

# HOW DOES THE PRESENCE OF HOUSEHOLDS' FOREIGN CURRENCY DENOMINATED DEBT INFLUENCE THE TRANSMISSION OF MONETARY POLICY?\*

BÁLINT HERCZEG\*\*

University of Debrecen, Faculty of Economics and Business Administration

first draft: 2007. 04. 11.

this draft: 2009. 12. 15.

Preliminary results, please do not quote.

*The paper deals with the question of whether the increased volume of households' foreign currency loans changes the direction of the exchange rate channel of monetary policy. For this purpose I use a structural vector autoregressive model with impulse response functions conditional to the amount of foreign currency debt and test the hypothesis of whether the path of consumption differs significantly with a lower amount of foreign currency debt in 2002q1 compared to that in 2008q3. Impulse response functions provide almost significant differences, despite the diversity of point estimates.*

Keywords: monetary transmission, wealth effect, household consumption, SVAR

Journal of Economic Literature (JEL) code: C32, E44, E52

## 1. Introduction

This paper measures whether the accumulation of foreign currency denominated debt made households more sensible towards exchange rate fluctuations, and so affects the transmission of monetary policy through the exchange rate channel.

Previous measures find low interest sensitivity of households' consumption, as for example *Jakab and Vadas* [2001] and *Jakab et al.* [2006]. Thus it seems a valid question why households would react more sensitively to an exchange rate shock in the presence of foreign currency denominated debt than to an interest rate shock with debt denominated in domestic currency. One might expect that in spite of a change in the interest rate, where loans with a

---

\* I would like to thank Balázs Vonnák for his comments and advice; all remaining errors are of course mine.

\*\* University of Debrecen, Faculty of Economics and Business Administration; PhD Student, Email: balint.herczeg@gmail.com

fixed interest rate react differently than loans with variable rates, an exchange rate shock, through the revaluation of the monthly repayments, immediately affects the disposable income of households indebted in foreign currency and can influence their consumption in a more comprehensive manner.

If households' exchange rate sensitivity had changed due to the increasing amount of debt denominated in foreign exchange, than this would have decreased the strength of the exchange rate channel of monetary policy<sup>1</sup>. After all a depreciation could lead to increasing exports, but through the revaluation of the repayments it also could lead to decreasing consumption, which, taken together, means that monetary policy's short term ability to affect inflation, as well as causing countercyclical movements, would be limited.

To measure the effect of foreign debt on consumption I estimate a nonlinear structural vector autoregression model, so that the resulting impulse response functions are conditional in the amount of foreign currency debt; in this way I am able to compare the reaction of households' consumption to the same shock with a small amount of foreign currency debt and also with today's total amount.

The rest of the paper is organized as follows: in the first part I introduce some stylized facts relating to developments on the liability side of Hungarian households' balance sheets. After a brief review of the different channels of the monetary transmission mechanism (henceforth MTM) which could be influenced by foreign debt development, I demonstrate the method used in this paper. The next section is about the data used, followed by the estimation result. The last section summarizes.

## **2. Liabilities denominated in foreign currency and channels of monetary transmission through households' wealth**

In this section I briefly review some stylized facts about developments in consumption and in the financial wealth<sup>2</sup> of Hungarian households over the last decade. This should help us to see the processes that resulted in the increasing indebtedness in foreign currency. At the end of the section I develop a hypothesis, about how the above developments should change the monetary transmission mechanism, and thus the way monetary policy can affect consumption.

### *2.1. Consumption, saving and accumulation of wealth in Hungary*

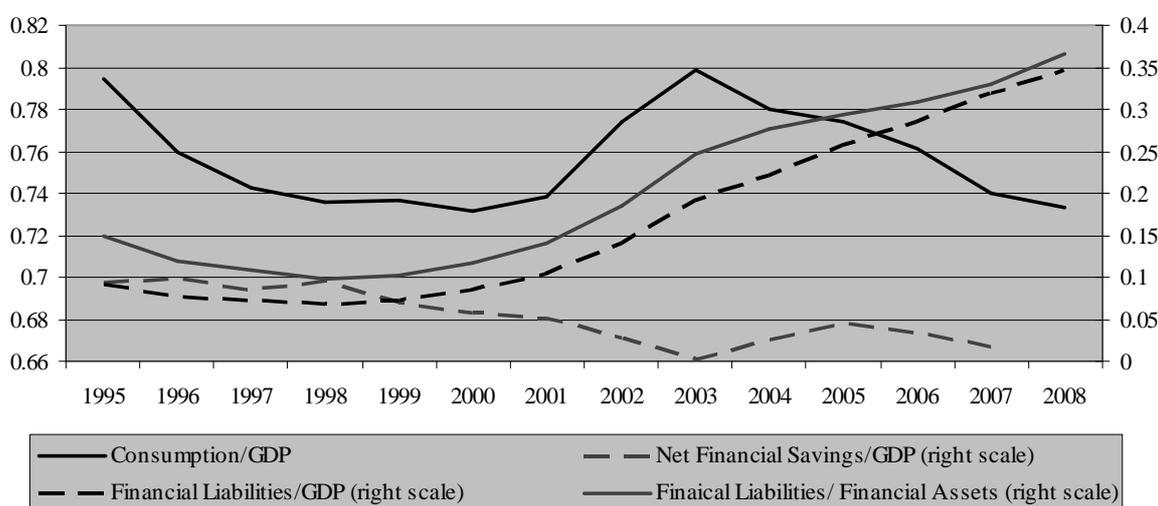
---

<sup>1</sup> *Rezessy* [2006] and *Vonnák* [2006] showed that in Hungary monetary policy is able to influence exchange rates, and *Jakab et al.* [2006] showed that the exchange rate movements transmit the main proportion of the monetary impulse.

<sup>2</sup> Concerning the development of other types of wealth, real estate and durable consumption goods see *Vadas* [2007].

As a starting point let us examine the results of *Árvai and Menczel* [2001] concerning the development of savings of Hungarian households between 1995 and 2000. They found that beyond the financial liberalization, and the decreasing liquidity constraint it caused, there are two special characteristics that are typical of the transition countries, and which could explain the decreasing amount of savings. Firstly an increase in expected permanent income could inspire a higher consumption and indebtedness rate, further strengthened by impatience caused by the postponed consumption during the transition crisis. The developments in the consumption rate and the financial saving rate between 1995 and 2008 can be seen in *figure 1*.

*Figure 1. Consumption and net financial savings\* between 1995 and 2008 (as a percentage of GDP)*



Source of data: KSH and MNB

\* Difference between the transactions of financial assets and liabilities

The consumption rate was stable at around 74% of GDP at the end of 2001. In the first quarter of 2002 the expansion of subsidized mortgage loans on second hand real estate properties and the significant wage increase in 2002 going to families who did not really smooth their consumption resulted in an increase in the consumption rate by over 80%<sup>3</sup>. According to the estimation of the Hungarian National Bank 15-30% of the subsidized loans were spent directly on consumption, and not on real estate (*MNB* [2004]). After the peak in 2003, the consumption rate fell back slowly to its 1999-2001 level, namely to around 74%.

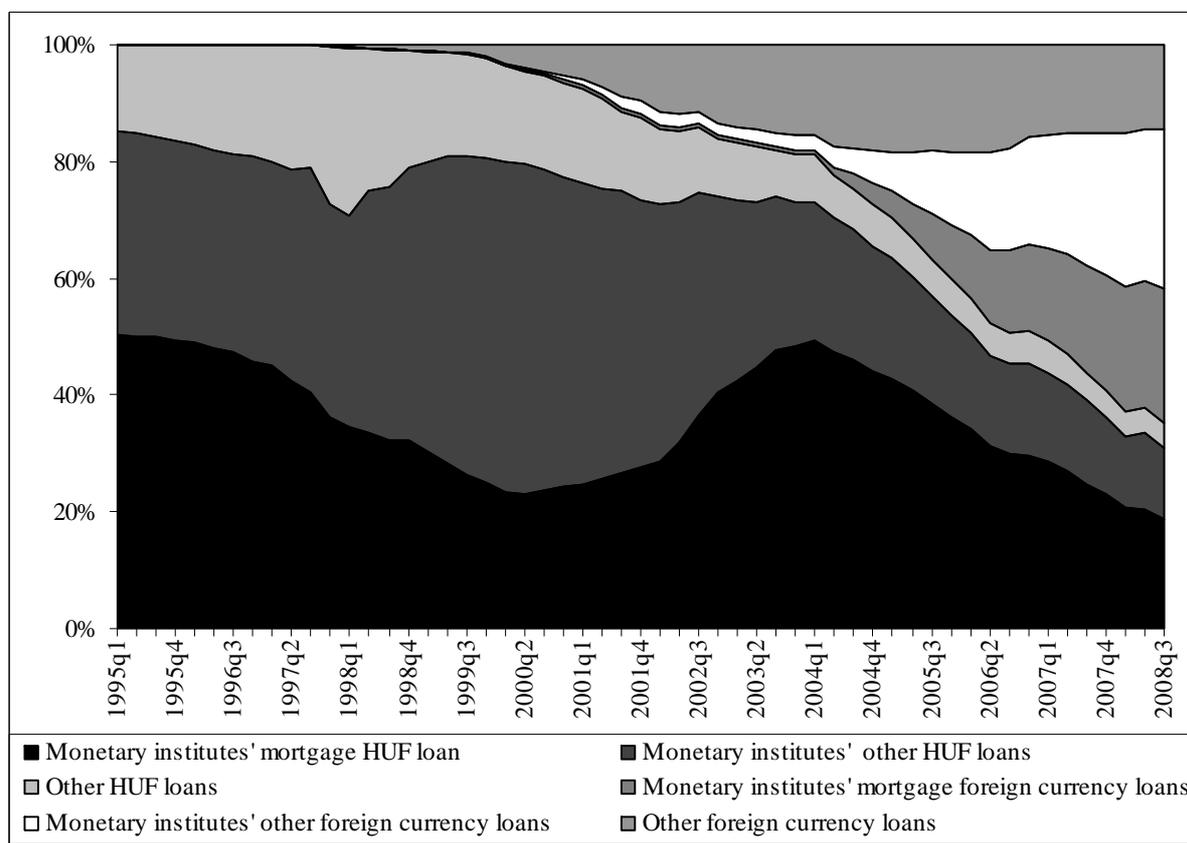
Parallel to this process, an indebtedness process also continued which resulted in a higher debt level. The household debt to GDP ratio was 31.7% in the first quarter of 2008, which, compared to the 59.85% EMU average, is still low, but considering the financial liabilities to financial wealth ratio Hungary caught up to the Euro Area level (36.5% against 32.5%).

