Transmission of Hungarian Monetary Policy

Vonnák Balázs

Magyar Nemzeti Bank (Central Bank of Hungary)

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Abstract

This paper attempts to aggregate and summarize fresh results concerning the monetary transmission mechanism in Hungary. Within a research project at the MNB nine studies have been published investigating the channels through which Hungarian monetary policy affects the economy. We create a framework for synthesizing particular results based on Mishkin's (1996) classification. We analyze how demand and supply are affected through those channels. Our conclusion is that during the past ten years monetary policy did exert measurable influence on real activity and prices. The dominance of the exchange rate channel explains why price respond faster and output responds milder than in closed developed economies like the US or the eurozone. We expect that after adopting the euro the absence of exchange rate will be compensated by the fact that the interest rate channel will work through foreign demand as well, therefore no significant asymmetries can be expected inside the eurozone in terms of monetary transmission.

Keywords: monetary transmission mechanism, monetary policy shock, exchange rate channel

JEL classification: E44, E52, E58

1. Introduction

In the beginning of 2004 a comprehensive research project has been launched at the Magyar Nemzeti Bank. The objective of the project was to provide quantitative results about the Hungarian monetary transmission mechanism (MTM) to form an overall picture. The focus of the project was on empirics. We investigated first of all those areas, where most up-to-date econometric methods could be applied. The sample period of the estimations was typically the decade between 1995 and 2004.

This paper tries to create a synthetic view from particular results. During 2004 and 2006 nine papers have been published within the project as either an MNB study or an MNB working paper. The synthesis basically relies on those studies, but other research results are also considered as long as they concern the transmission mechanism.

In the assessment of the overall picture we focus on two particular issues that are of primary interest. The first one is about the effectiveness of the monetary policy. Having an open capital market with predominant presence of foreign investors, interest rates and the exchange rate are strongly influenced by risk preferences and risk assessment of international players. It was sometimes not obvious whether there is an autonomous monetary policy in Hungary that can conduct a policy according to its targets, or it simply tries to neutralise extreme movements caused by international shocks. Hence, we first posed the question, whether it is possible to detect significant effect of monetary policy on key variables.

The second question we try to answer is whether the exchange rate channel dominates the transmission mechanism. Hungarian monetary policy has paid special attention to exchange rate movements and expectations. The belief was that this is the most, if not the only effective channel of transmission. It was observed that tradable goods prices followed closely exchange rate movements and it could pass through to relative incomes, wages and other prices. Should this picture alters significantly, there might be consequences for the monetary policy strategy.

In order to be able to address the above-mentioned issues we need a comprehensive view of the transmission mechanism. We try to synthesise particular results using a scheme that separates two stages of transmission mechanism. At the first stage monetary policy impulses are transmitted by special markets to agents who make decisions on purchasing

and production. To describe the first stage we rely on Mishkin's (1996) classification of different channels of transmission mechanism. He distinguishes between the interest rate, exchange rate, other asset price and credit channels. Each mechanism is based on a particular theory of the effect of monetary policy. We add the expectation channel to the analysis, a mechanism that relates to the transparency and credibility of the monetary policy objective and strategy.

Several studies addressed explicitly this first step within the MTM project. Horváth et al. (2004) (HKN henceforth) investigated how commercial bank rates follow the policy rate. Rezessy (2005) presented estimates of the pass through to government bond yields and equity prices. Kiss and Vadas (2005) provide information about the Hungarian housing market. HKN (2006) posed the question whether credit supply of banks is affected by monetary policy.

The first stage includes the behaviour of the exchange rate as well. Unfortunately, the empirical literature provided so far mainly puzzling result regarding the effect of monetary policy. Although these puzzles were interesting from scientific point of view, for large, closed economic entities like the U.S. or the euro area they were of less importance. Hungary is a small open economy and the exchange rate has played a distinguished role in formulating and communicating monetary policy. Hence, we allocated more resources to this issue than it is usual in the literature of monetary transmission mechanism. Whereas Rezessy (2005) and Karádi (2005) investigated the short term reaction of the exchange rate using high frequency data from the very recent period, Vonnák (2005) obtained estimates for a longer horizon.

After commercial bank interest rates and asset prices accumulated all the information about the stance of monetary policy, economic agents on goods market make their purchase and production decisions. As a next step, we analyze the behaviour of aggregate demand and how aggregate supply responds to changes in demand and costs. As for the demand, we investigate the reaction of private consumption, investment decisions and foreign trade to the monetary policy.

As Barth III and Ramey (2000) emphasize, the transmission picture is not complete without the supply side. They argue that the dynamics of output and inflation cannot be understood if one ignores how monetary policy affects production costs. Hence we finalize

our task by summarizing all the relevant information about the possible supply side effects including the labour market.

The structure of the paper is the following: in section 2 we present the overall picture and put it into an international context highlighting the special features of Hungarian MTM. Section 3 classifies particular results using Mishkin's (1996) approach. In section 4 we investigate aggregate demand. In section 5 we review empirical evidence about how production adjusts. Section 6 concludes.

2. The overall picture

The most important aspect of the transmission mechanism is the way monetary policy can influence inflation and output. Central banks usually have the primary goal to maintain price stability measured by some consumer price index. The volatility of output is also of distinguished concern. In this section we present a bird's eye view of the effect of a Hungarian monetary policy shock. We compare our results for inflation and output to findings for other countries. In the subsequent sections we go beyond the overall picture and try to describe the mechanism in more detail and to explain the special features of Hungarian MTM.

The response of Hungarian consumer prices to an unexpected interest rate increase is shown in Figure 1 borrowed from Jakab et al. (2006; JVV henceforth). There is substantial similarity between the three impulse response functions, each of them coming from a model estimated on Hungarian data. Consumer prices react to monetary tightening by a quick drop. The lower price level seems to persist for several years. In terms of yearly inflation rate, which is the target variable in Hungary, it means that the effect of monetary policy is the largest within the first two years with the peak being somewhere at the end of the first year.

This shape of price response is somewhat different form those found in closed, developed economies like the U.S. or the Euro area. Most SVAR estimates[1] show a slight increase during the first year and prices typically begin to fall only later, but then the decline lasts for several years. Accordingly, yearly inflation rate is higher at the beginning, but later falls

[1] For examples see Christiano et al (1998) and Angeloni et al (2003).

below the baseline persistently. This stands in clear contrast with the Hungarian price dynamics.

The response of Hungarian output is not as clear-cut as in the case of prices. While two models in JVV show a slight decline in real activity after the contractionary shock, SVAR estimates using time series of GDP suggest rather a small although not significant increase. The reason for this is that within the same framework a significantly higher consumption of households is detected that offsets the decline in investments. It should be noted, however, that using the same methodology but industrial production data instead of GDP, Vonnák (2005) estimated a significant drop in industrial output and the magnitude was even higher than those found by the other two models in JVV.

