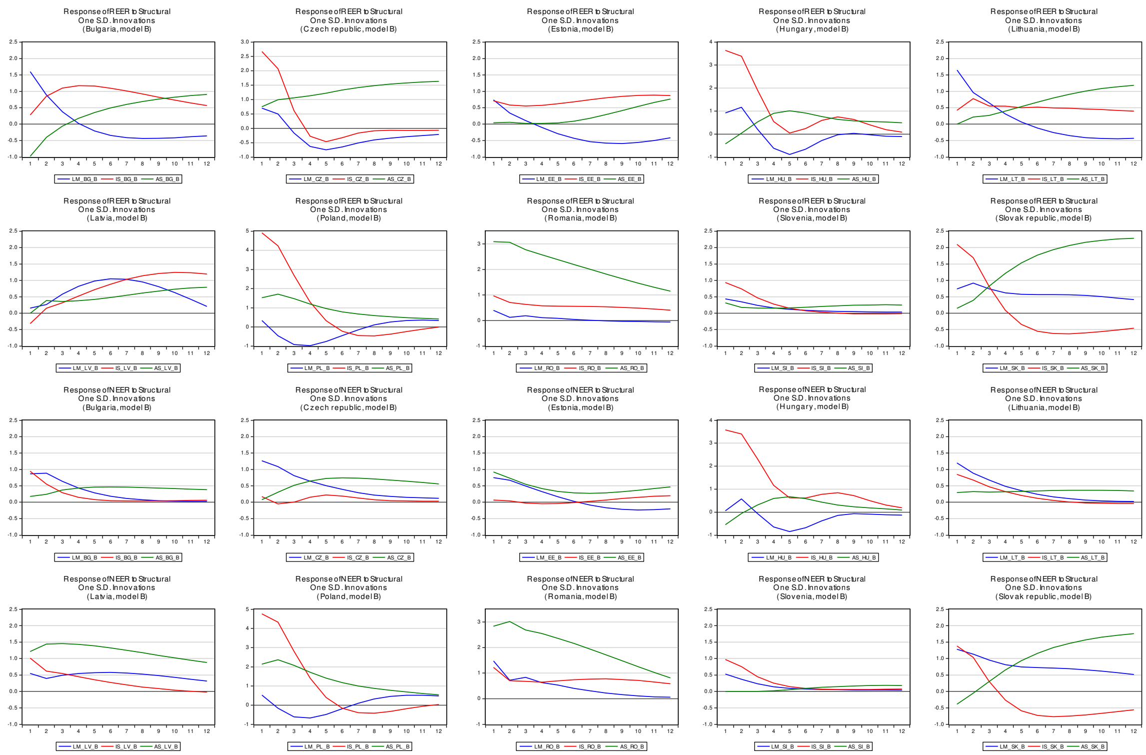
Note: Curves represents responses of REER and NEER to one standard deviation positive structural shocks in each individual country from the group of the European transition economies.
Source: Author's calculation.

Supply shock caused immediate exchange rate appreciation in the Czech republic (NEER), Estonia (REER, NEER), Lithuania (REER, NEER), Latvia (NEER), Romania (REER, NEER), Slovenia (REER, NEER) and the Slovak republic (REER, NEER) while in the remaining countries REER and NEER appreciated with short-term lag length up to four quarters (REER in Hungary) eventually six quarters (NEER in Hungary). Durability of the shock differed among countries. While the positive effect of the shock died out quite early in the Czech republic (NEER), Estonia (REER), Slovenia (REER) and the Slovak republic (REER), its effect in Bulgaria (NEER), Estonia (NEER), Hungary (REER, NEER), Lithuania (REER, NEER), Latvia (REER, NEER), and Poland (REER, NEER) disappeared in the long period while the permanent effect of the shock we experienced in Bulgaria (REER), the Czech republic (REER), Slovenia (NEER) and the Slovak republic (NEER).

The figure 6 shows estimated responses of REER and NEER to positive structural one standard deviation nominal, demand and supply shocks in the European transition economies during the extended period. Crisis period affected responses of REER and NEER to nominal, demand and supply shocks. *Nominal shock* was followed by REER and NEER appreciation in all countries. Immediate REER and NEER responses to the shock are similar to pre-crisis period seem to be slightly reduced in Hungary (NEER) and Poland (REER, NEER) while in Bulgaria (REER), Estonia (REER), Hungary (REER), Lithuania (REER, NEER), Romania (NEER), Slovenia (REER) and the Slovak republic (NEER) the effect of the nominal shock seems to accelerated. Immediate exchange rate responses were followed by lagged exchange rate path to the equilibrium reflecting increased REER and NEER volatility on its way to pre-shock levels in all countries but the Czech republic (NEER).