<sup>3</sup> Which is high, even by international comparison (*MNB* [2005]).

There are long term processes behind these developments, such as the development of a modern, liberalized financial system (equilibrium deepening of the financial sector) and competition between the banks, which lowered the liquidity constraint (according *Vadas* [2007] the liquidity constraint eased due to increasing income, and that is why Forint denominated loans become available in 1998), as well as positive expectations, which results in a smoothing out of the volatility of consumption. But the short term processes, such as state subsidized real estate mortgage loans, the 20% wage increase in the public sector in 2002 and the tax free minimum wage, also played a dominant role in influencing households' consumption and saving decisions (*MNB* [2004]).

*Kiss et al.* [2006] tried to establish whether the indebtedness process had been a fundamentally justified catching-up trend or a risky credit boom. As a benchmark they estimated the connection between various variables (income etc.) and the level of liabilities for the Eurozone countries; they then simulated the possible equilibrium trends and found that the fast credit growth experienced in Hungary can be explained by convergence. *Vadas* [2007] characterizes the whole process as the opposite of the "saving miracle", which characterized the second half of the nineties as households again used the favourable opportunity created by the state subsidized loans to rearrange their wealth portfolios and to put more emphasis on real estate and consumption, instead of financial savings.

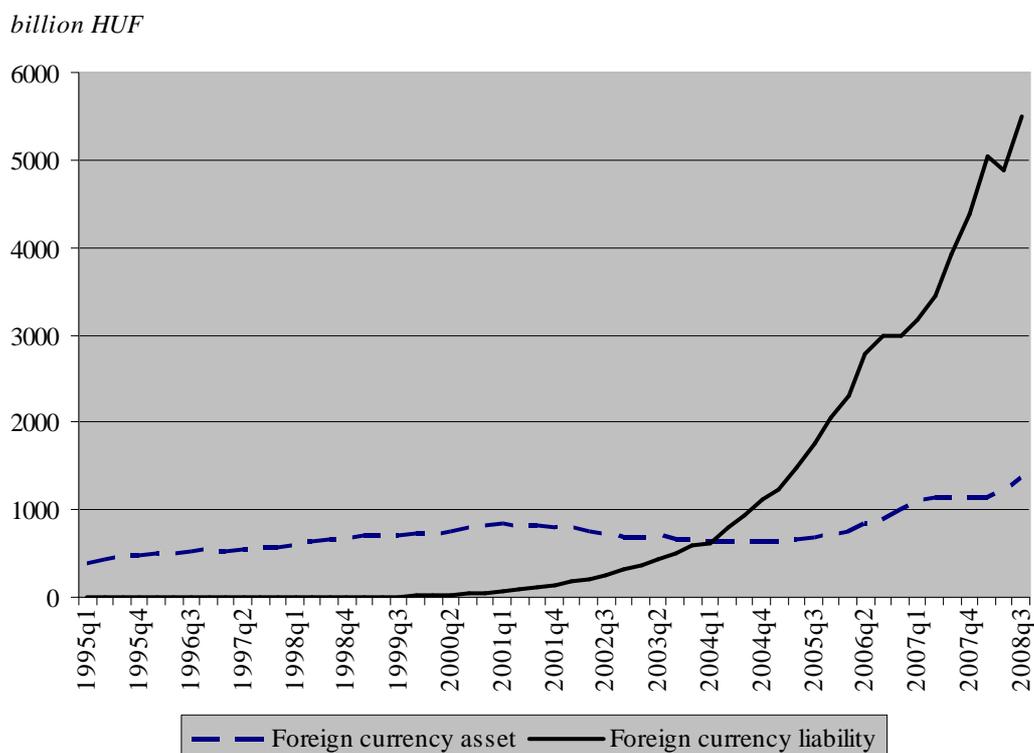
Figure 2. Structure of Hungarian household liabilities between 1995q1 and 2008q3



Source of data: MNB

As can be seen in *figure 2*, foreign currency denominated consumption loans first appeared in 2000, but it was not till 2004q1 that they started a rapid expansion, so that by 2008q3 the share of foreign currency debt accounts for more than 64% of households' liabilities. *Rosenberg and Tirpák [2008]* searched for the incentives that affect the level of foreign currency loans in the new member states (NMS). They found that Hungarian households increased their foreign currency borrowing by 50 percent between 2000 and 2007, which is a bigger increase than households in any other NMS. They also found that the interest differentials have a major influence on foreign currency borrowing, adding that the tightening of eligibility criteria for housing subsidies in Hungary in 2003 is believed to have induced consumers to switch to cheap foreign currency loans (also found in *Vadas [2007]* and *Bethlendi et al. [2005]*). The EU also has an indirect effect, because it boosts the private sector's confidence in exchange rate stability and imminent euro adoption, which makes the exchange rate risk seem negligible.

Figure 3. Households' net foreign currency position between 1995q1 and 2008q3



Source of data: MNB

So households' higher consumption is accompanied by an indebtedness process, which in 2004, as a result of various factors (tightening housing mortgage subsidies, interest rate differences, unperceived/neglected exchange rate risk etc.) shifted the loan demand towards foreign currency lending, resulting in a large negative net exchange rate position, see *figure 3*. (in 2008q3 it reached 15% of GDP).

## 2.2. Which channels of monetary policy ought to be changed because of the changes in the wealth of households?

How would the foreign currency debt affect the monetary transmission mechanism? The transmission channels are the same ones operating through households' wealth, listed by *Mishkin* [1996], the difference is that in this case not only interest rate, but also exchange rate shocks can also have an effect through the foreign currency denominated debt (or an interest rate shock, through the exchange rate channel). In the following the channels are described with a positive exchange rate shock (negative interest rate shock):

- *income effect*: a depreciation would increase the HUF value of the foreign currency denominated debt and so also increase the forint repayments and through this decrease disposable income together with consumption;

- *wealth effect*: a (lasting/durable) depreciation would increase the HUF value of the foreign currency denominated debt, resulting in a decrease in the net wealth, which could lead to less consumption;
- *cash flow effect*: the decreased disposable income (income effect) makes it more difficult to receive additional credit and to smooth consumption;
- *balance sheet effect*: the increased liabilities in the balance sheet make it more difficult to receive credit (because the reduced net financial wealth can act as collateral for fewer liabilities) and smooth consumption.

All the above channels point in the same direction; the depreciation of the exchange rate in the presence of significant foreign currency debt can cause a reduction in consumption and through it a reduction in output, and inflation. Since, according to the standard UIP, the interest rate reduction (*ceteris paribus*) causes depreciation, this would mean that the effects of an expansionary monetary policy step is weakened or even reversed.

### 3. Methodology

The transmission of the monetary policy is often investigated with vector autoregression (VAR) methodology, but in normal cases, an impulse response function (IRF), arising from a VAR model, measures the average response to an impulse. In this case it is not sufficient because my aim is to compare the reaction of households' consumption to the same shock with small or almost no amount of foreign currency debt and with the current amount. For this experiment one needs impulse response functions that are conditional on the amount of foreign currency debt.

For this purpose I run a VAR with 5 endogenous variables (output, price level, consumption, households' foreign currency debt denominated in foreign currency, exchange rate) and with cross products of the foreign currency denominated debt and the exchange rate. These cross products serve as the forint value of the debt that can be revalued by the changes in the exchange rate (or stock of debt), and through this the IRF-s will become conditional on the amount of foreign currency debt. The estimated equations are

$$\begin{aligned}
 y_t = & \alpha_{t,y} + \sum_{i=1}^p \beta_{i,y} y_{t-i} + \sum_{i=1}^p \gamma_{i,y} p_{t-i} + \sum_{i=1}^p \delta_{i,y} c_{t-i} + \sum_{i=1}^p \epsilon_{i,y} fx_{t-i} + \sum_{i=1}^p \zeta_{i,y} ex_{t-i} + \\
 & + \sum_{i=0}^p \eta_{i,y} fx_{t-i} ex_{t-i} + u_{t,y}
 \end{aligned} \tag{1}$$

$$\begin{aligned}
pi_t = & \alpha_{t,pi} + \sum_{i=1}^p \beta_{i,pi} y_{t-i} + \sum_{i=1}^p \gamma_{i,pi} pi_{t-i} + \sum_{i=1}^p \delta_{i,pi} c_{t-i} + \sum_{i=1}^p \varepsilon_{i,pi} fx_{t-i} + \sum_{i=1}^p \zeta_{i,pi} ex_{t-i} + \\
& + \sum_{i=0}^p \eta_{i,pi} fx_{t-i} ex_{t-i} + u_{t,pi}
\end{aligned} \tag{2}$$

