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## Interest Rate Transmission Mechanism of Monetary Policy in the Selected EMU Candidate Countries

Rajmund Mirdala\*

**Summary:** The stable macroeconomic environment, as one of the primary objectives of the Visegrad countries in the 1990s, was partially supported by the exchange rate policy. Fixed exchange rate systems within gradually widen bands (Czech Republic, Slovak Republic) and crawling peg system (Hungary, Poland) were replaced by the managed floating in the Czech Republic (May 1997), Poland (April 2000), Slovak Republic (October 1998) and fixed exchange rate to euro in Hungary (January 2000) with broad band (October 2001). Higher macroeconomic and banking sector stability allowed countries from the Visegrad group to implement the monetary policy strategy based on the interest rate transmission mechanism. Continuous harmonization of the monetary policy framework (with the monetary policy of the ECB) and the increasing sensitivity of the economy agents to the interest rates changes allowed the central banks from the Visegrad countries to implement monetary policy strategy based on the key interest rates determination. In the paper we analyze the impact of the central banks' monetary policy in the Visegrad countries on the selected macroeconomic variables in the period 1999-2008 implementing SVAR (structural vector autoregression) approach. We expect that higher sensitivity of domestic variables to interest rates shocks can be interpreted as a convergence of monetary policies in candidate countries towards the ECB's monetary policy.

**Key words:** Monetary policy, Short-term interest rates, Structural vector autoregression, Variance decomposition, Impulse-response function.

**JEL:** C32, E52.

### Introduction

After the entry to the European Union in 2004 the euro adoption became one of the most challenging objectives of the transition countries from the region of the Central and Eastern Europe. The Slovak Republic became the member of the European Monetary Union (EMU) in 2009 while the three remaining Visegrad countries (Czech Republic, Hungary and Poland) still didn't definitely specify the length of the period they need for the preparation to adopt the euro. Accord-

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ing to Vladimír Gonda (2006) one of the most important determinants to decide when to enter the eurozone we emphasize the ability of the candidate countries to sustainably meet the criteria of the nominal and real convergence before but also after the entry to the EMU. For example Sabine Herrmann and Axel Jochem (2003) emphasize there is a trade-off between the real and nominal convergence, because at least in the short to medium term, a strengthening of nominal convergence makes real economic convergence more difficult. Opponents of the early EMU enlargement centre the point of the discussion to the higher vulnerability of the candidate transition countries to the exogenous macroeconomic shocks after sacrificing the ability to control the exchange rates. For more details on the exchange rate and output vulnerability to exogenous shocks in the Visegrad countries see Rajmund Mirdala (2009) and Nabil Ben Arfa (2009). On the other hand Jan Iša and Ivan Okáli (2008) argue the central banks in the European transition economies have only limited ability to determine the exchange rate path in the medium and long period. Also not all of the candidate countries prefer the scenario of the early euro adoption because according to Ivana Šikulová (2009) the immediate advantages might be overwhelmed by the drop of the competitive advantages in the long period. Concerning current negative exchange rate development in the Czech Republic, Hungary and Poland, Daniel Stavárek (2008) emphasizes that a shift in their exchange rate regime towards the quasi-fixed ERM II can help the countries to eliminate exchange market pressures. Current episodes of the excessive exchange market pressures can make the fulfilment of the exchange rate stability criterion more difficult in all of the countries.

Besides the discussion about the length of the period that is necessary for the candidate countries to prepare to fully enjoy the positive outcomes of the sacrificing the monetary sovereignty it is also important to analyze the preparedness of the candidate countries for the single monetary policy of the European Central Bank (ECB). In order to achieve its primary objective (price stability of the Eurosystem) ECB uses monetary policy instruments and procedures that form the operational framework to implement the single monetary policy. The main channel for transmitting the ECB's monetary policy decisions is represented by the interest rate transmission mechanism. For this purpose ECB controls its official interest rates.

The macroeconomic stabilization, as one of the primary objectives of the Visegrad countries in the 1990s, was according to Kosta Josifidis, Jean-Pierre Allegret, and Emilija Beker Pucar (2009) and Jaromír Šindel and Stanislav Sároch (2008) partially supported by the exchange rate policy. Fixed exchange rate systems within gradually widen bands (Czech Republic, Slovak Republic) and crawling peg system (Hungary, Poland) were replaced by the managed floating in the Czech Republic (May 1997), Poland (April 2000), Slovak Republic<sup>1</sup> (Oc-

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<sup>1</sup> During the preparation phase for the euro adoption Slovak crown joined ERM II in November 2005.

tober 1998) and fixed exchange rate to the euro with the broad band in Hungary<sup>2</sup> (October 2001). Higher macroeconomic and banking sector stability allowed Visegrad countries to implement the monetary policy strategy based on the interest rate transmission mechanism. Continuous harmonization of the monetary policy framework (with the monetary policy of the ECB) and increasing sensitivity of the economy agents to the interest rates changes allowed central banks of the Visegrad countries to implement the monetary policy strategy based on the key interest rates determination.

In the paper we analyze the impact of the central banks' monetary policy in the Visegrad countries (performed by the short-term interest rates determination) on the selected macroeconomic variables in the Czech Republic, Hungary, Poland and the Slovak Republic<sup>3</sup> in the period 1999-2008 implementing SVAR (structural vector autoregression) approach. We focus on the role of the short-term interest rates in the monetary policy strategy of the selected group of the transition countries in order to estimate the sensitivity of the selected macroeconomic indicators to the monetary policy impulses (effects of the monetary policy shocks in the world leading economies using SVAR methodology were discussed for example in Stefan Gerlach and Frank Smets 1995; and Joao Miguel Sousa and Andrea Zaghini 2006). We expect that higher sensitivity of domestic variables to interest rates shocks can be interpreted as a convergence of monetary policies in candidate countries towards the ECB's monetary policy. In such a case euro adoption by the EMU candidate countries must not necessarily lead to higher vulnerability of the countries to the unexpected exogenous shocks.