Output response estimates for the U.S. and the Euro area show a much less ambiguous picture. Although there are some studies that could not find significant output response,[2] most results indicate a clear slowdown of the economy after an unexpected monetary tightening. The consensus view fits the basic features of a new-keynesian economy with sticky prices: after the monetary policy action volumes react quicker to the changes of demand and output returns to its natural level only when price adjustment takes place, that is GDP response leads price response.

In the case of Hungary the same new-keynesian model is not able to explain alone what happens after a monetary policy shock. The response of output is quite negligible. The reaction of prices is instantaneous and does not lag behind that of output gap. For Hungary some alternative description of the transmission mechanism is needed. In the following sections we try to identify the special features of Hungarian MTM relying mainly on our fresh results.

3. The channels of monetary transmission

The mechanism through which monetary policy affects the economy can be divided into two steps. In the first step monetary policy influences market interest rates, the exchange rate, asset prices, credit supply of the bank sector and the expectations through its policy rate and communication. Economic agents extract signal transmitted by those markets and

[2] For example Uhlig (2005).

make decisions on their demand for goods and production. The second stage of MTM consists of the reaction of demand as well as the adjustment process of the supply side. In this section we classify results that relate to the first stage of MTM relying first of all on Mishkin (1996) who distinguishes between interest rate, exchange rate, asset price and credit channels. We augment this classification scheme by the expectation channel.

3.1 Interest rate channel

The first stage of the interest rate channel is the mechanism through which policy rate passes through to commercial bank rates, that is to corporate and household deposit and loan rates. The second stage is when households and firms make their consumption and investment decisions in face of new interest rate conditions. We summarize here our findings concerning the first stage which is far simpler than the second.

Monetary policy has the power to determine the very short end of the yield curve by providing or absorbing liquidity with a maturity ranging typically from overnight to two weeks or one month. The rate set by the central bank is the (opportunity) cost of having excess liquidity for commercial banks, and therefore influences money market interest rates of the same maturity very quickly and effectively. In Hungary during the past ten years a short-term deposit rate acted as policy instrument. Up until 1997 its maturity was one month, since then the policy rate is the two-week deposit rate.

According to the expectation hypothesis, longer maturities are linked to the policy rate through expectations on future development of short term rates. For example, if an interest rate hike by the central bank is expected to be temporary, longer term interest rates will not be affected to the extent short term rates change. On the contrary, if market expects higher rates will remain for longer period, long term yields increase more, thereby monetary policy may be more effective.

An important feature of most of our research is that typically 3-month money market or T-bill rates are used as policy rate instead of the central bank's deposit interest rate. The reason for this is twofold. On the one hand, for higher frequency estimation (monthly or more frequent) the policy rate sometimes does not represent the frequent change in monetary policy stance. On the other hand, we can consider 3-month interest rates as embedding more information than the policy rate, since it contains expectations about its movement in the very near future. If, for example, the Monetary Council leaves the base

rate unchanged according to market expectations, but at the same time releases a statement containing tightening bias, 3-month market rates will rise and this reflects a genuine monetary tightening correctly, even in the absence of immediate interest rate move. Nonetheless, at monthly or quarterly frequency the policy rate co-moves with 3-month market rates closely, as it is shown in Figure 2.

For government bond yields and T-bill rates Rezessy (2005) estimated the immediate effect of an unexpected interest rate move on the yield curve. He found significant impact all along the curve. Even the 10-year benchmark yield increases by 10 basispoint after a 100 basispoint surprise policy rate hike on the same day. As long as forward rates reflect interest rate expectations, the reaction of forward rates can be interpreted as the half of the unexpected move is expected to be maintained one year later, and to die out completely by the fifth year.

Although the pass-through from short to longer maturities is found to be satisfactory, it is not necessary for an effective interest rate channel because in Hungary the maturity of loans and deposits are typically shorter than in developed countries. In some cases, like corporate loans, even if the maturity is longer, the interest rate is linked to the 3-month interbank rate rendering it essentially a short term debt with frequent re-pricing.

HKN (2004) investigate the connection between short-term money market rate and commercial bank rates. They detect relatively fast pass through with the adjustment of corporate loan rates being the fastest and most complete, but even the most slowly and least completely reacting consumption loan rates absorb the 80 percent of short term interest rate moves.

From our point of view the relevant finding of these papers is that this first stage of the interest rate channel performs well, it depends on the household and corporate sector whether interest rate movements exert direct influence on aggregate demand. As we will see in section 4, the interest rate channel may be effective through mainly investment decisions.

3.2 Exchange rate channel

The first, and perhaps empirically the most challenging step of the exchange rate channel is the reaction of the exchange rate to interest rate movements. A very simple and in theoretical modelling widely used assumption is uncovered interest rate parity (UIP).

Within the UIP framework risk neutral agents demand excess yield on assets that compensate them from the expected loss caused by depreciation:

$$i_t = i_t^* + E_t s_{t+1} - s_t \qquad (1)$$

where i denotes one period yield, s is the home currency (forint) value of the foreign currency (euro) and * stands for foreign variable.

As in Dornbusch's (1976) model, an unexpected interest rate increase with flat foreign rates causes the spot exchange rate to appreciate and/or the expected future rate to weaken. Unfortunately, statistical methods failed to detect this mechanism[3]. The estimated relationship between interest rate and exchange rate was just the opposite, that is appreciation was more frequently coupled with decreasing interest rate differential.

One possible explanation is the presence of time-varying risk preferences. When the right-hand side of (1) is augmented with a risk premium term, the relationship alters in a way that investors require compensation not only for an expected depreciation, but also for holding domestic assets at all. The latter term can represent, for instance, an exchange rate risk premium if investors are risk averse.

$$i_t = i_t^* + E_t s_{t+1} - s_t + rp_t \qquad (1')$$

It is easy to see that an increase in risk premium (rp) can lead to higher domestic interest rate, to a spot depreciation or can be offset by an appreciation in the future. If risk premium shocks dominate autonomous monetary policy, the observed co-movement between interest rate and exchange rate will be the opposite of the pure UIP case.

For Hungary the model containing time-varying risk premium is certainly the relevant one. During the past decade, since foreign portfolio investors appeared at forint markets, several episodes were recorded when it was obvious that changing risk assessment and preferences caused large swings in the exchange rate. Monetary policy tried to partially neutralise those shocks, otherwise they would have caused undesired movements in consumer prices.

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[3] For a survey see MacDonald and Taylor (1992)

The presence of shocks to risk premium renders measuring the effect of monetary policy to the exchange rate difficult. Relying purely on the correlation between interest rate and exchange rate would lead to a perverse effect, monetary tightening would seem to weaken the currency. Distinguishing between two types of "financial" shock, monetary policy and risk premium shocks, is therefore crucial. Unfortunately, due to its limited relevance for developed economies, this problem has not received much attention in the empirical literature.