$$\begin{aligned}
c_t = & \alpha_{t,c} + \sum_{i=1}^p \beta_{i,c} y_{t-i} + \sum_{i=1}^p \gamma_{i,c} pi_{t-i} + \sum_{i=1}^p \delta_{i,c} c_{t-i} + \sum_{i=1}^p \varepsilon_{i,c} fx_{t-i} + \sum_{i=1}^p \zeta_{i,c} ex_{t-i} + \\
& + \sum_{i=0}^p \eta_{i,c} fx_{t-i} ex_{t-i} + u_{t,c}
\end{aligned} \tag{3}$$

$$\begin{aligned}
fx_t = & \alpha_{t,fx} + \sum_{i=1}^p \beta_{i,fx} y_{t-i} + \sum_{i=1}^p \gamma_{i,fx} pi_{t-i} + \sum_{i=1}^p \delta_{i,fx} c_{t-i} + \sum_{i=1}^p \varepsilon_{i,fx} fx_{t-i} + \sum_{i=1}^p \zeta_{i,fx} ex_{t-i} + \\
& + \sum_{i=1}^p \eta_{i,fx} fx_{t-i} ex_{t-i} + u_{t,fx}
\end{aligned} \tag{4}$$

$$\begin{aligned}
ex_t = & \alpha_{t,ex} + \sum_{i=1}^p \beta_{i,ex} y_{t-i} + \sum_{i=1}^p \gamma_{i,ex} pi_{t-i} + \sum_{i=1}^p \delta_{i,ex} c_{t-i} + \sum_{i=1}^p \varepsilon_{i,ex} fx_{t-i} + \sum_{i=1}^p \zeta_{i,ex} ex_{t-i} + \\
& + \sum_{i=1}^p \eta_{i,ex} fx_{t-i} ex_{t-i} + u_{t,ex}
\end{aligned} , \tag{5}$$

where  $y_t$  is the output,  $pi_t$  is the price level,  $c_t$  stands for consumption,  $ex_t$  is the exchange rate and  $u_t$  is the residual. The best way to bring the foreign currency debt into the equation would be the repayment of the given period, but no such data is available. The nearest available proxy could be the stock of foreign currency debt, which leads to the problem of the timing of the stock variable (start vs. end of period). The system above suggests that the best solution is that stock is taken at the beginning of each period; otherwise one would have to calculate for the interaction/endogeneity between the consumption and the debt during the period as well. Two is the minimum number of lags that solve most of the autocorrelation problem and leave enough degree of freedom; so  $p=2$ . With equations (1)-(3) the contemporaneous cross product is also among the independent variables, because in this case it is probable that the stock of households' debt denominated in forints would affect the variables in question. As these equations can only be estimated ineffectively with the least squares method, I use the two-stage least squares method with an instrumental variable euro-dollar exchange rate<sup>4</sup>. Equations (4)-(5) were estimated with ordinary least squares, as no contemporaneous forint debt was added to these equations. There are two reasons for this; on the one hand because of the identification, the effect of a forint debt shock could work through the mainly affected consumption, and on the other hand in this way a recursive solution is possible.

---

<sup>4</sup> Because the foreign currency stock is from the start of the period (so flows of the given period do not affect it) one only needs an instrument for the exchange rate.

To keep the identification as simple as possible, a lower triangular identification was considered<sup>5</sup>, with the ordering of the endogenous variables: output, price level, consumption, foreign currency debt, and exchange rate<sup>6</sup>.

As can be seen, the methodology above is only appropriate for experimenting with the effect of an exchange rate shock given the different balance sheet positions of the households. To be able to speak about changes in the transmission of monetary policy, one needs interest rate in the model and a method to identify monetary policy.

With an additional endogenous variable  $si_t$ , which stands for the short-term interest rate and with it an additional equation, I come to the following equation system:

$$y_t = \alpha_{t,y} + \sum_{i=1}^p \beta_{i,y} y_{t-i} + \sum_{i=1}^p \gamma_{i,y} pi_{t-i} + \sum_{i=1}^p \delta_{i,y} c_{t-i} + \sum_{i=1}^p \varepsilon_{i,y} fx_{t-i} + \sum_{i=1}^p \phi_{i,y} si_{t-i} + \sum_{i=1}^p \zeta_{i,y} ex_{t-i} + \sum_{i=0}^p \eta_{i,y} fx_{t-i} ex_{t-i} + u_{t,y} \quad (6)$$

$$pi_t = \alpha_{t,pi} + \sum_{i=1}^p \beta_{i,pi} y_{t-i} + \sum_{i=1}^p \gamma_{i,pi} pi_{t-i} + \sum_{i=1}^p \delta_{i,pi} c_{t-i} + \sum_{i=1}^p \varepsilon_{i,pi} fx_{t-i} + \sum_{i=1}^p \phi_{i,pi} si_{t-i} + \sum_{i=1}^p \zeta_{i,pi} ex_{t-i} + \sum_{i=0}^p \eta_{i,pi} fx_{t-i} ex_{t-i} + u_{t,pi} \quad (7)$$

$$c_t = \alpha_{t,c} + \sum_{i=1}^p \beta_{i,c} y_{t-i} + \sum_{i=1}^p \gamma_{i,c} pi_{t-i} + \sum_{i=1}^p \delta_{i,c} c_{t-i} + \sum_{i=1}^p \varepsilon_{i,c} fx_{t-i} + \sum_{i=1}^p \phi_{i,c} si_{t-i} + \sum_{i=1}^p \zeta_{i,c} ex_{t-i} + \sum_{i=0}^p \eta_{i,c} fx_{t-i} ex_{t-i} + u_{t,c} \quad (8)$$

$$fx_t = \alpha_{t,fx} + \sum_{i=1}^p \beta_{i,fx} y_{t-i} + \sum_{i=1}^p \gamma_{i,fx} pi_{t-i} + \sum_{i=1}^p \delta_{i,fx} c_{t-i} + \sum_{i=1}^p \varepsilon_{i,fx} fx_{t-i} + \sum_{i=1}^p \phi_{i,fx} si_{t-i} + \sum_{i=1}^p \zeta_{i,fx} ex_{t-i} + \sum_{i=1}^p \eta_{i,fx} fx_{t-i} ex_{t-i} + u_{t,fx} \quad (9)$$

<sup>5</sup> The fact that the amount of debt is from the beginning of the period suggests that consumption cannot affect the stocks within the period, but the shock to the debt can affect the consumption, so an identification like

$\begin{pmatrix} 1 & 0 & 0 & 0 & 0 \\ a_{21} & 1 & 0 & 0 & 0 \\ a_{31} & a_{32} & 1 & a_{34} & 0 \\ a_{41} & a_{42} & 0 & 1 & 0 \\ a_{51} & a_{52} & a_{53} & a_{54} & 1 \end{pmatrix}$  with the same ordering of the variables as above, would suit this idea more; however using

the simple lower triangle identification does not affect the results.

<sup>6</sup> This ordering would not be appropriate if anything other than the effect of the exchange rate shock were being investigated.

$$\begin{aligned}
s_i_t = & \alpha_{t,si} + \sum_{i=1}^p \beta_{i,si} y_{t-i} + \sum_{i=1}^p \gamma_{i,si} p i_{t-i} + \sum_{i=1}^p \delta_{i,si} c_{t-i} + \sum_{i=1}^p \varepsilon_{i,si} f x_{t-i} + \sum_{i=1}^p \phi_{i,si} s i_{t-i} + \\
& + \sum_{i=1}^p \zeta_{i,si} e x_{t-i} + \sum_{i=0}^p \eta_{i,si} f x_{t-i} e x_{t-i} + u_{t,si}
\end{aligned} \tag{10}$$

$$\begin{aligned}
e x_t = & \alpha_{t,ex} + \sum_{i=1}^p \beta_{i,ex} y_{t-i} + \sum_{i=1}^p \gamma_{i,ex} p i_{t-i} + \sum_{i=1}^p \delta_{i,ex} c_{t-i} + \sum_{i=1}^p \varepsilon_{i,ex} f x_{t-i} + \sum_{i=1}^p \phi_{i,ex} s i_{t-i} + \\
& + \sum_{i=1}^p \zeta_{i,ex} e x_{t-i} + \sum_{i=1}^p \eta_{i,ex} f x_{t-i} e x_{t-i} + u_{t,ex}
\end{aligned} \tag{11}$$

with the other variables as in equations (1)-(5). Because of the contemporaneous cross products in equations (6), (7), (8) and (10), these equations had to be estimated with the two-stage least square method, with the instrumental variable as before.