Estimated SVAR model help us to assess the variance decomposition of the real GDP, core inflation, money supply (M3), short-term interest rates and the REER (real effective exchange rate) in order to describe the contribution of the monetary policy actions to the endogenous variables conditional variance. We also calculate the impulse-response functions of the endogenous variables to determine their responses to the structural one standard deviation monetary policy shock (innovation).

## **1. Econometric model**

SVAR models are based on applying the long-run restrictions to the unrestricted VAR models. Our unrestricted model is represented by the following moving average representation:

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<sup>2</sup> Since the February 2008 the Hungarian forint is freely floating against the euro.

<sup>3</sup> Because the Slovak Republic joined EMU in the January 2009 and the data for the model estimation are from the period 1999-2008 in the paper we assume the Slovak Republic is from the group of the candidate countries for the euro adoption together with the Czech Republic, Hungary and Poland.

$$X_t = A_0 e_t + A_1 e_{t-1} + A_2 e_{t-2} + \dots = \sum_{i=0}^{\infty} A_i e_{t-i} = \sum_{i=0}^{\infty} A_i L^i e_t = A(L) e_t \quad (1)$$

where  $X$  is a vector of the endogenous macroeconomic variables,  $A(L)$  is a polynomial variance-covariance matrix of lag-length  $l$ ,  $L$  is a lag operator and  $e$  is a vector of reduced form shocks in elements of  $X$ . The vector of the endogenous variables of the model,  $X$ , consists of the following five elements: real output ( $y$ ), core inflation ( $p$ ), money supply ( $m$ ), short-term money market interest rate ( $i$ ), exchange rate ( $e$ ). Vector of structural shocks,  $e$ , consists of demand shock ( $e_y$ ), inflation shock ( $e_p$ ), liquidity shock ( $e_m$ ), monetary policy shock ( $e_i$ ), exchange rates shock ( $e_e$ ).

The shocks in the reduced form are likely to be correlated so they cannot be considered as true structural shocks.

In order to correctly identify the structural shocks we have to impose fifteen restrictions<sup>4</sup>. Five restrictions we obtain by normalizing the original matrix. Ten remaining long-run identifying restrictions are following:

- demand shock do not have permanent effect on inflation /1/, money supply /2/, real exchange rate /3/,
- inflation shock do not have permanent effect on real output /4/, money supply /5/, real exchange rate /6/,
- liquidity shock do not have permanent effect on real output /7/, real exchange rate /8/,
- monetary policy shock do not have permanent effect on money supply /9/, real exchange rate /10/.

Estimated VAR representation (1) can be inverted to obtain the Wold moving average representation:

$$X_t = u_t + B_1 u_{t-1} + B_2 u_{t-2} + \dots = \sum_{i=0}^{\infty} B_i u_{t-i} = \sum_{i=0}^{\infty} B_i L^i u_t = B(L) u_t \quad (2)$$

where  $B(L)$  is a polynomial variance-covariance matrix containing the responses of the endogenous variables to the underlying structural disturbances,  $L$  is lag operator and  $u$  is a vector of identically normally distributed, serially uncorrelated and mutually orthogonal (normalized) white noise disturbances.

From equations (1) and (2) we see that  $u_t = A_0 e_t$ . In order to transform residuals from the vector autoregression to the true structural shocks we have to identify matrix  $A_0$ . The identification scheme (based on normalizing the original matrix, an assumption of the structural shocks orthogonality, and the

<sup>4</sup> The number of long-run identifying restrictions is given by the simple equation  $n(n+1)/2$ , where  $n$  denotes the number of endogenous variables of the model.

long-run identifying restrictions) is characterized by the following non-recursive structure:

$$\begin{bmatrix} u_{y,t} \\ u_{p,t} \\ u_{m,t} \\ u_{i,t} \\ u_{e,t} \end{bmatrix} = \sum_{i=0}^{\infty} \begin{bmatrix} 1 & 0 & 0 & a_{14i} & a_{15i} \\ 0 & 1 & a_{23i} & a_{24i} & a_{25i} \\ 0 & 0 & 1 & 0 & a_{35i} \\ a_{41i} & a_{42i} & a_{43i} & 1 & a_{45i} \\ 0 & 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} e_{y,t} \\ e_{p,t} \\ e_{m,t} \\ e_{i,t} \\ e_{e,t} \end{bmatrix} \quad (3)$$