Three of our research papers dealt explicitly with the reaction of exchange rate to monetary policy. Rezessy (2005) estimated the immediate impact of monetary policy shocks on exchange rate. He used daily data starting in the middle of 2001 when the intervention band of the forint has been widened and the inflation targeting regime has been introduced. His identification strategy exploited the fact that on rate-setting meetings of the Monetary Council monetary policy shocks are typically larger than on other days. He detected significant effect with the expected sign on the first day, and an even larger effect on the day after rate-setting meeting.

For a longer period, beginning in 1995, Vonnák (2005) estimated the dynamic effect of monetary policy shocks on industrial production, consumer prices, short term interest rate and nominal exchange rate. It is important to note that the response of the exchange rate was in one case part of the identifying assumptions, therefore it cannot be considered as being purely estimated. One identification strategy there assumed that out of all the possible shocks that have only delayed effect on output, monetary policy shock is the only one producing negative correlation between the interest rate and exchange rate (higher interest rates with appreciation). The other identification scheme, however, did not use any presumption about the exchange rate, it was based instead on some historical evidence about Hungarian monetary policy. The response of exchange rate was in each case almost identical, and despite the different data set, comparable to Rezessy's (2005) results. We are therefore quite certain that during the past 5-10 years monetary policy have been able to influence the exchange rate. An unexpected 25 basispoint rate hike on average appreciates the exchange rate almost immediately by 0.5-1 percent.

Karádi (2005) introduce a more sophisticated model of monetary policy and exchange rate. In his set-up there are two channels of affecting the exchange rate by the central bank: one is the traditional interest rate policy, the second one is influencing exchange rate expectations. The relevance of his model is obvious from the characteristics of the

Hungarian monetary policy in the past. During the crawling peg regime the preannounced rate of depreciation anchored expectations. Even later, in the first two years of inflation targeting a target zone of exchange rate was usually announced, which was considered to be consistent with the inflation target.

From (1) it is obvious that with a complete control over exchange rate expectations it is possible to manage the spot exchange rate without changing the policy rate. With constant foreign and home interest rates, one percent change of expected future exchange rate will move the spot rate by the same amount to the same direction. It is therefore possible to tighten monetary conditions simply by announcing a credible exchange rate target, which is stronger than earlier expected. Something similar happened after the widening of the intervention band in May 2001. The measure itself was a clear message for the markets that the MNB would like to see a more appreciated exchange rate in order to bring down the inflation. As a consequence, the forint appreciated by 10 percent within two month without any policy rate hike.

The second step in the exchange rate channel is the relationship between domestic prices and the exchange rate. This link is traditionally viewed as the most important one in Hungary. Monetary policy strategies have been based on the role exchange rate. Being a small open economy, the consensus view has been that exchange rate movements are tracked closely by tradable good prices and affect tradable sector strongly. Hence, the level of the exchange rate, not the interest rate was considered as a proper representation of the monetary policy stance. Although this link of the MTM belongs rather to the second stage as it works through goods supply and demand, here we review briefly the most important findings for Hungary.

There is a branch of papers in the literature investigating how exchange rate changes passes through to domestic nominal variables. From our point of view, most of the results are only partly informative, since we restrict our attention to exchange rate movements that are generated by monetary policy. Pass-through coefficient estimates are usually not conditioned to a specific shock, therefore they can be considered as an average across all possible sources of shocks with weights proportional to the importance, or frequency of that particular shock, as it is stressed in Bouakez and Rebei (2005).

In order to highlight this issue let us consider the case of changing risk premium again. In several cases Hungarian monetary policy has been successful in preventing the real

economy from being affected by risk premium shocks. It achieved this by quickly reverting exchange rate movements induced by sudden shifts in risk assessment of foreign investors. As a result, these shocks have had virtually no effect on output and prices. In contrast with this, autonomous monetary policy had persistent effect on the exchange rate, and therefore consumer prices also reacted in medium term. Intuitively, after an exchange rate change economic agent are more or less aware of the nature of the shock, and they reset their prices only if they do not expect the exchange rate to return to its previous level quickly.

To our knowledge, two papers have attempted so far to estimate the Hungarian exchange rate pass-through or describe its main features. Darvas (2001) applied an equilibrium real exchange rate framework. He modelled price and exchange rate dynamics in a two-equation system, and estimated time-varying parameters for Hungary, Czech Republic, Poland and Slovenia. He found that long run exchange rate pass-through was high in Hungary compared to the other three countries during the years of the crawling peg regime.

Jakab and Kovács (2003) investigate the role of expectations, goods market and labour market in the exchange rate pass-through. Simulating with the Hungarian block of the NIGEM model they conclude that during the first 1-2 years after an exchange rate movement the pass-through mainly depends on the pricing elasticity to cost changes and the role expectations play in price and wage-setting. From the third year onwards the mark-up elasticity becomes dominant. Labour market characteristics, namely the elasticity of wages to unemployment and productivity are important only on longer run, roughly after 5 years after the shock.

Our project has not included any research with the sole aim to obtain fresh estimates for the pass-through. Nevertheless, for the understanding of consumption and investment decision JVV could not escape from dealing with exchange rate pass-through when appreciation or depreciation occurs because of the monetary policy. Using information of three empirical macromodels they concluded that pass-through to tradable good prices is immediate and almost complete, but it is slow to prices of non-tradable goods. The pass-through to overall consumer prices seems to be gradual.

Finally, Kovács (2005) gives a very informative insight into the effect of exchange rate depreciations on the real economy using the experiences of the austerity package of finance minister Bokros Lajos in 1995. One central element of that package was the surprise

devaluation of the forint by 9% which serves as an excellent example to investigate some aspects of the exchange rate channel. His main conclusions concerning the external equilibrium were the following: (1) the profitability of the corporate sector was not significantly affected by the devaluation; (2) the position of the household sector deteriorated because of the negative income effect of the surprise inflation; (3) the success of the package hinged primarily on the fiscal policy, especially on the fact that the inflating the expenditure side of the budget was not followed by a correction, so there was a persistent improvement in real terms on the expenditure side.

3.3 Asset price channel

According to the monetarist or Keynesian theories, after a monetary contraction asset prices decline. Higher interest rate results in higher yield expected from bonds decreasing bond prices. Stock prices also fall. The loss of property value can be also important as households' consumption spending might be affected through house equity withdrawal.

Mishkin (1996) explains the asset price channel focusing on the stock prices. The first example he cites is Tobin's *q* theory of investment (Tobin, 1969). When equities are cheap relative to the replacement cost of capital, firms do not want to issue new equities in order to buy investment goods, therefore investments decline. The second channel works through households' consumption. Lower equity prices reduce households' wealth and they consume less.

In Hungary there are at least two reasons for considering stock price channel as irrelevant. First, there is no empirical evidence that monetary policy affects stock prices. We have estimates only the instantaneous impact of monetary policy decisions on the Hungarian stock market index (BUX). Rezessy's (2005) found no effect which is in contrast with Rigobon and Sack (2004) who detected significant decrease in major U.S. stock market indices after an unexpected tightening. Taking into account the ability of stock markets to absorb news quickly, it is hard to imagine that monetary policy shocks have only delayed effect on equity prices.