In the figure 6 we summarize impulse-response functions of REER and NEER for the model with extended time series (model B) in the European transition economies.

Figure 6 Responses of REER and NEER to Structural Shocks (2000Q1-2011Q4)



Note: Curves represents responses of REER and NEER to one standard deviation positive structural shocks in each individual country from the group of the European transition economies.
Source: Author's calculation.

After *demand shock* REER and NEER appreciated immediately in all countries though its effect seems to be just temporary and died out in about one year after the shock in all countries but Estonia (REER), Lithuania (REER), Latvia (REER), Romania (REER, NEER) and the Slovak republic (NEER). Both nominal and demand shocks seems to be neutral in determining REER and NEER leading path in the long period.

Crisis period also affected response of REER and NEER to *supply shock*. Both exchange rates immediate responses to supply shock seem to differ from pre-crisis period in all countries but Slovenia. On the other hand we observed significant increase in the long-run effects of the shock on both REER and NEER. While in the Czech republic (NEER), Hungary (REER, NEER), Latvia (NEER), Poland (REER, NEER), Romania (REER, NEER) positive effect of the shock continuously died out over time with increased lag, in rest of the countries we observed long-run (permanent) effects on leading path of the exchange rates.

5. Conclusion

Exogenous structural shocks determined exchange rates in the European transition economies in the line with the general empirical investigations though we observed some specific implications and related distorting effects of structural shocks during the crisis period leading to the unpredicted exchange rate shifts that may be a subject of a further academic discussion focusing on the specific causalities of the economic crisis. Variance decompositions and impulse-response functions computed from estimated VAR model revealed notable differences in the behavior of real and nominal exchange rates after being hit by the one standard deviation positive nominal, demand and supply shocks as well as in their contribution to the real and nominal exchange rate conditional variability.

In general, our results mostly confirmed our expectations of the exogenous shocks determination potential related to the real and nominal exchange rate conditional variance in our sample of ten transition economies during the pre-crisis period. While the role of demand shock seems to be crucial in determining the real exchange rate path (not only in the short period) in all ten countries, its contribution to the variability of nominal exchange rate has decreased in general (Slovenia, the Slovak republic) or with lag (the Czech republic, Lithuania, Romania). The role of nominal shock and supply shocks in determining nominal and real exchange rate differed reasonably in many cases. While nominal shocks changed their contribution especially in the short period, the role of supply shocks increased mainly with rising lag.

Crisis period significantly affected the role of shocks in determining REER and NEER leading path in all countries but Hungary and partially in Poland (though minor differences are present in these countries too). We emphasize obvious reduction in contribution of demand shock to REER variance in Bulgaria, the Czech republic, Romania and the Slovak republic associated with increased role of supply shock in the Czech republic, Romania and Slovak republic and of nominal shock in Bulgaria. This trend is also present in NEER variance decomposition though with reduced intensity. We suggest the "swap-trigger effect" between two shocks (decreasing role of demand shocks vs increasing role of supply shocks) may be considered as the most significant side effect of the crisis related causalities that should be the subject of the further rigorous investigation.

Following our expectations nominal and demand shocks caused immediate REER and NEER appreciation in most countries from the group of the European transition economies. Prevailing high short-run sensitivity of exchange rates to demand shock resulted in significant vulnerability of REER and NEER to sudden shifts caused by substantial aggregate demand components (especially in external demand) that seems to be a crucial subject of interest mainly in small opened economies (especially the Czech republic, Slovenia, the Slovak republic and Baltic countries). On the other hand increasing medium-term and long-term importance of supply shock in determining REER reflects increasing role of domestic sources of supply shocks including changes in relative competitiveness and productivity.

Responses of REER and NEER due to crisis effects reflected changed contribution of structural shocks to the exchange rate leading path during the crisis period in all ten European transition economies. We emphasize short-term destabilizing effects of nominal shocks to REER path in the Czech republic, Hungary and Poland as well as permanent effects of supply shocks on REER path in Bulgaria and the Czech republic as well as NEER path in Slovenia and the Slovak republic. Although it may be difficult to understand and interpret early benefits of Eurozone membership due to common crisis effects we suggest our results may contribute to the discussion about short-term and long-term effects of sacrificing monetary sovereignty in small open transition economies while still leaving room for further empirical investigation.

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