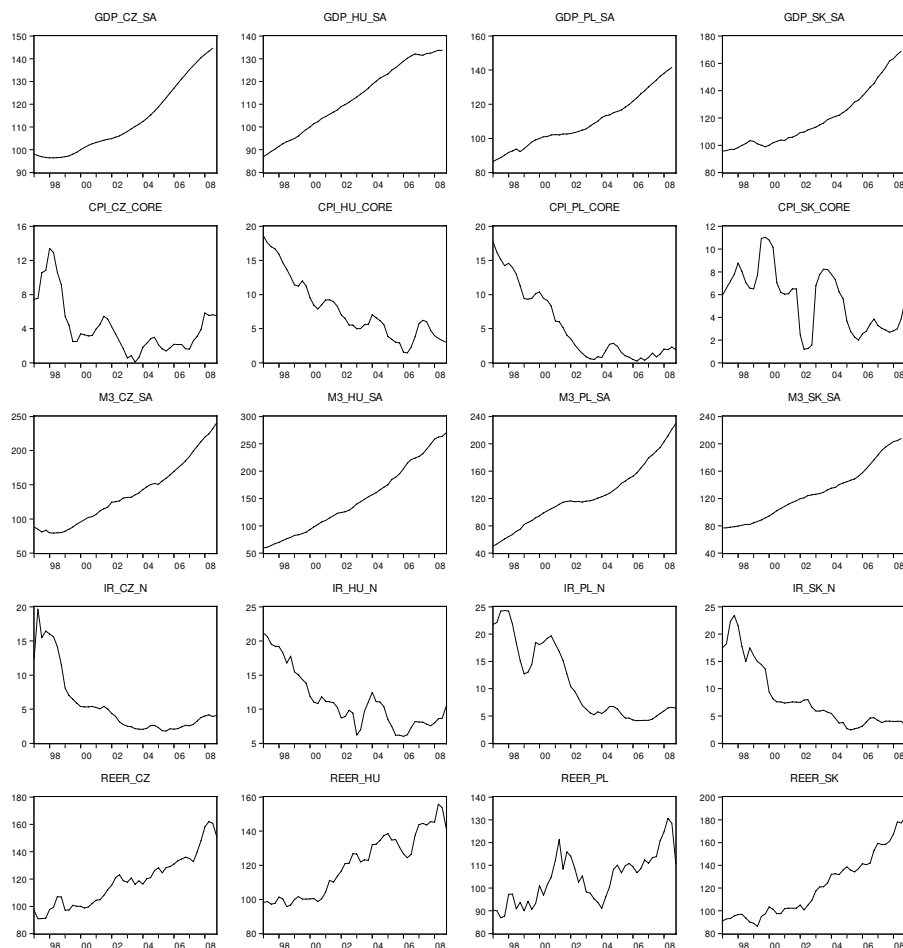
Estimated SVAR model help us to assess the variance decomposition of the endogenous variables of the model to determine the contribution of the monetary policy shock to the real GDP, inflation, money supply, short-term interest rate and real exchange rate conditional variance and to calculate the impulse-response functions of the endogenous variables to determine their response to the structural one standard deviation monetary policy shock (innovation) in the selected EMU candidate countries.

## 2. Data and results

In order to estimate our model consisting of the five endogenous variables for the Czech Republic, Hungary, Poland and the Slovak republic we use the quarterly data ranging from 1999Q1 to 2008Q3 for the quarterly real GDP, annual core inflation, monetary aggregate M3, average three month money market interest rate and real effective exchange rate. Time series for the quarterly real GDP and the monetary aggregate M3 are seasonally adjusted. The main reason for selecting the year 1999 as the beginning point of the data series is the fact that in 1999 the ECB started to conduct the single monetary policy. Another argument reflects an increased role of the interest rates in the monetary policy of the Visegrad countries' central banks at the end of the decade (the role of monetary aggregates in the operational monetary policy framework has slightly decreased) in regard to the higher stability of the national money markets.

Figure 1 shows the development of the variables for each of the country from the Visegrad group.

Figure 1: Variables



**Source:** Developed by author using data from BIS and OECD:

[<http://www.bis.org/statistics/eer/index.htm>,

[http://www.oecd.org/document/15/0,3343,en\\_2649\\_201185\\_1873295\\_1\\_1\\_1\\_1,00.html](http://www.oecd.org/document/15/0,3343,en_2649_201185_1873295_1_1_1_1,00.html)]

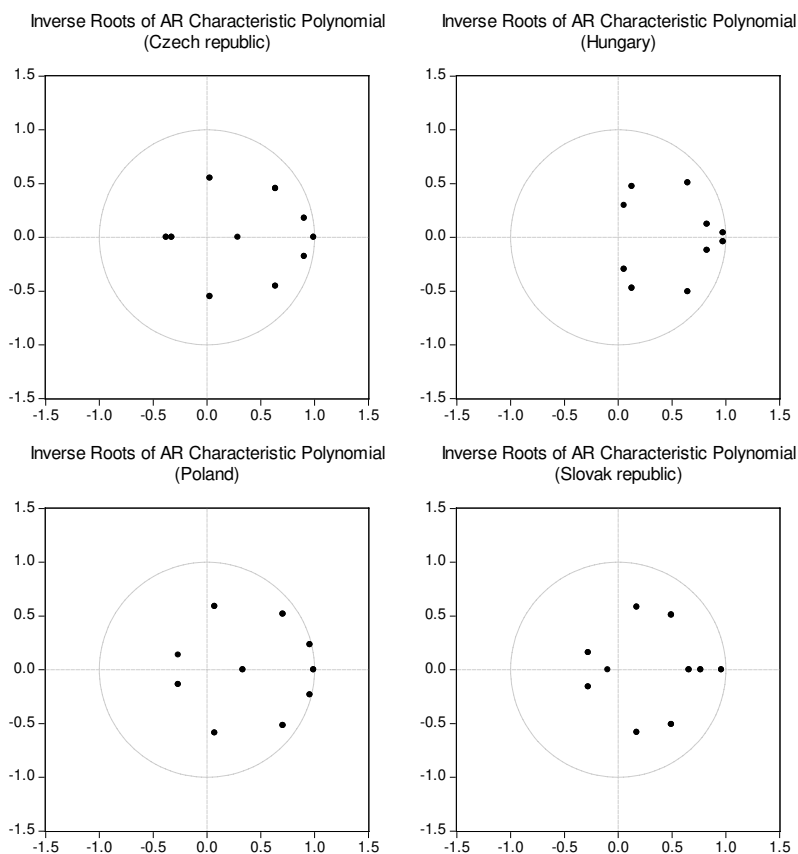
Before estimating the model we test the time series for stationarity and cointegration. The augmented Dickey-Fuller (ADF) and the Phillips-Perron (PP) tests were computed to test the endogenous variables for the existence of the unit roots. Both ADF and PP test indicates the variables are non-stationary 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 integrated of the order one (I(1)).