Second, shares play minor role in Hungarian households' financial wealth. They amounted typically roughly to the 10 percent of all financial assets during the past ten years. The same is true for other securities, like government bonds. Their amount has never exceeded ten percent of total assets. Even households' financial wealth itself is not as large as usual in

more developed countries. At the end of 2004 total financial assets excluding items that are not supposed to play role in the asset price channel (cash, deposits, insurance technical reserves) amounted to 40 percent of annual GDP (see Figure 3).

Housing wealth may play a more important role in asset price channel, as their market value is more than three times larger than households' financial assets. Kiss and Vadas (2005) estimated the effect of an interest rate increase on house prices. They then fed the results into the consumption function of the MNB's quarterly projection model.[4] It is important to emphasise that they obtained an estimate that combines the asset price channel with the credit channel, as the consumption function cannot distinguish between the two mechanisms. They detected significant effect of interest rate on private consumption and housing investments through house prices. However, if we compare it to other macro level estimates like JVV or Vonnák (2005) and take into account the relative size of the interest rate shock[5], we can conclude that even the housing market is incapable to explain the effect of monetary policy.

3.4 Credit channel

The role of credit supply in magnifying the effect monetary policy is discussed in details among others in Bernanke et al. (1995). The basic idea is that monetary tightening leads to higher external finance premium stemming from imperfections on credit market, such as principal-agent problem. They argue that the conventional cost-of-capital effect fails to explain the size, timing and the composition of the observed response of spending on durable goods. The additional mechanism called credit channel should not be imagined as a stand-alone mechanism but rather as an amplifier of the conventional way interest rate exerts its effect. It works in the same direction: a monetary contraction not only reduces demand for durables, it also decreases loan supply.

The authors distinguish between bank lending channel and balance sheet channel. The former concept rests on the assumption that a monetary contraction drains loanable fund

[4] A non-technical summary of the model is available on the MNB's website (Jakab et al, 2004).

[5] Kiss and Vadas (2005) assumed a permanent 1 percentage point increase in interest rate and they got 0.3 and 1 percent deviation of consumption and housing investments from the baseline. In JVV a much smaller interest rate shock (0.4 percentage point increase in the first quarter, shrinking to 0.1 by the end of the year) resulted in a 0.1-0.2 percent response of GDP components.

from the banking sector. Commercial banks can raise new funds only at higher price by issuing certificates of deposits or equity. The balance sheet channel is related to the financial accelerator phenomenon. Changes in interest rate affect the net worth of a firm through its cash-flow and the value of collateral. Higher interest rates thus lead to lower net worth and higher external finance premium.

Stylised facts about the Hungarian economy suggest that even if there exists a credit channel, its contribution to the transmission mechanism may not be highly significant. Large part of commercial banks as well as the non-financial corporate sector is owned by large foreign companies. Loans from the parent company is available for numbers of domestic firms at normal price even if the monetary policy is tight in Hungary, as either these loans are in fact internal financing at firm level or the cost of raising additional funds from external sources is not affected by Hungarian monetary policy. The same argument but to a limited extent also applies to Hungarian commercial banks owned mainly by foreign banks.

Regarding the estimation, Kashyap and Stein (1995) argue that the easiest way to test for the existence of credit channel is to use cross-section estimates. In this way one can identify credit supply effect that is independent of the demand side. The idea is that certain banks and firms, typically the smaller ones suffer more from higher external premium. HKN (2006) tested whether the existence of cross-bank asymmetries in lending activity can be rejected in Hungary. They estimated several credit supply equation on a panel of 25 commercial banks during the period of 1995 to 2004. They related banks' ability to raise new funds to their size, liquidity, capitalization and foreign ownership. In the regression they also controlled for GDP growth, inflation, exchange rate and foreign interest rate. Using several specifications they could not reject the null hypothesis that the effect of the monetary policy is magnified by the bank lending channel.

As for the balance sheet channel we have no research at hand dedicated exclusively to that phenomenon. However, there is some indirect evidence. Kátay and Wolf (2004) estimated an investment equation on a large panel of non-financial firms. In their specification the investment depended on the user cost of capital, sales revenues and the cash-flow. They found that the latter had significantly non-zero effect on investment spending. Although there may exist several channels through which cash-flow can influence investments, one plausible candidate is the external finance premium, that is the balance sheet channel.

Taking into account the ownership structure of Hungarian banking and corporate sector, as well as the results of HKN (2006) and Kátay and Wolf (2004) we arrive at the conclusion that although empirical evidence points towards the existence of the credit channel, for structural reasons we do not consider it to be a crucial ingredient in the transmission mechanism.

3.5 Expectations

In a simple model with a Taylor-type monetary policy rule the long term or steady state inflation is determined by the target of the central bank. Forward looking and rational agents in this model-world anchor their interest rate expectations to the known policy rule, their long run inflation expectations to the known target. If a shock occurs, the monetary policy responds to it according its rule and no one doubts that all the variables, including inflation will return to the steady-state value. As a consequence of forward-lookingness, the effect of the shock is mitigated by the public expectations as well. Similarly, if the central bank changes its target and announces it, expectations may help the interest rate policy to achieve the new goal, as long as perfect credibility is assumed. In the model-world the expectation channel has more to do with the policy rule rather than with policy shocks.

In the real world it is usually the case that either the target is not explicit or is not believed by the public (credibility problem). The central bank may want to signal that his target is below or above the current or forecasted level of the inflation. He can do it by communication or in the absence of credibility, by demonstrative, unexpected changes of its instrument. Monetary policy shocks can be thus useful to send messages about the preference of monetary policy and to gain credibility, to signal commitment. In the reality and particularly when policy preferences are changing the expectation channel is related more to monetary policy surprises than systematic policy.

The role of monetary policy in coordinating expectations is most obvious in price and wage-setting, the two mechanisms that play crucial role in new-keynesian theories of monetary transmission. The higher the credibility of the monetary policy, the lower the real cost of disinflation, that is the sacrifice ratio depends heavily on the expectation channel. With more flexible nominal wages, production can be adjusted to changes in real demand without minor changes in employment, therefore the short-run supply curve is more vertical than in the rigid-wage case.

An important example for the way expectations determine price-setting is the so-called Taylor-hypothesis. Taylor (2000) investigates the observed low pass-through of cost shocks to consumer prices. He relates the phenomenon to the low inflation and low nominal volatility environment arguing that when setting their prices, producers do not follow closely input prices as changes in the latter are expected to be short-lived due to the nominal stability established by the monetary policy.

Expectations also play role in some of the earlier-analysed channels, especially in the response of asset prices including the exchange rate. The way interest rate steps affect the entire yield curve is determined mainly by what market participants think of the future course and the effectiveness of monetary policy. The reaction of exchange rate as well as other asset prices is also crucially dominated by the assessment of monetary policy.