The main task after estimating equations (6)-(11) is to decompose residuals  $u_t$  into structural shocks  $\varepsilon_t$ . This corresponds to finding the contemporaneous relationship between structural and reduced form innovations, or finding the matrix  $A$  in the equation

$$u_t = A^{-1} \varepsilon_t, \tag{12}$$

where  $\varepsilon_t$  denotes the vector of structural shocks and  $u_t$  is a vector made from the residuals of the equations (6)-(11). The element in the  $i$ -th row and  $j$ -th column of the matrix  $A^{-1}$  is the magnitude by which the  $j$ -th structural shock affects  $i$ -th variable simultaneously. As the matrix  $A^{-1}$  is not unique, some additional information (in the form of  $n(n-1)/2$  restrictions) and consequently the identification of structural shocks is needed. My identification here follows that of *Smets* [1997] and *Smets and Wouters* [1999]<sup>7</sup>. In the main part of the matrix  $A^{-1}$  recursive identification is used (with the ordering  $y_t, p i_t, c_t, f x_t, s i_t, n e e r_t$ ), but it is surely not appropriate between the monetary shocks and residuals of the interest rates and exchange rates. So in the beginning the matrix  $A^{-1}$  takes the form:

$$A^{-1} = \begin{pmatrix} 1 & 0 & 0 & 0 & 0 & 0 \\ a_{21} & 1 & 0 & 0 & 0 & 0 \\ a_{31} & a_{32} & 1 & 0 & 0 & 0 \\ a_{41} & a_{42} & a_{43} & 1 & 0 & 0 \\ a_{51} & a_{52} & a_{53} & a_{54} & a_{55} & a_{56} \\ a_{61} & a_{62} & a_{63} & a_{64} & a_{65} & a_{66} \end{pmatrix}. \tag{13}$$

To see what this means, consider the following short-run reduced model as in *Smets and Wouters* [1999]:

<sup>7</sup> Also used by *Mojon and Peersman* [2001].

$$u_{t,si} = a_{55}\varepsilon_t^P + a_{56}\varepsilon_t^E, \quad (14)$$

$$u_{t,ex} = a_{65}\varepsilon_t^P + a_{66}\varepsilon_t^E, \quad (15)$$

where  $\varepsilon_t^P$  denotes the policy shock and  $\varepsilon_t^E$  denotes the exchange rate shock, and  $u_{t,si}$  and  $u_{t,ex}$  are the residuals of the equation of  $si_t$  and  $ex_t$  in the system (6)-(11). Equation (14) can be considered as a short run reaction function of the monetary authorities. Interest rate is adjusted to changes in the monetary policy stance  $\varepsilon_t^P$  or to the movements of the exchange rate due changes in risk premium or foreign interest rate shocks  $\varepsilon_t^E$ . Equation (15) states that in the equilibrium the exchange rate depends on domestic policy innovations and exchange rate shocks.

The model in (14) and (15) is under-identified. The recursive scheme would imply that either  $a_{56} = 0$  or  $a_{65} = 0$ . As the integrated capital markets are one of the main characteristics of globalization to assume  $a_{65} = 0$  would be too restrictive (meaning that domestic monetary policy is unable to immediately affect the exchange rate), and because of the interest rate parity the sign of  $a_{65}$  should be negative. The assumption of  $a_{56} = 0$  would mean that the monetary policy does not react to the shocks of the exchange rate within period, which seems to be inappropriate for a small open economy. This problem of simultaneity should be resolved.

As my main interest is the identification of  $\varepsilon_t^P$ , I solve the equation (14) and (15) for the monetary policy shock:

$$\varepsilon_t^P = \frac{a_{66}}{a_{66}a_{55} - a_{65}a_{56}}u_{t,si} - \frac{a_{56}}{a_{66}a_{55} - a_{65}a_{56}}u_{t,ex}, \quad (16)$$

and following *Smets* [1997] renormalize the monetary policy shock such that the sum of the weights on the domestic interest rate and exchange rate residuals gives one, so multiply both sides with  $\frac{a_{66}a_{55} - a_{65}a_{56}}{a_{66} - a_{56}}$  resulting in:

$$\varepsilon_t^P = \frac{a_{66}}{a_{66} - a_{56}}u_{t,si} - \frac{a_{56}}{a_{66} - a_{56}}u_{t,ex}. \quad (17)$$

Equation (17) can be rewritten as

$$\varepsilon_t^P = (1 - \omega)u_{t,si} + \omega u_{t,ex}, \quad (18)$$

where  $\omega = -\frac{a_{56}}{a_{66} - a_{56}}$ . This can be interpreted as a short-run monetary condition index (MCI)

which is often used to measure the changes in the stance of monetary policy. In case of depreciation the monetary policy, which aims to stabilize the exchange rate, would raise the interest rate, so  $a_{56}$  should be positive. With  $a_{66} > 0$  - because the exchange rate shock has a direct positive effect on the exchange rate - the weight  $\omega$  should be smaller than zero<sup>8</sup>. This weight can be calculated from the estimated equation (with the assumption that  $\varepsilon_t^p = 0$ )

$$u_{t,si} = -\omega / (1 - \omega) u_{t,ex}, \quad (19)$$

using the two stages least squares method with various instrumental variables to tackle the endogeneity problems. The next step is the estimation of the equation (19) using the residuals of the fifth and sixth equation in the system (6)-(11). As the intuition behind this estimation is to see how the unexplained interest rate reactions can be regressed to the unexplained exchange rate movements, the residual of euro short term interest (regressed on its own lags) should serve as a very good instrument in this case (see *Smets* [1997] footnote 13.).

Equation (18) and the weight from equation (19) can be built into the identification through the following equation

$$A\Omega A' = \Sigma, \quad (20)$$

where  $\Omega = E(u_t u_t')$  is the variance-covariance matrix of the reduced form residuals and  $\Sigma = E(\varepsilon_t \varepsilon_t')$  is the variance-covariance matrix of the structural shocks. It is assumed that the structural shocks are orthogonal to each other, so the matrix  $\Sigma$  is diagonal. This is the estimated relationship and the weight  $\omega$  is built into matrix  $A$  in the following way

$$A = \begin{pmatrix} 1 & 0 & 0 & 0 & 0 & 0 \\ \alpha_{21} & 1 & 0 & 0 & 0 & 0 \\ \alpha_{31} & \alpha_{32} & 1 & 0 & 0 & 0 \\ \alpha_{41} & \alpha_{42} & \alpha_{43} & 1 & 0 & 0 \\ \alpha_{51} & \alpha_{52} & \alpha_{53} & \alpha_{54} & 1 - \omega & \omega \\ \alpha_{61} & \alpha_{62} & \alpha_{63} & \alpha_{64} & \alpha_{65} & 1 \end{pmatrix}. \quad (21)$$

So in this case the effects of the identified monetary policy shock are featured in the figures.

---

<sup>8</sup> As *Smets and Wouters* [1999] use the exchange rate definition foreign currency price of the domestic currency (the invert of the definition used in this paper),  $a_{56}$  is negative in their paper, which together with  $a_{66} > 0$  means

that  $\omega = -\frac{a_{56}}{a_{66} - a_{56}}$  is between zero and one.

#### **4. Data**

For the estimation quarterly data is used with a sample length from 1996q1 to 2008q3. Output is the seasonally and calendar effects adjusted and reconciled GDP at average prices of 2000 from the Hungarian Statistical office (KSH). Quarterly inflation from the KSH is used to calculate the price level (1994q4=100), but as this variable is seasonally unadjusted in this case seasonal dummies were also added to equation (2) and (7). Consumption is at average prices for the year 2000, adjusted and reconciled for seasonal and calendar effects. Households' foreign currency denominated debt is from the Hungarian National Bank's financial accounts (and converted into euros) together with quarterly euro exchange rates and 3 month market interest rates. In all cases except for the interest rate, the logarithms of the variables are used in the estimations.

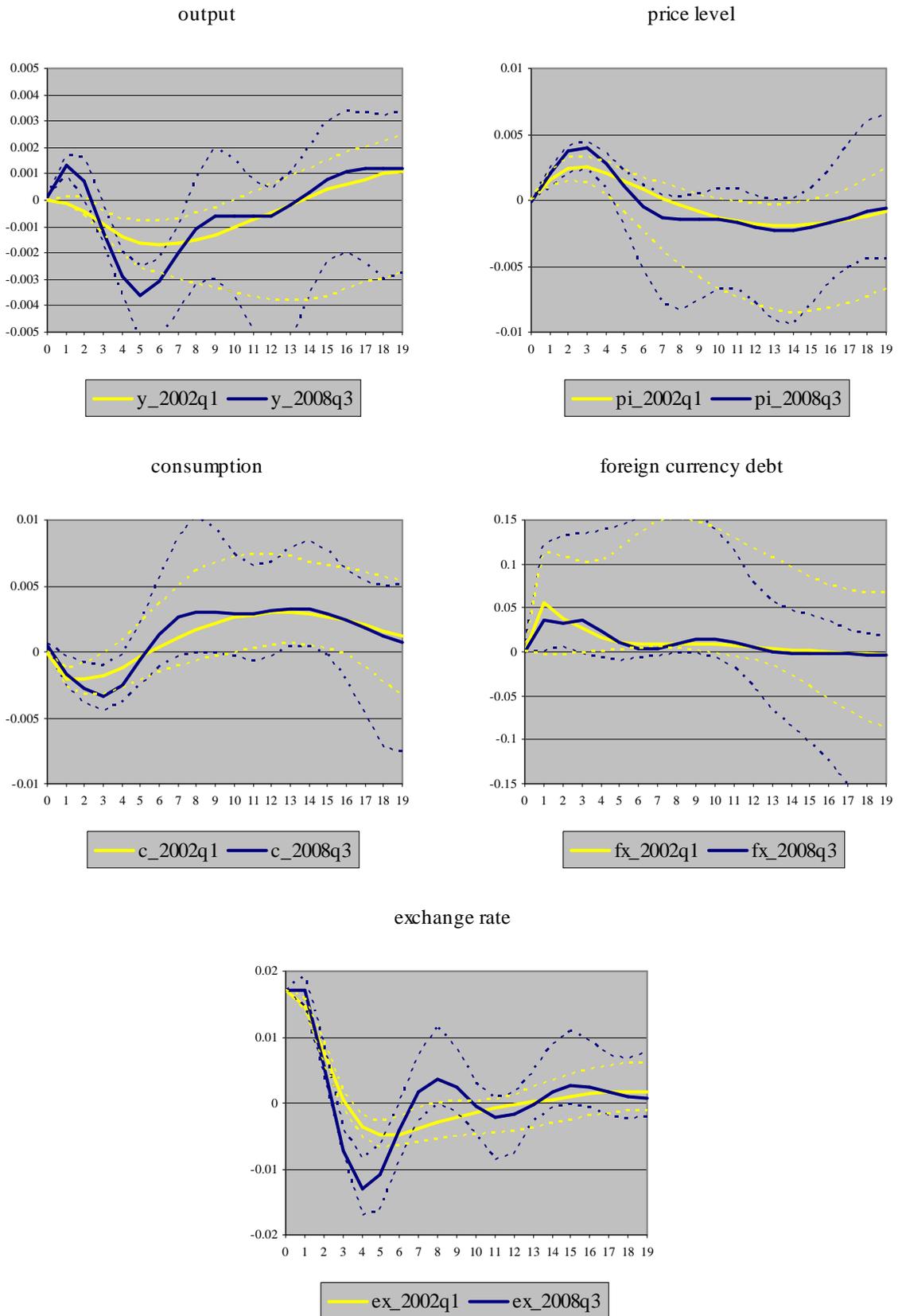
#### **5. Results**

In this section I present the resulting impulse response functions. Because the impulse response functions are conditional on the amount of foreign currency it is important from which point the IRF starts. To be able to show the effect of the change in the balance sheet position of the households two starting points are considered; 2002q1 and 2008q3. The two periods differ in the amount of foreign currency debt, because in 2002 the foreign currency debt accumulation boom had not yet started (see *figure 2* or *figure 3*), but other parameters, such as the exchange rate and monetary policy regime, are not fundamentally different between the two periods.