Because the endogenous variables have a unit root on the values it is necessary to test the time series for cointegration using the Johansen cointegration test. The test for the cointegration was computed using three lags as recommended by the AIC (Akaike Information Criterion). The results of the Johansen cointegration tests are not so clear in comparison with the results of the unit root tests. In the Czech Republic, Poland and the Slovak Republic the results of the trace statistics (at 0.05 level) indicate the presence of one cointegrating equation. This finding was not confirmed by the results of the maximum eigenvalue statistics (with an exception in the Slovak Republic, where the test also confirmed one cointegrating equation). After increasing the lag length to four lags both tests indicate no cointegration among the endogenous variables of the model. In Hungary the maximum eigenvalue statistics denotes the rejection of the null hypothesis about no cointegration among variables (indicating the existence of one cointegrating relationship) while the trace statistics reports no cointegration among the variables. Here again an increase in the length of the lag to four lags resulted in the loss of the cointegrating relationship among variables. The results of unit root and cointegration tests are not reported here to save space. Like any other results, they are available upon request from the author.

As the results of the Johansen cointegration tests indicate the endogenous variables are not cointegrated (because they follow the different stochastic trend in the long run) it implies that there is no long-run equilibrium relationship among the variables of the model.

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, although several roots are near unity in absolute value (Figure 2).



**Figure 2: VAR stability condition check (Visegrad countries)**

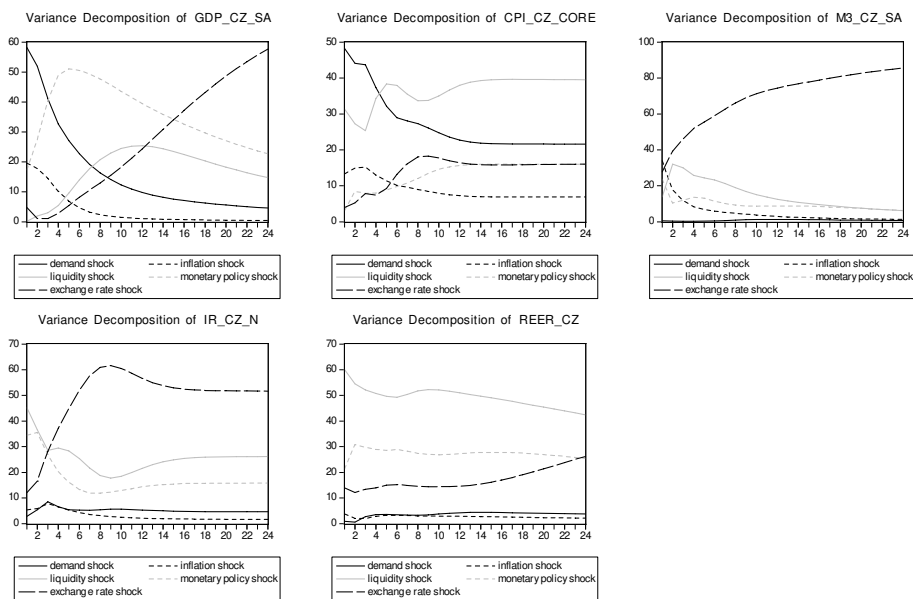
**Source:** Author's calculations.

Following the results of the stationarity and cointegration tests we estimate the model using the variables in the first differences so that we can calculate the variance decomposition (contributions of each structural shock to the endogenous components conditional variance) and impulse-response functions (responses of the endogenous components to one standard deviation structural shocks) of the endogenous variables for each country from the Visegrad group. In Figures 3-6 we summarize the relative importance of each of the structural shocks to changes in each of the variables. In Figures 7-10 we summarize the responses of all variables to unexpected structural shocks.

Because the main objective of the paper is to analyze the impact of the monetary policy performed through the short-term interest rates determination

we concentrate the interpretation of the results to the analysis of the monetary policy shock effects on the variability in the endogenous variables of the model.

**Figure 3: Variance decomposition (Czech Republic)**



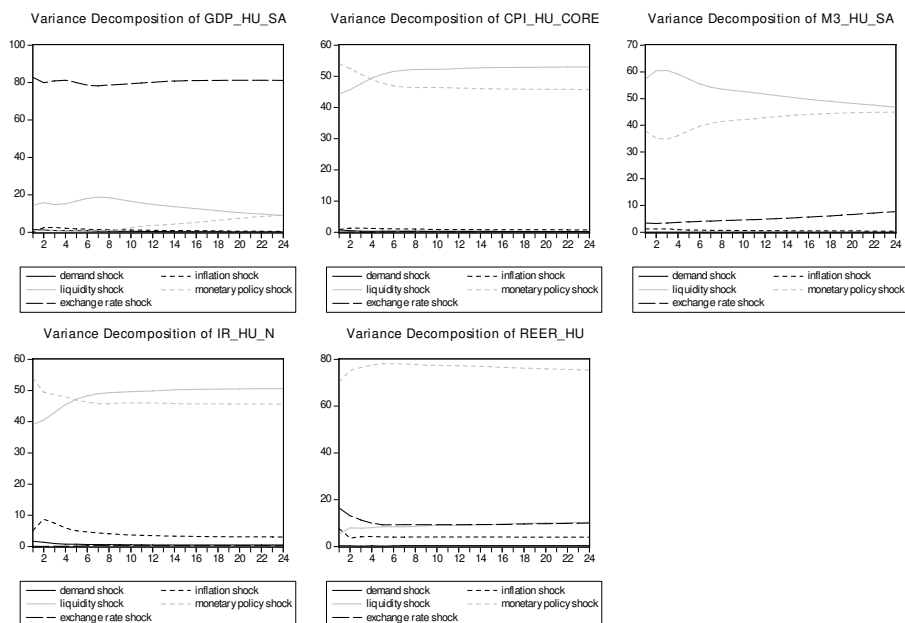
**Source:** Author's calculations.