Unfortunately, we have limited knowledge about price- and wage-setting in Hungary and how it has been changing over time. As for pricing behaviour, Tóth and Vincze (1998) and Tóth (2004) report the results of a survey in which Hungarian private companies were asked about their pricing practice in 1998 and 2001. In 1998 the typical frequency of price reviews was lower in Hungary than that was found in the UK by a similar survey reported in Hall et al (1997). In an environment of higher inflation one would expect more frequent re-optimising of prices, yet, whereas a typical Hungarian firm reviewed it quarterly in the UK respondents chose monthly frequency. Another counterintuitive result was that in the 2001 Hungarian survey the pattern became more similar to the UK pricing practice despite the fact that the Hungarian inflation had been decreasing between 1998 and 2001 even if not very dramatically (from 14-15% to 10%). However, the responses regarding the reasons for price-changing suggest that the cost channel is stronger than the expectations channel in relation to price-setting. We will come back to these surveys in Section 5.

We know even less about the Hungarian labour market. Pula (2005) gives a comprehensive description of the flexibility of Hungarian labour market. He claims that in Hungary the bargaining power of trade unions and employees are weak compared to other EU-members. On the other hand, JVV found that nominal wages are rigid. After a monetary policy shock it takes at least one year until nominal wages are modified according to the new path of prices. Putting these two observations together we can conclude that the most likely reason for wage stickiness is the backward-looking nature of wage-setting.

Some results related to other channels bear information about the expectations. One possible explanation of the findings of Rezessy (2005), namely that long term forward interest rates decrease after an unexpected rate hike is that market participants believed in the success of monetary policy. Interest rate policy served to some extent as a channel for signalling long term monetary policy preferences.

Karádi's (2005) exchange rate model incorporates public expectations about central bank exchange rate preference. His results show that communication was effective in coordinating market participants' exchange rate expectations and it helped exert influence on spot rate, too. These two examples highlight the importance of expectations of agents on financial markets.

Our overall impression is that while financial market were supportive and expectations made policy more effective, expectations of price and wage-setters has not been anchored by the goals of monetary policy. Nevertheless, the latter fact is quite natural taking into account that the monetary policy in our sample period can be best characterised as shifting gradually from a more external-position-oriented regime towards a price-stability-oriented one and gaining credibility for the new objectives takes time.

4. Demand

In basic models of MTM, production is affected by monetary policy mainly through the demand channel, as it is explained in Ireland (2005). According to the new-keynesian view, changes in demand first influence output with prices adjusting only with some delay. The mechanism is the following: tighter (looser) monetary policy reduces (expands) demand for real goods to which firms first respond by temporarily decrease (increase) their output, as re-pricing is costly and thus can be made only later. Lower demand without price adjustment results in output level and marginal costs lower (higher) than natural. As time goes, firms are allowed to modify their sticky prices according to the altered environment and whey cut (lift) their prices. Lower (higher) prices stimulate (calm down) demand and production will return to its natural level. This mechanism can be labelled as the output gap, or demand channel.

As for Hungary, there is some empirical evidence of such new-keynesian pattern in the demand channel. Tóth and Vincze (1998) digest the results of a survey taken among Hungarian private companies in 1998. Tóth (2004) evaluates how the picture has changed

relying on a 2001 survey. One of the questions in both surveys was the ordering of possible responses to a change in demand. Firms typically ranked steps like adjusting hours worked and employment or changing capacity before re-pricing. Their finding is in accordance with the result of a similar survey in the UK in 1995 (Hall et al 1997).

In this section we review what we have learned about the behaviour of some key components of aggregate demand, namely, consumption, investment and net export. For this section JVV is our starting point. Using three different macromodels they show that significant effect of monetary policy can be detected in the case of investments and to a lesser extent for consumption. In the following we survey the relevant literature and check how their findings fit existing evidence. At the end of the section we connect the demand components to the individual channel of the transmission.

4.1 Consumption

Investigating the transmission mechanism within an SVAR framework, Angeloni et al (2003) found that while in the U.S. households' consumption dominates the response of output to monetary policy shocks, in the eurozone the contribution of investments is more important. Nevertheless, the sign of impulse responses are intuitive in both economies, namely, after an unexpected tightening both the consumption and investments drop.

In contrast with the eurozone and the U.S., two out of three models in JVV indicated that in Hungary consumption typically increases after monetary contraction. This finding may appear to be counterintuitive especially when one takes into account the results of Kiss and Vadas (2005) who detected significant consumption effect of monetary policy through the housing market.

Nevertheless, there are some empirical studies as well as theoretical ones that suggest this type of consumption response is plausible. Theoretically, the main reason for rising consumption after monetary tightening can be that the appreciation of the currency increases the wealth of households. Households then may spend their excess revenue stemming from higher purchasing power of their wealth to either tradable or non-tradable goods depending on the income elasticities of both. Benczúr (2004) shows in a two-sector dynamic growth model how a nominal appreciation can stimulate consumption.

Van Els et al. (2001) compare the main characteristics of MTM in eurozone members using country models. In four out of the twelve countries consumption is above the baseline

during a couple of years after a tightening monetary shock. In Belgium and Italy the authors attribute rising consumption to the net creditorship of households. In the case of Finland their explanation is in line with Benczúr (2003) claiming that the pure exchange rate channel dominates. In the German model prices fall faster than nominal wages raising real wages and thereby consumer spending.

JVV explain the reaction of consumption by the stickiness of nominal wages and relatively quick exchange rate pass-through. Their argument is that non-tradable prices respond to monetary policy quickly because they track exchange rate movements closely. Since the short-term reaction of no-tradable prices are virtually neutral, overall price level declines already during the first year. Contrary to prices, nominal wages remain unchanged for almost two years meaning that real wages rise. The income effect suppresses other mechanism, like asset price changes etc. leading to higher level of consumption.

It is important to stress that the evidence of this kind of consumption response is not strong enough. Although SVAR estimates in JVV were significantly different from zero, one out of the three models, namely the 5GAP provided the opposite response. Moreover, the identification of the effect of monetary policy is complicated by the fact that the appreciation of the forint after the widening of the intervention band, coincided with several fiscal measures aimed at stimulating private consumption. Since the band widening in 2001 can be regarded as probably the biggest unexpected monetary tightening during the past ten years[6], statistical methods that do not control for fiscal policy may fail to separate the two effects. Nevertheless, JVV explanation of higher consumption after monetary contraction is in line with Jakab and Vadas (2001) who found that wages are far the most important explanatory variable for consumption and they could not detect significant role for interest rates.

To sum up and putting these finding into Mishkin's framework we can conclude that there are some signs that after a monetary tightening private consumption rise in Hungary. The reason is the relatively quick exchange rate pass-through and a slower nominal wage adjustment. Our interpretation is that the exchange rate channel dominates interest rate, asset price and other channels concerning the behaviour of Hungarian households.

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[6] Actually, one of the identification schemes of Vonnák (2005) was based on that assumption and proved to be equivalent to a completely different approach.