As differences in the dynamics of the exchange rate can cause differences in the responses of other variables, it would be interesting to see as a robustness check, to establish whether the differences are caused by the exchange rate dynamics or not. So to filter out these differences in one specification, additional shocks are added to the exchange rate impulse response, starting at 2008q3, so that it does not differ from that starting at 2002q1.

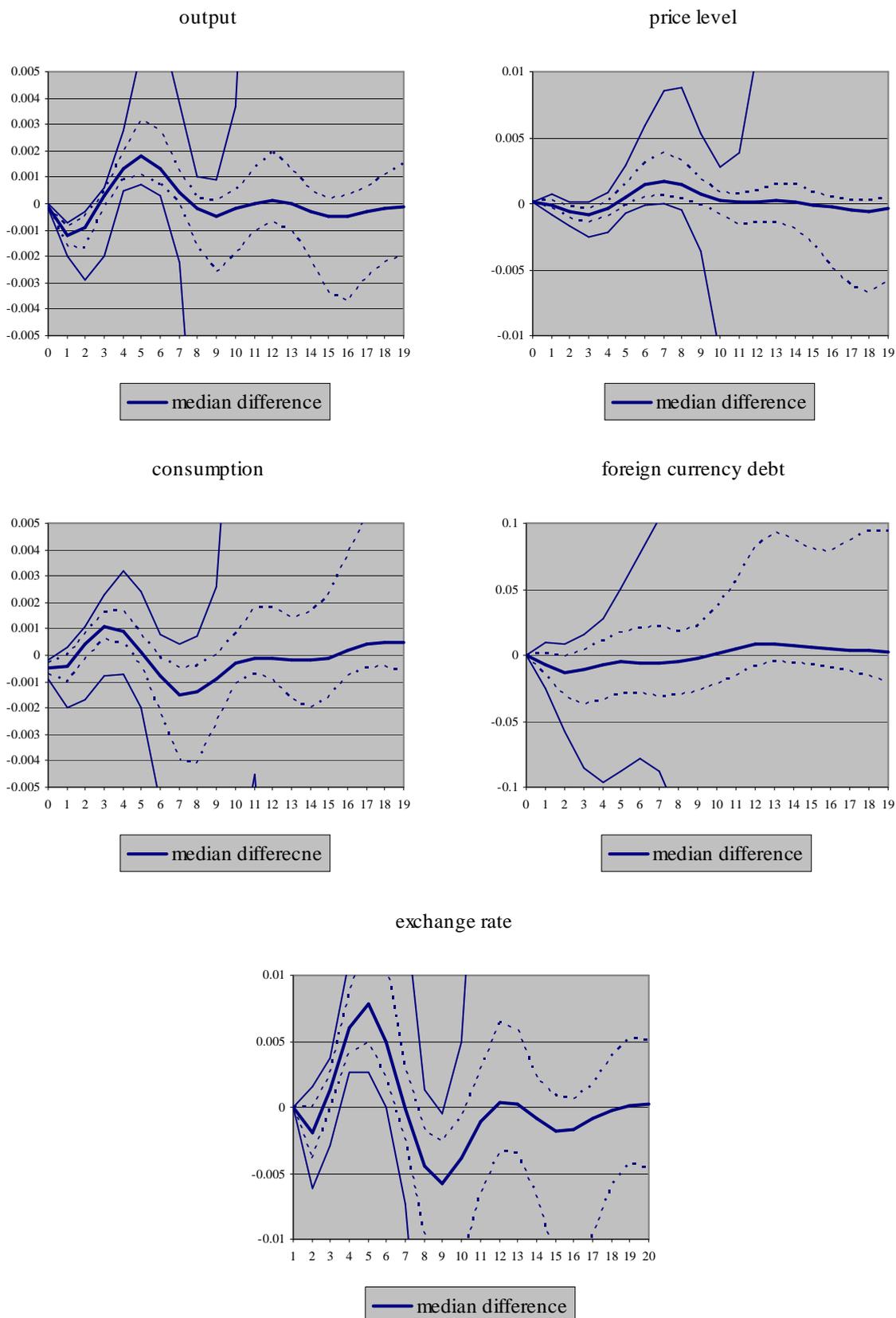
The confidence intervals in the figures contain 60% of the 10000 Monte Carlo simulations.

Figure 4a. IRF without interest rate, without additional exchange rate shocks



Source: own calculations

Figure 4b. Differences of IRFs (2002q1 minus 2008q3) without interest rate, without additional exchange rate shocks



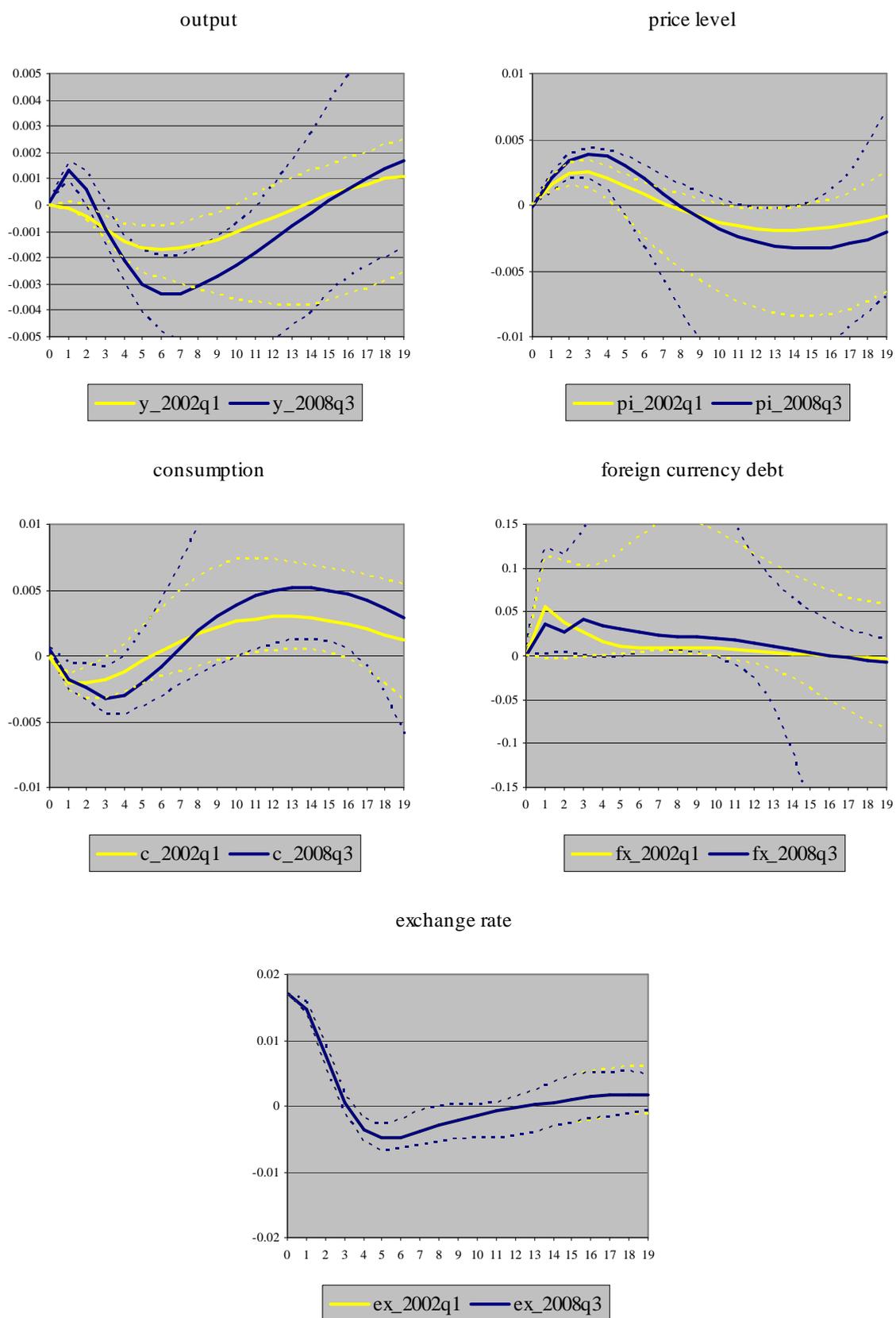
(The bold blue line is the difference in the medians from the Monte Carlo simulations; thin lines represent the 90% confidence interval; dashed lines represent the 60% confidence interval)  
 Source: own calculations

In *figure 4a* the IRF-s based on the 2002 amounts tell the following story: the exchange rate depreciation caused a significant rise in prices (exchange rate pass-through) and a significant decline in consumption; these together leading to the decline of output. The reaction of the consumption may be considered strange, but it is in line with the earlier findings of *Jakab et al.* [2006], who found that an interest rate increase causes a consumption increase, because the slowing inflation increases real wages, and through this, consumption. In this case the same explanation can be used. It is also interesting to notice how the foreign currency debt rises sharply just after the shock, probably as households (still without greater amounts of debt) try to smooth their consumption. The IRF-s based on 2008q3 amounts tell a different and less straightforward story. The decline in consumption and the moderate rise of foreign currency debt are in line with households heavily indebted in foreign currency, and the immediate rise in prices shows a faster exchange rate pass-through (about 25%). However, the initial rise in output (also significant) is counterintuitive, and thus a puzzle. The presence of an additional fluctuation can also be observed in the reaction of the exchange rate and more clearly in the borders of the confidence intervals.