The Figure 3 depicts the variance decomposition of all five variables of the model in the Czech Republic. The variance decomposition of the real output reflects a rapid increase of the monetary policy shock influence on the variability in the real GDP during the first five quarters. Rather high influence of the exchange rate shock highlights the role of changes in the international competitiveness in determining the real output variability in the longer period. The Czech Republic has experienced the long trend of high real GDP growth since the beginning of the period that might be explained as a result of positive impact of the central bank on an interest rate decrease. On the other hand the variance decomposition of the core inflation indicates rather limited ability of the central bank to control the inflationary pressures. The core inflation seemed to be more sensitive to the liquidity shock that is usually coupled with the foreign capital inflows<sup>5</sup>. The variance decomposition of the wider monetary aggregate M3 similarly reflects the relatively low significance of the monetary policy shock in determining this aggregate. Monetary sector (represented here by the money sup-

<sup>5</sup> In general the foreign inflows obviously rise money supply in the target economy.

ply and interest rates) was considerably affected by the exchange rate shock. This finding corresponds with an assumption of the high significance of the exchange rate pass-through of the external impulses in the small open economy. The variance decomposition of the REER reflects the relatively stable influence of the monetary policy shock in its determination. On the other hand the high importance of the liquidity shock in explaining the REER variability emphasizes the prevalence of the quantitative oriented determination of the REER development.

**Figure 4: Variance decomposition (Hungary)**

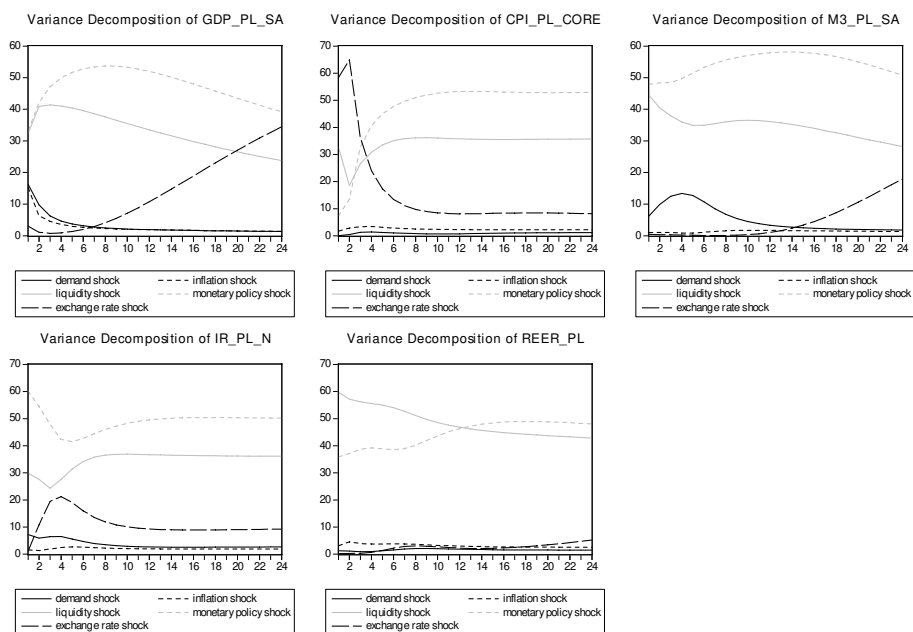


**Source:** Author's calculations.

The Figure 4 shows the variance decomposition of all five variables of the model in Hungary. The variance decomposition of the GDP was clearly determined by the exchange rate shock. The result is not so surprising considering the overall high trade and financial openness of Hungary. On the other hand the negligible influence of the monetary policy shock on the GDP variability emphasizes the neutrality of the real sector from the central bank's signals. The absolutely different picture depicts the variance decomposition of the core inflation. High influence of the monetary policy shock reflects the relatively high controllability of the inflation by the central bank. On the other hand the high impact of the liquidity shock on the variability in the inflation emphasizes the

significant role of the foreign capital flows in the variability of the inflation. The variance decomposition of the monetary aggregate M3 and the short-term interest rate depicts a similar picture just like in the case of the core inflation suggesting the high influence of the monetary policy and liquidity shocks. The dominant contribution of the monetary policy shock reflects the variance decomposition of the REER. This finding suggests that the international competitiveness of the Hungarian production was significantly determined by the interest rate development.