4.2 Investments

JVV found that the reaction of investment spending is the most robust ingredient of the demand effect of unexpected monetary policy. Hence, to form an overall picture about the monetary transmission mechanism, it is crucial that we understand the mechanism through which firms' investment decisions are affected.

Kátay and Wolf (2004, KW henceforth) give us a deeper insight into the investment behaviour of Hungarian firms. They estimated an investment function using large number of observations of firm level balance sheet data obtained from the APEH database. The main advantage of their approach over aggregate time series techniques is the high degree of freedom from cross-section.

Most importantly, they found a significant reaction of investments to changes in user cost, which reinforces the finding of JVV. In order to compare the results of both papers, we simulated the investment behaviour by the KW. We treated all the right hand side variables as exogenous. Giving a one-period temporary shock to the user cost and keeping other explanatory variables constant we obtained an impulse response of investments. Two out of the three specifications showed a pattern that was very similar to macro estimates, namely, after a marked instantaneous fall in the first year investments return quickly to the baseline. The third specification also indicated a quick reaction, but it was followed by an oscillating dynamics.

Of course there are serious limitations of translating KW's result to macro level. The first problem comes from the cross section heterogeneity. The obtained impulse response is valid at aggregate level only as long as there is no considerable heterogeneity between firms with regard to their investment function, particularly the user cost elasticity.

The second challenge is the missing link between the instrument of monetary policy (in Hungary it is the two-week deposit rate) and the user cost. The specification they used relates investments to the user cost, which consists of expected return on equity, bank lending rates among others. Obviously, monetary policy has no control over these factors. In order to assess the impact of monetary policy on investments, we need to know the relationship between policy rate and user cost, but, unfortunately, we have no empirical evidence.

The third difficulty to overcome is that they estimated only one dynamic equation in which investment spending are explained by the user cost, sales and cash flow. Even if we treat user cost as exogenous, which is also a questionable assumption in itself, cash flow and sales depend apparently on past investments, therefore, for the calculation of the dynamic effect of user cost additional relationships would be necessary.

Finally, monetary policy can affect firms' cash flow and sales through channels other than investments. The adequate exercise would be therefore to simulate the effect of policy instrument on user cost, cash flow and sales, calculate the response of investments to these variables, taking into account that lagged investment changes also influence cash flow and output. The simulated firm level behaviour needs then a proper aggregation technique.

Using the same database as KW, Reiff (2006) estimated on firm-level an investment model for Hungarian corporate sector in which firms face three types of adjustment costs: the standard convex cost, a fixed cost and an irreversibility cost. Using the estimated model he was then able to analyze at both aggregate and firm-level how investments respond to a so-called profitability shock. In line with KW and JVV he finds that firms react immediately by reducing investment spending after profitability falls. His findings are informative also from the MTM point of view as there are substantial similarities between monetary policy and profitability shocks and he solves the aggregation problem as well.

Despite all the shortcomings mentioned above, the high degree of similarity between impulse responses from micro- and macroestimates make us believe that those results reinforce each other and – similarly to the eurozone – investments are key ingredients of the demand effect of monetary policy. As we will show in the next subsection, the demand for investment goods may help keeping foreign trade balanced despite the strong exchange rate response.

Noteworthy to mention that although the cost-of-capital channel is usually counted to the classical interest rate channel, the role of exchange rate in investment decisions may be important, as JVV emphasize. Since investment goods are typically tradables, their price move closely together with the exchange rate. The cost of capital includes the (expected) inflation of investment goods in a way that declining prices mean higher costs as postponing investment spending pays-off. Their conclusion is that although the existing evidence is insufficient to separate exchange-rate effect from direct interest rate effect, the response of investments is likely to be affected through both channels.

4.3 Net exports

The third main component of output investigated by JVV is net exports. The results from the three models they used were less conclusive than for private consumption and investments and the authors concluded that they could not detect any significant effect of monetary policy. Only one model predicted considerable deteriorating of trade balance after an unexpected monetary tightening, the other two suggested rather a balanced path but with substantial uncertainty.

Looking at exports and imports separately it becomes obvious that while the models indicate similar response of exports, it is the reaction of imports that is responsible for diverging results. All three models predict a sizable drop in exports after a monetary tightening. Export prices also decline quickly suggesting that the export sector reacts flexibly to changes in demand. The lack of price stickiness can be understood taking into account the strong competition on international goods markets.

There is, however, much less agreement among models on how import reacts to monetary policy. According to the quarterly projection model of the MNB, imports rise after a tightening. Contrary to that, the other two models used in the referred paper predict declining imports that can explain the rather balanced net export response they obtained.

There might be several plausible explanations for the insignificant net export response, and the ambiguous import response. According to Kim (20001), after an appreciation expenditure-switching results in less exports and more imports, due to change in their relative price. The observed behaviour of Hungarian consumption itself would imply higher import demand. On the other hand, contractionary monetary policy may reduce imports through lowering domestic demand, that is through income-absorption. In Hungary the significant drop in investments and exports may easily offset the additional import effect of higher consumption, because of their high import content.

To conclude, foreign trade is probably affected by monetary policy in several ways. First of all, exchange rate changes cause quick response of exports both in volumes and prices. Secondly, changes in investments and consumption as well as exports influence imports. It seems that the import demand from investments and exports dominate imports, therefore income-absorption effect offsets expenditure-switching implying that no significant net export reaction can be detected by econometric methods.

4.4 How individual channels of transmission influence demand for real goods?

In this subsection we combine the findings on particular channels of transmission with those regarding demand. Of course, not all channels can be associated with all components of demand; for example, we have no idea how credit supply asymmetries could affect net export. In other cases the interpretation is not straightforward. This is especially true for the exchange rate channel with regard to consumption and investments. There are also cases that are not covered by our research project. Nevertheless, using this two-dimensional grid, we can arrange our results in a way that can help to assess relative importance of the particular mechanisms.

We simplify the assessment procedure by disregarding the errors of particular estimates. We do it not only for the sake of ease but also because in some cases there are no confidence bands reported or they do not contain all sources of uncertainty rendering exact meta-level inference almost impossible. Of course, using only the point estimates or the most probable outcome may lead to wrong conclusions[7]. Nevertheless, we do not deem this problem to be too relevant to invalidate our findings.

The following matrix depicts the overall picture about the Hungarian monetary transmission mechanism formed in the light of the most up-to-date empirical results. The table assesses whether the first stage of different channels operates efficiently, and reports our best guess how components of aggregate demand respond to an unexpected monetary tightening. Although expectations as well as the cost channel are probably important ingredients of the transmission mechanism, we omit these aspects from the table due to the fact that they are beyond the scope of our research project.

[7] For instance, let us suppose that one effect is estimated with high error and therefore can not be distinguished from zero, while the other is significantly non-zero but the point estimate is small compared to the error of the first effect estimates. In that case concluding that the second effect dominates the first one with high probability is statistically incorrect

Mishkin's channels		Effect on demand		
Name	Relevance	Consumption	Investments	Net exports
Interest rate	efficient	0	−	
Exchange rate	efficient	+		0
Asset price	not bad	0	0	
Credit channel	may exist	?	?	