Because the above IRF-s are not independent of each other, the same draw from the Monte Carlo simulation was used to calculate both IRFs, and their differences, so *figure 4b* shows the differences of the IRF-s calculated from the Monte Carlo simulations. The bold blue line is the difference in the medians of the 10000 Monte Carlo simulations, thin lines represent the 90% confidence interval, while dashed lines represent the 60% confidence interval.

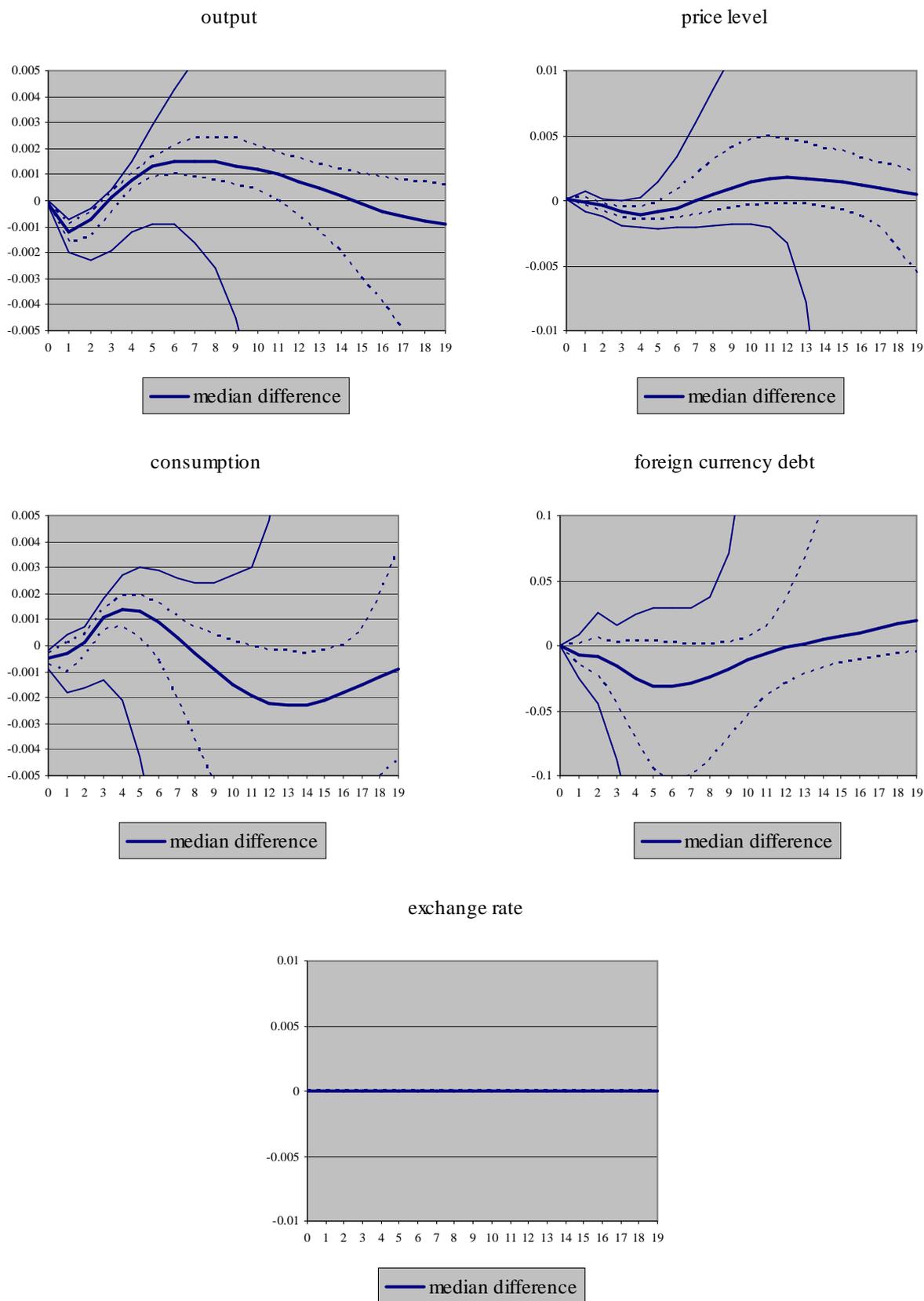
Even if the significant difference between the reaction function of the output is caused by the puzzling features, consumption also shows a significant difference at 60%. The difference between reactions in the stock of the foreign denominated debt does not differ from zero. There is also a significant difference in the reaction of prices, hinting at an increasing exchange rate pass-through. The excess volatility in the reaction of the exchange rate dated to 2008q3 causes significant differences, but it is possible that these volatile movements distort the other results, so these should be discounted.

Figure 5a. IRF without interest rate, with additional exchange rate shocks



Source: own calculations

Figure 5b. Differences of IRFs (2002q1 minus 2008q3) without interest rate, with additional exchange rate shocks

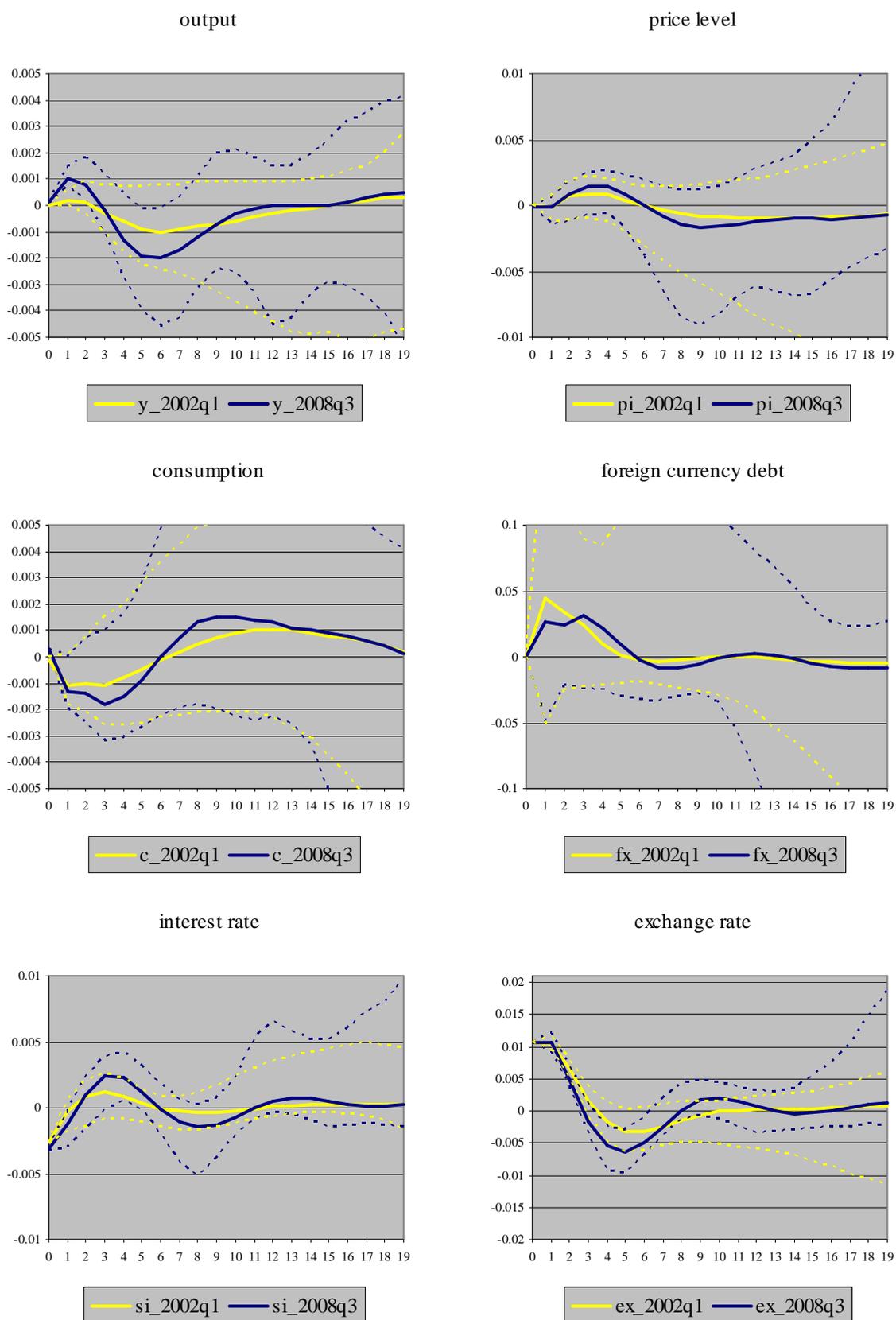


(The bold blue line is the difference in the medians from the Monte Carlo simulations; thin lines represent the 90% confidence interval; dashed lines represent the 60% confidence interval)  
 Source: own calculations

To make sure that differences in the reaction of the exchange rate reaction do not cause the differences in the estimated IRF-s of other variables, the response functions starting from 2008 were simulated with additional exchange rate shocks, so the reaction is the same as the one based on values from 2002. The result of this simulation is shown in *figure 5a*. The significant blips in output are still present (also the significant difference between the reactions based on 2002 data and 2008 data), but this operation took care of the additional fluctuation mentioned previously and so the differences between the IRF-s based on 2002 and 2008 are more durable, but still not significant.