**Figure 5: Variance decomposition (Poland)**

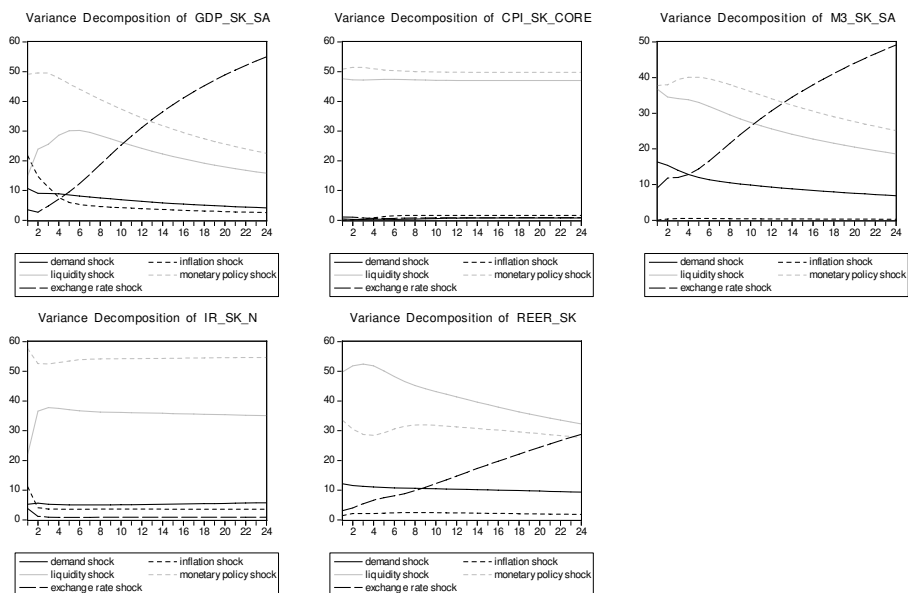


**Source:** Author's calculations.

The results of the variance decomposition of all five variables of the model in Poland reflect the Figure 5. The variability in the GDP was significantly determined by the monetary policy and liquidity shocks while the relative importance of the exchange rate shock increases in the long run. Similarly the variance decomposition of the core inflation depicts the high influence of the monetary policy and liquidity shocks. The high influence of the exchange rate shock on the core inflation variability within first two initial quarters sharply decreases through the time. More than 80 percent of the variability in the monetary aggregate M3, short-term interest rates and REER (here it is more than 90

percent) is similarly explained by the combination of the liquidity and monetary policy shocks.

**Figure 6: Variance decomposition (Slovak Republic)**

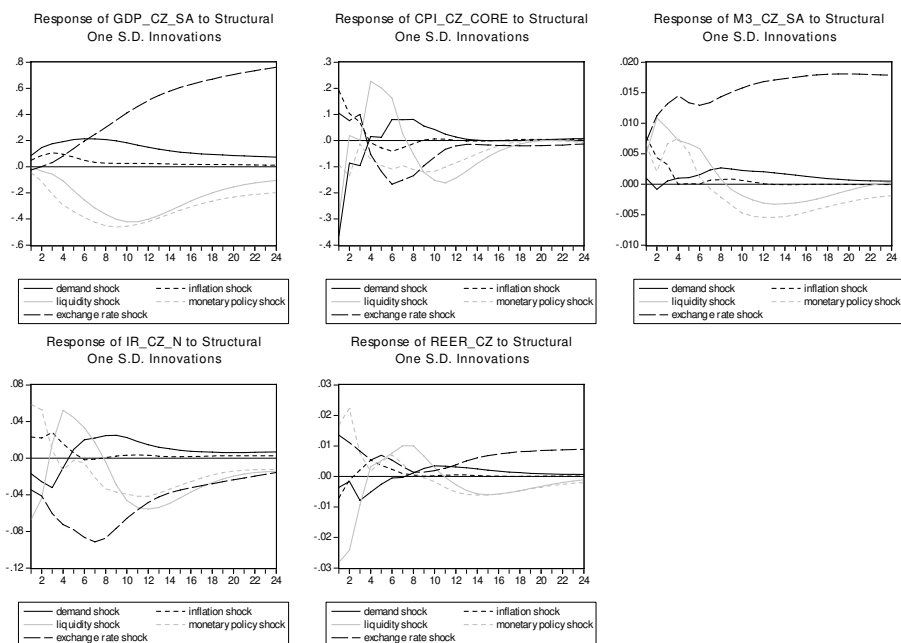


**Source:** Author's calculations.

The Figure 6 shows the variance decomposition of all five variables of the model in the Slovak Republic. The variability in the GDP was considerably determined by the monetary policy shock (especially in the short period) with the continuously decreasing intensity. It reflects the positive role of the interest rates decrease since the beginning of the period (1999). The contribution of the monetary policy shock is also visible from the variance decomposition of the core inflation that confirms the applicability of the monetary policy strategy based on the interest rate controls. It is also clear the high impact of the liquidity shock usually associated with the changes in the money demand in the variability of the core inflation. The variance decomposition of the monetary aggregate M3 depicts the relatively high contribution of the monetary policy shock in its variability. Despite the key role of the interest rates in the monetary policy strategy of all central banks in the Visegrad countries the ability to determine the monetary aggregates variability contributed to the positive trend of disinflation in the selected period. In comparison with Poland the variance decomposition of the short-term interest rate in the Slovak Republic shows quite similar results. The stable and high influence of the monetary policy shock on the short-term interest rate variance emphasizes the stable linkage between the central bank's