We denoted by plus or minus signs if significant increase or decrease after a monetary contraction is found. In the case of consumption we used small mark because the statistical evidence is not very strong. Zeros indicate if we could not detect the presence of that particular mechanism. Perhaps it is important to stress, as mentioned above, that this can mean either no effect or the weakness of our measurement process. Question marks denote areas we have no empirical results for, or we cannot assess the magnitude of that effect. Shaded cells indicate that we cannot assign sensible content to that area.

According to the matrix, the Hungarian monetary transmission mechanism through the demand side could be described roughly as follows: the monetary policy affects aggregate demand first of all through investment decisions. Investments may be sensitive to the interest rates as well as exchange rate movements caused by the monetary policy. Private consumption reacts into the opposite direction driven by income effect which is actually another aspect of the exchange rate channel. Although other channels might be also important, we have either no corresponding research or statistical evidence for that.

5. Supply

Barth III and Ramey (2000) argue that the way monetary policy affects firms through their production cost might be as important as the standard output gap channel. They focus on the interest expenses and claim that the cost channel can explain why empirical estimates fail to detect declining prices after a monetary contraction. In their argument interest rate matters because firms have to pay factors before they receive revenues from sales and therefore they borrow to finance these payments.

Beyond the interest rate expenses the factor prices also influence firms' profit. McCallum and Nelson (2001) present an open-economy model in which imports are treated not as finished goods but rather as raw-material inputs to domestic production. Hence, exchange rate movements affect production costs directly through the price of intermediate goods.

They show that their model produced a relationship between exchange rate and inflation that is closer to empirical evidence.

Taking into account the fast reaction of exchange rate to monetary policy impulses in Hungary, in highly competitive sectors using imported inputs prices may respond almost instantaneously. Beyond the effect of price competitiveness, one additional factor behind quick price reaction of export sector may be that they use substantial amount of raw materials, and since import prices correlate strongly with exchange rate, lower costs after an appreciation gives room to cut prices.

We have only little empirical evidence on how production costs affect output volumes and prices. Although our project has not covered supply side, we can invoke other studies. As Tóth and Vincze (1998) report, the two most important reasons for changing their prices, Hungarian companies in a survey refer to change in "fuel, raw material, accessories price" or in "the exchange rate". On the other hand, demand and productivity are ranked among least important determinants of pricing. This observation suggests that the cost channel may be relevant in Hungary.

Kovács (2005) investigates the effect of the austerity package in 1995 that contained a 9 percent surprise devaluation of the forint. Although the package contained several other measures that could also influence corporate sector's profitability, some tentative conclusions can be drawn from that experience. He demonstrates that firms' profit did not significantly improve after the appreciation in 1995-1996. The reason is that while surprise inflation decreased real wages, material related expenses grew considerably at the same time, rendering the total effect nearly neutral. The neutralizing role of material costs was particularly important for firms producing for export. After the nominal appreciation in 2001-2002 similar story but with opposite sign can be read from firm level data. Kovács (2005) makes the general statement that in Hungary corporate sector's profitability is mainly determined by foreign trade partners' business cycle and the role of real exchange rate is negligible.

Finally, labour market developments also affect firms' profit. Similarly to other determinants of cost channel, we do not know much about how Hungarian labour market reacts to monetary policy. Relying on several microestimates, Pula (2005) concludes that the flexibility of the Hungarian labour market is at least as satisfactory as in other EU-member states. From our point of view, the problem with those microstudies is that the

referred authors estimated elasticity of real wages in relation to productivity and unemployment, and that of employment to real wages in general, that is irrespectively of the source of the shock.

JVV present wage responses to a monetary policy shock. Nominal wages tend to react only after one year later than the shock occurs, which is not an extremely sticky wage-setting, but taking into account the relatively quick exchange rate pass-through to consumer prices, results in significant changes in real wages.

Figure 4 presents impulse responses from an SVAR similar to those used in JVV. As in JVV, nominal wages decline slower than consumer prices after a monetary contraction. Real wages, therefore, increase significantly for two years. On the other hand, employment drops quickly and begins to return to the baseline as early as in the second year. Probably it is the higher unemployment rate that promotes the nominal wages to adjust. According to the SVAR estimates, firms respond to higher wage costs by cutting jobs. Lower employment then pushes wages down allowing firms to keep prices low even 3-4 years after the monetary shock. This finding is in line with Jakab and Kovács (2003) who found that several years after an exchange rate shock pass-through depends on labour market developments.

Our conclusion regarding the supply-side effects of monetary policy is the following: although a monetary contraction raises real wages, costs of other inputs that are affected by exchange rate probably offset it. In the medium run, 3-4 years after the shock, nominal wage adjustment prevents prices to return to their original level.

6. Conclusion and future trends

In this paper we reviewed the fresh results of nine studies made under the umbrella of the Hungarian MTM project. Relying on other studies as well, we created a synthesis from particular findings.

Our overall picture about how monetary policy works in Hungary can be summarized as follows: consumer prices are affected immediately in the first year after the monetary policy has increased its policy rate. The price response is persistent, as it remains lower for several years. On the other hand, output reacts only marginally. The reason for this on the demand side may be that while investment drops significantly after a monetary tightening,

consumption seems to increase offsetting more or less the demand effect of decreasing investment spending.

The output and price dynamics differ significantly from that found for large, developed economies. Empirical estimates for US and eurozone monetary transmission mechanism suggest that in those economies output reacts first and significantly, and consumer prices are adjusted only with substantial lag.

We attribute the difference first of all to the central role exchange rate plays in the Hungarian monetary transmission mechanism for several reasons. First, due to openness, exchange rate movements pass through to tradable prices quickly. Second, cost channel, often referred to as a plausible explanation for delayed price response, works in both directions in Hungary, as higher interest and staff related expenses are offset by lower investment and intermediate goods prices. Third, the output effect is mitigated by households' higher consumption which is another aspect of the exchange rate channel.

Being an EU-member country, Hungary is expected to adopt the common European currency as soon as it meets the Maastricht criteria. With the adoption of the euro, the most important channel of transmission will disappear. This raises the question, whether it is optimal for Hungary to join the eurozone running the risk that the economy will remain without effective monetary policy that could smooth shocks. As Orbán and Szalai (2005) point out, after euro adoption the scope of the interest rate channel will broaden as monetary policy shocks will then influence Hungarian economy through foreign demand as well. They conclude that the differences between Hungarian MTM and those of present eurozone-member countries will not be so important that asymmetric response to common monetary policy and real divergence in the eurozone could be expected.