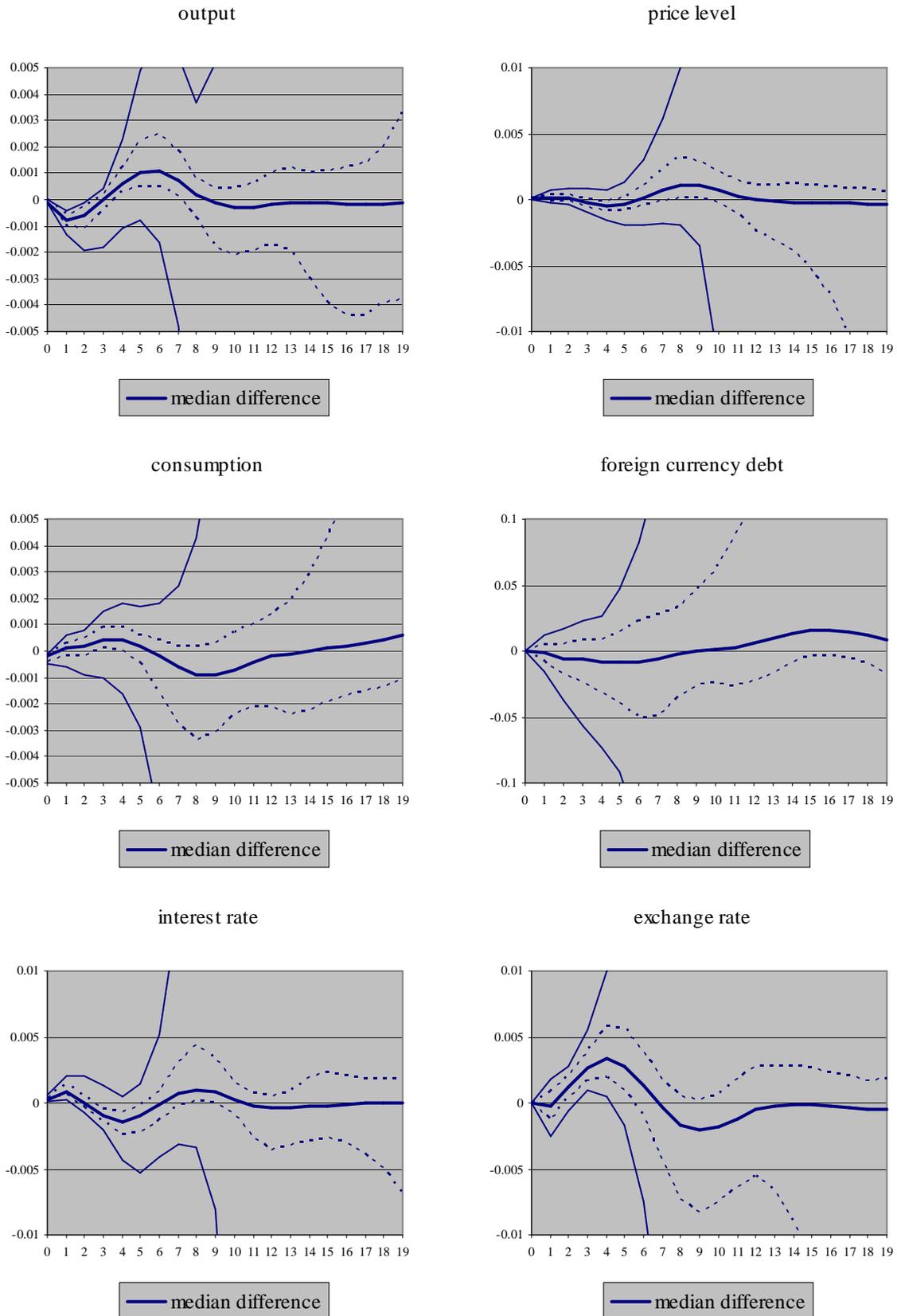
The differences in the reaction of the consumption and in the reaction of the price level are significantly different from zero even after the volatility of the exchange rate is taken care of (*figure 5b*).

Figure 6a. IRF with interest rate, without additional exchange rate shocks



Source: own calculations

Figure 6b. Differences of IRFs (2002q1 minus 2008q3) with interest rate, without additional exchange rate shocks



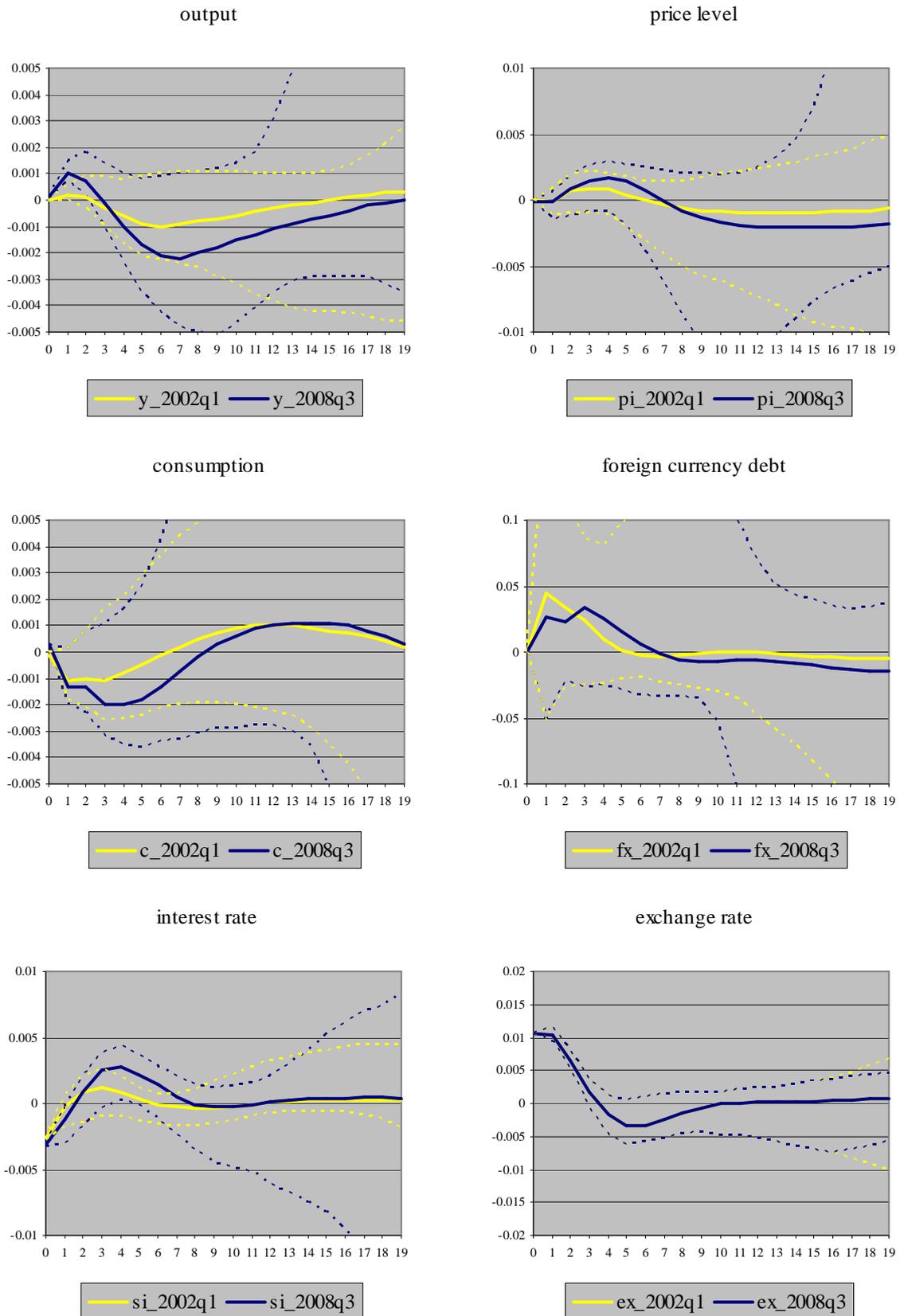
(The bold, blue line is the difference in the medians from the Monte Carlo simulations; thin lines represent the 90% confidence interval; dashed lines represent the 60% confidence interval)  
 Source: own calculations

*Figure 6a* shows the IRF from the 6 variable SVAR, where the monetary policy is identified as shown in the part 3. The 2002 case is the following: the simultaneous drop in the interest rate and rise in the exchange rate causes the drop in consumption, and a sharp rise in the foreign currency debt is consistent with the need to smooth consumption. The decline in output and the increase in the price level have both lost their significance, as has the reduction in consumption. The other disturbing fact is the rapid increase (and overshooting) of the interest rate despite the falling price level, which makes the interest rate look more flexible than the exchange rate, which is counterintuitive.

The picture from 2008 is no clearer; there is a significant initial rise in output, followed by a faster and deeper decline compared to the reaction of the output in 2002, but it is still insignificant. The increase in the price level is smaller, and only starts after several quarters and is not significant either. Consumption shows a great decline, which lasts 6 quarters, accompanied by a modest increase in debt. After the initial negative shock the interest rate recovers very rapidly, which is not in line with the falling price level. There are no significant differences between the functions launched from different points in time. As in case of the mere exchange rate shock in previous figures, the reactions show additional fluctuations, clearly observable in the confidence interval of the output.