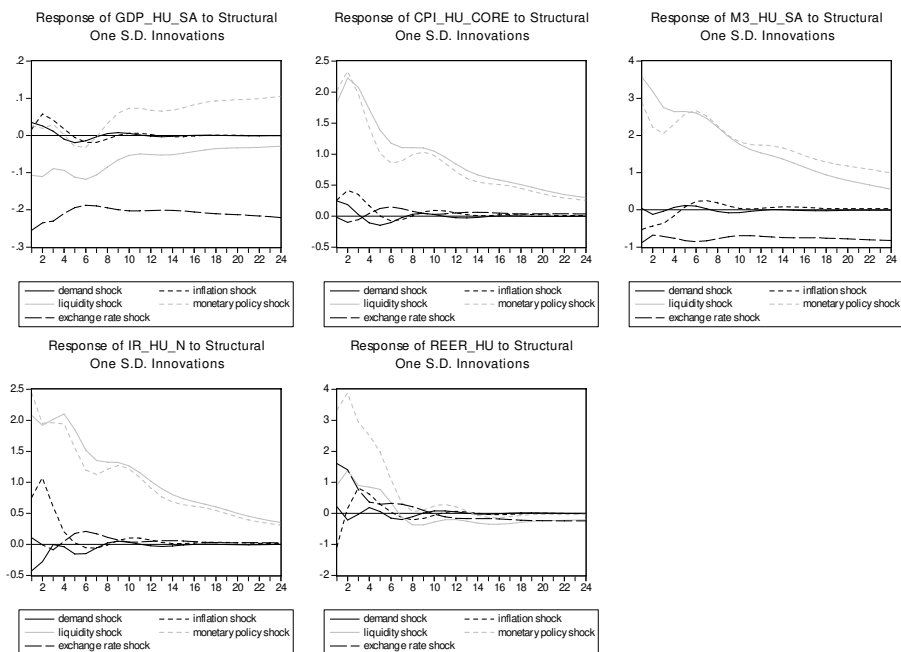
decisions and short-term interest rate responses. The variance decomposition of the REER is quite similar to the results in the Czech Republic.

**Figure 7: Impulse-response function (Czech Republic)**



**Source:** Author's calculations.

The behaviour of the impulse-response functions that reflect the responses of the variables to the individual structural shocks in the Czech Republic is shown in the Figure 7. The specific feature of the impulse response functions of all variables is the high degree of the monetary policy shock persistence. After the positive monetary policy shock, represented by an increase of one-time the standard deviation of the short-term interest rate, the real GDP as well as the inflation decreased. As a result of the monetary policy tightening the monetary aggregate M3 increased in the short period. We assume that an associated increase in the short-term interest rates increased especially short-term timed deposits held by domestic and also foreign investors. The later decrease in the nominal interest rates could be the result of the initial overshooting of the real short-term interest rates increase associated with the drop of the inflation. The immediate response of the REER (REER appreciated in the short period) on the monetary policy shock was the result of the interest differential increase due to the monetary policy tightening.

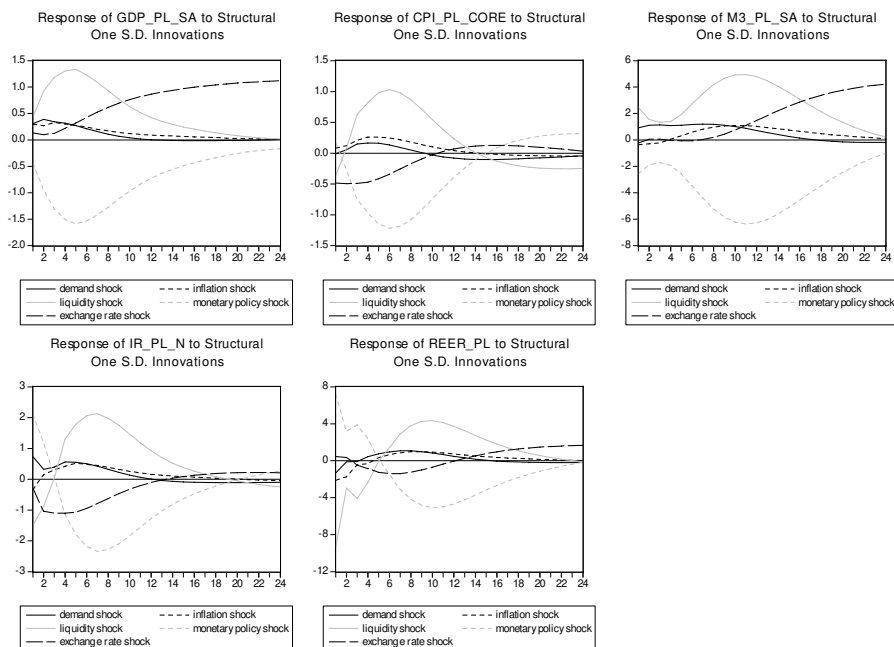
**Figure 8: Impulse-response function (Hungary)**

**Source:** Author's calculations.

The responses of the endogenous variables to the structural shocks in Hungary are shown on the Figure 8. Rather surprising is the response of the real GDP to the monetary policy shock that is hardly understood by the standard macroeconomic theory. The positive monetary policy shock caused an increase in the inflation<sup>6</sup>. The response of the monetary aggregate M3 to the positive monetary policy shock is even stronger in comparison with the Czech Republic. The increase in interest rates stimulated the transfer from the cash holdings to the short-term timed deposits increase. The monetary policy shock significantly raised the short-term interest rates. It emphasizes the relatively high impact of the central bank on the money market development. Higher short-term interest rates on the other hand stimulated the appreciation of the REER.

<sup>6</sup> We suggest it is due to the signal function of the higher interest rates that led economy agents to increase their inflation expectations.