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Figures

Figure 1: CPI responses to an unexpected rate hike (NEM and 5GAP model simulations from JVV, SVAR estimates from Vonnák 2005)

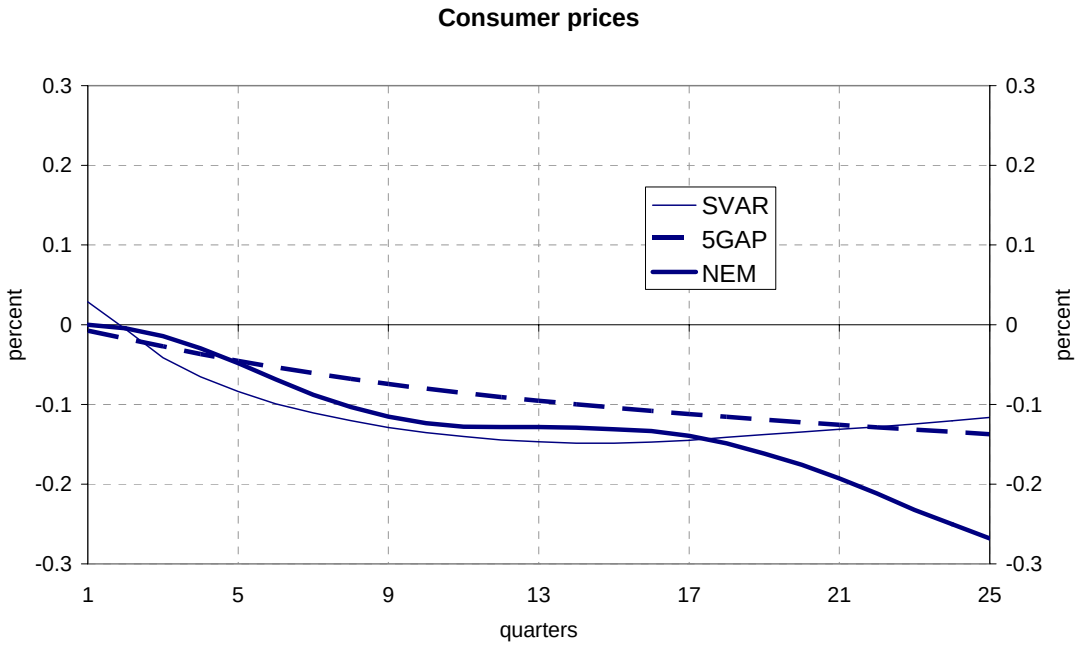

Figure 2: 3-month money market, T-bill rates and the policy rate

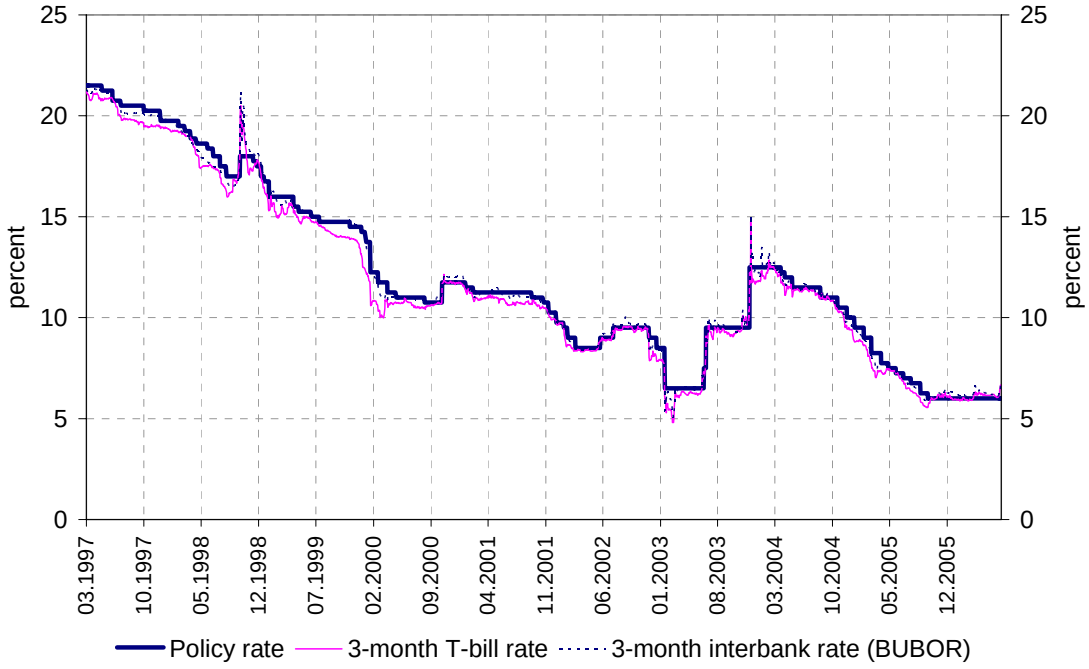

Figure 3: Households' wealth as a percentage of GDP

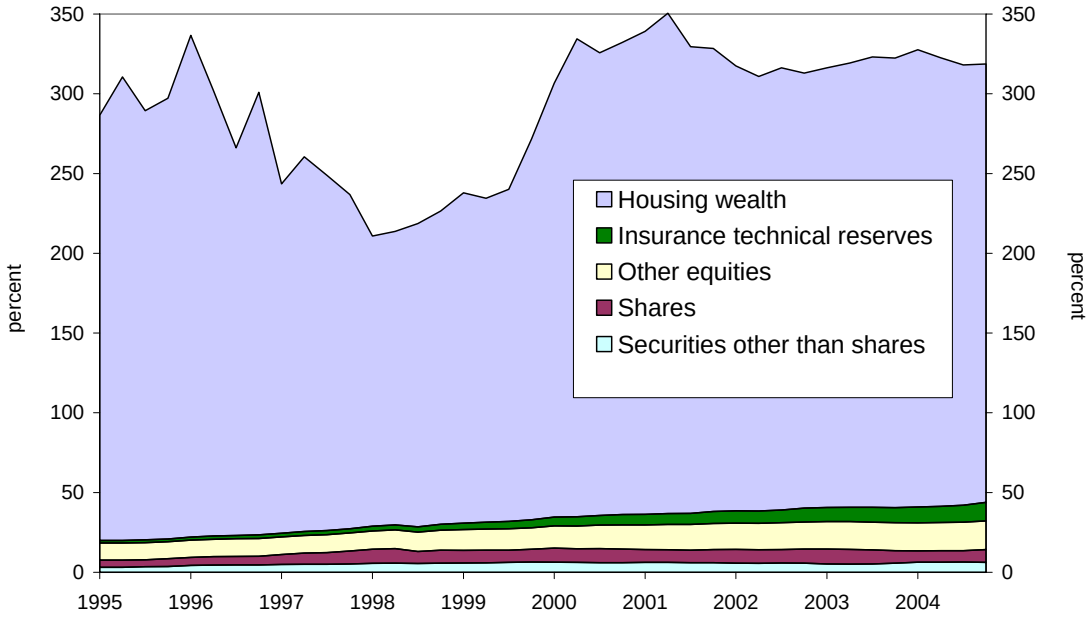

Figure 4: Response of employment and private sector wages to an unexpected rate hike (SVAR estimates)