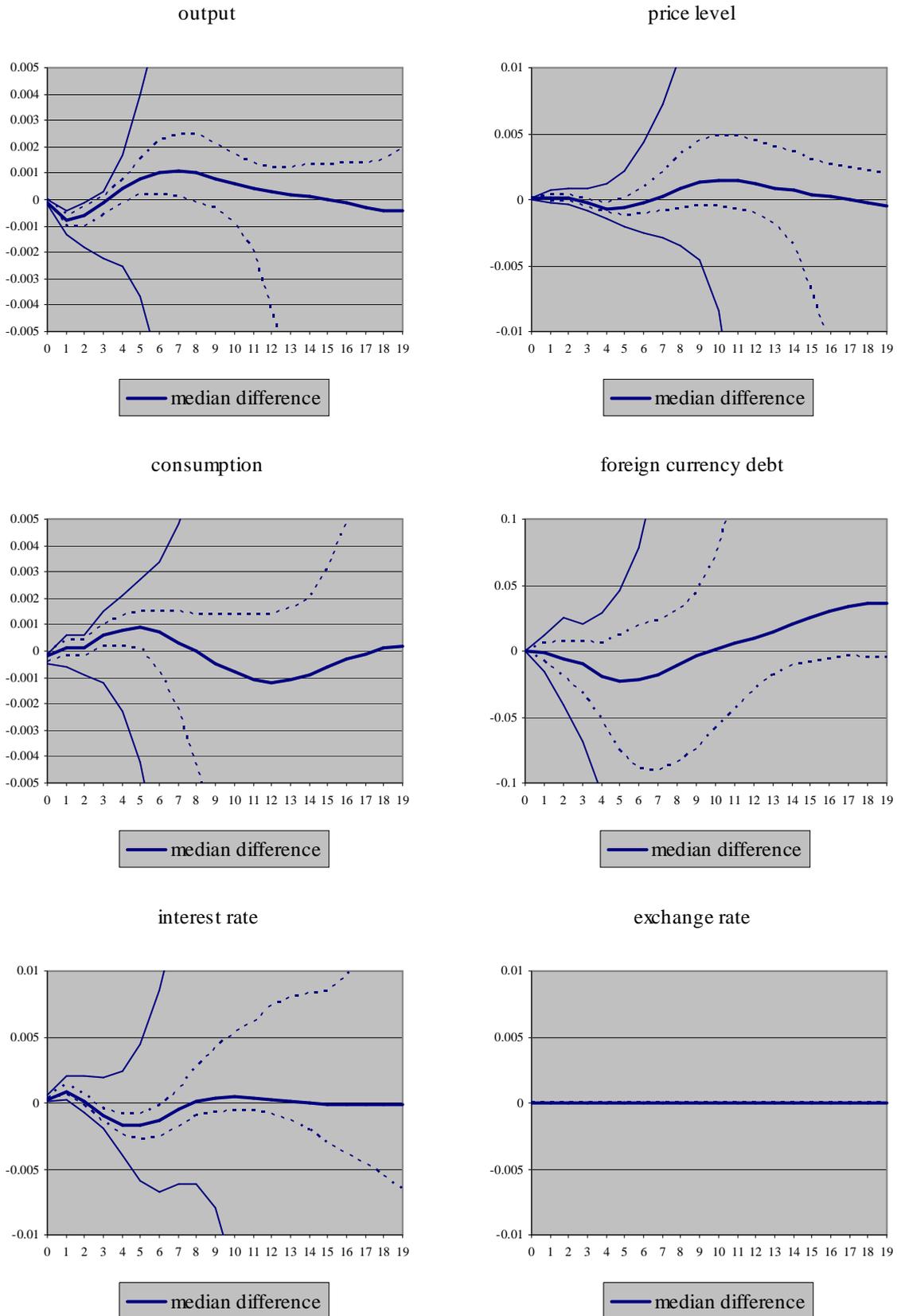
According *figure 6b* there is a significant difference between the reaction functions of consumption and even the interest rate at a 60% confidence level, but not between the reactions of the price level. The foreign debt stock shows the same behaviour as in the previous scenarios, and the difference between the exchange rate reactions is due to the fluctuation.

Figure 7a. with interest rate, with additional exchange rate shocks



Source: own calculations

Figure 7b. Differences of IRFs (2002q1 minus 2008q3) with interest rate, with additional exchange rate shocks



(The bold, bold line is the difference in the medians from the Monte Carlo simulations; thin lines represent the 90% confidence interval; dashed lines represent the 60% confidence interval)  
 Source: own calculations

Again additional exchange rate shocks were added to the impulse response functions launched from the 2008q3 data, to eliminate the differences in the reaction of the exchange rate. This only affects the duration of differences, but not their general shape or significance, as can be seen in *figure 7a* or *7b*.

## **6. Summary**

The aim of the paper was to search for differences in the transmission of monetary policy caused by the Hungarian households' indebtedness in foreign currency. As the rapid foreign currency debt accumulation, driven by interest rate differentials, neglected exchange rate risks in the light of the expected adoption of the euro, making household consumption more sensitive to exchange rate depreciation, the hypothesis was drawn that the exchange rate channel of monetary policy should be weakened or even inverted.

Non-linear VARs were used to make the resulting impulse response functions conditional on the accumulated debt, which made it possible to compare the reaction of the economy in two scenarios. In the first case the IRF-s were launched from 2002q1, when household foreign currency debt was still negligible, the second case is from 2008q3 where the ratio of household debt denominated in foreign currency reached 64% of households' liabilities. A further advantage of these two dates is that neither the exchange rate nor monetary policy regime changed significantly between these two points in time, keeping regime changes to the minimum.

The results show almost significant differences of the reaction of consumption in the presence of more foreign currency denominated debt in every scenario, but several counterintuitive movements were found in the case of other variables, which makes the results less solid.

The short time series and the absence of considerable depreciations make it hard to get significant results, a situation which will definitely be solved by time.

## **References**

- ÁRVAI, ZSÓFIA – MENCZEL, PÉTER [2001]: Saving of Hungarian households 1995-2000. Magyar Nemzeti Bank, MNB Working Papers Series, WP No. 2000/8, (March, 2001).
- BETHLENDI, ANDRÁS – CZETI, TAMÁS – KREKÓ, JUDIT – NAGY, MÁRTON – PALOTAI, DÁNIEL [2005]: Driving forces behind private sector foreign currency lending in Hungary. National Bank of Hungary, MNB Background Studies 2005/2, (April, 2005) available only in Hungarian.
- JAKAB, M. ZOLTÁN – VADAS, GÁBOR [2001]: Forecasting Hungarian households' consumption with econometric methods. Hungarian National Bank, MNB Background Studies 2001/1, (October, 2001).

- JAKAB, M. ZOLTÁN – VÁRPALOTAI, VIKTOR – VONNÁK, BALÁZS [2006]: How does monetary policy affect aggregate demand? A multimodel approach for Hungary *in VONNÁK BALÁZS (ed.) [2006]: Monetary Transmission in Hungary. Hungarian National Bank, Budapest, pp. 181-206.*
- KISS GERGELY – NAGY MÁRTON – VONNÁK BALÁZS [2006]: Credit Growth in Central and Eastern Europe: Convergence or Boom? Magyar Nemzeti Bank, MNB Working Papers Series, WP No. 2006/10, (November, 2006).
- LETTAU, MARTIN - LUDVIGSON, SYDNEY - STEINDAL, CHARLES [2002]: Monetary Policy Transmission through the Consumption-Wealth Channel. Federal Reserve Bank New York, FRBNY Economic Policy Review, (May, 2002).
- MISHKIN, FREDERIC S. [1996]: The channels of monetary transmission: lessons for monetary policy. National Bureau of Economic Research, NBER Working Paper Series, WP No. 5464, (February, 1996).
- MNB [2004]: Report on inflation. Hungarian National Bank February 2004.
- MOJON, BENOIT – PEERSMAN, GERT [2001]: A VAR description of the effects of monetary policy in the individual countries of the euro area. European Central Bank, Working Paper Series, WP No. 92, (December, 2001).
- ORBÁN, GÁBOR – SZALAI, ZOLTÁN [2006]: The expected effect of the euro on the Hungarian monetary transmission. *in VONNÁK BALÁZS (ed.) [2006]: Monetary Transmission in Hungary. Hungarian National Bank, Budapest pp. 239-258.*
- REZESSY, ANDRÁS [2006]: Estimating the immediate impact of monetary policy shocks on the exchange rate and other asset prices in Hungary. *in VONNÁK BALÁZS (ed.) [2006]: Monetary Transmission in Hungary. Hungarian National Bank, Budapest, pp. 53-68.*
- ROSENBERG, CHRISTOPH B. – TIRPÁK, MARCEL [2008]: Determinants of Foreign Currency Borrowing in the New Member States of the EU. International Monetary Fund, IMF Working Paper, Wp/08/173., (July, 2008).
- SMETS, FRANK [1997]: Measuring Monetary Policy Shocks in France, Germany and Italy: the Role of the Exchange Rate. Bank for International Settlements, Monetary and Economic Department, Working Paper Series, WP No. 42. (June, 1997).
- SMETS, FRANK – WOUTERS, RAFAEL [1999]: The Exchange Rate and the Monetary Transmission in Germany. De Nederlandsche Bank, DNB Staff Reports, No. 35, (1999).
- VADAS, GÁBOR [2007]: Wealth Portfolio of Hungarian Households – Urban Legends and Facts. Magyar Nemzeti Bank, MNB Occasional Paper Series, No. 68, (November, 2007).
- VONNÁK, BALÁZS [2006]: Estimating the effect of Hungarian monetary policy within a structured VAR framework. *in VONNÁK BALÁZS (ed.) [2006]: Monetary Transmission in Hungary. Hungarian National Bank, Budapest, pp. 155-180.*