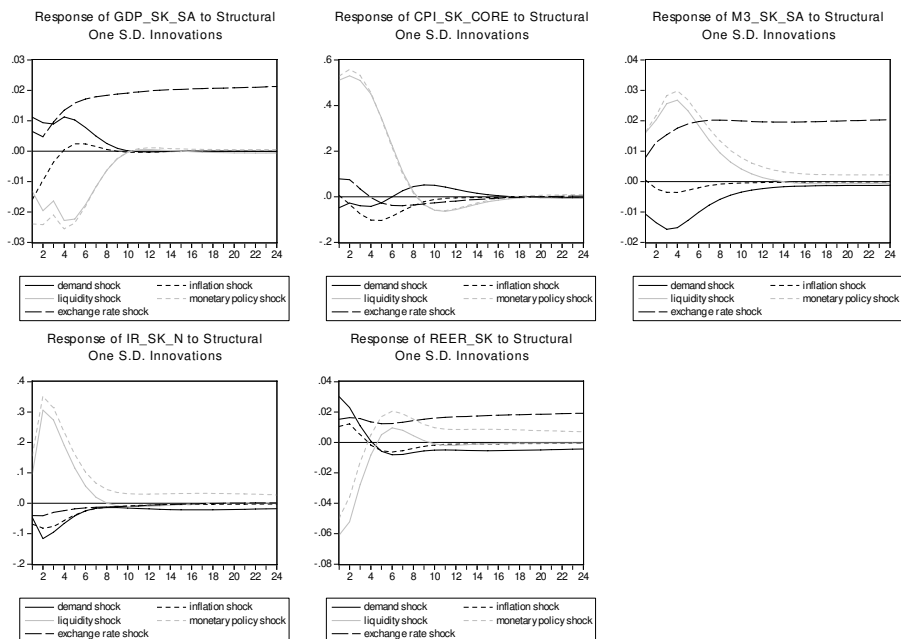
**Figure 9: Impulse-response function (Poland)**



**Source:** Author's calculations.

The responses of the endogenous variables to the structural shocks in Poland are shown on the Figure 9. The real GDP decreased after the monetary policy shock associated with the interest rate increase. In the later periods the negative effect of this shock continuously weakened. As we expected the core inflation decreases after the monetary policy shock. It emphasizes the relatively high controllability of the inflation by the central bank. In line with the quantitative theory of money the monetary aggregate M3 decreased as the result of higher interest rates especially because of the lower transaction demand for the money. The short-term interest rate increased after the monetary policy shock but after the short period short-term interest rate decreased below its initial level suggesting the initial overshoot of its equilibrium level. The same overshooting scenario we might observe from the response of the REER to the monetary policy shock.



**Figure 10: Impulse-response function (Slovak Republic)**

**Source:** Author's calculations.

The behaviour of the impulse-response functions that reflect the response of the variables to individual structural shocks in the Slovak Republic is shown in the Figure 10. Higher interest rates entailed by the monetary policy shock caused the decrease in the real GDP in the relatively short period (about 2 years). The reason for higher core inflation as a result of the monetary policy shock seems to be similar for the Slovak Republic and Hungary emphasizing the signal function of the tightened monetary policy. The impulse-response function of the monetary aggregate M3 similarly reflects the transfer from the cash holdings to the short-term timed deposits increase. This scenario we have already observed in Hungary. We suggest this effect was strengthened by the inflows of the short-term foreign capital. The monetary policy shock stimulated the increase in the short-term interest rates emphasizing the strength of the interest rate transmission mechanism of the monetary policy. Rather surprising is the REER depreciation after the increase in the short-term interest rates in the short period. We suggest that the higher prices of the domestic goods (the core inflation increases after the monetary policy shock) reduced the international competitiveness of the domestic production.

## **Conclusion**

In the paper we have estimated structural VAR model for the countries from the Visegrad group with the objective to analyze the sources of the movements in the real GDP, core inflation, monetary aggregate M3, short-term interest rates and REER during the period with (relatively) flexible nominal exchange rates.

The results of the variance decomposition of all five endogenous variables of the model are rather different across all the countries. This findings doesn't allow us to assess the clear statement about the "efficiency" of the interest rate transmission mechanism of the monetary policy pass-through in the Visegrad countries. The variance decomposition of the core inflation in Hungary, Poland and the Czech Republic reflects its relatively high controllability by the central banks' monetary policy while in the Czech Republic the influence of the monetary policy on the inflation pressures seems to be rather low. In the Czech Republic, Poland and the Slovak Republic the relatively high variability of the GDP can be explained by the impact of the monetary policy shock while in the Hungary its importance remained negligible. One of the most interesting finding in our model for Visegrad countries is the inferior role of the demand shocks and relatively high importance of the liquidity shocks in determining the variability of the endogenous economic variables. We suggest this result is based on the following assumptions: (1) the endogenous variables were much more vulnerable to the changes in the domestic demand for the money and the effects of the foreign the capital movements (both are usually associated with the (global) liquidity shock) and (2) the interest rates changes significantly associated with the monetary policy shock (except the Czech Republic) helped to eliminate the potential sources of the demand shock.

In all Visegrad countries (except Hungary) the GDP decreases after the positive monetary policy shock. Together with the finding that the monetary policy shock has high impact on the GDP variability it leads us to the assumption that the real GDP is rather sensitive to the changes in the monetary policy impulses. In the view of this fact it stresses the accent on the harmonization of the monetary policy framework (especially by the national interest rate smoothing with the eurozone interest rates) in the EMU candidate countries before the euro adoption. We suggest it would help the candidate countries to eliminate the negative pressures from the sudden ECB's monetary policy shocks. The influence of the monetary policy shock on the core inflation development in the Visegrad countries is rather different. While in the Czech Republic and Poland the positive monetary policy shock caused the decrease in the inflation (contractionary effect of the higher interest rates), in Hungary and the Slovak Republic the positive monetary policy shock caused an increase in the inflation (we suggest it is due to the signal function of the higher interest rates).

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